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DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT—INDEPENDENT AGENCIES APPROPRIATIONS FOR 1981

DOCUMENTS

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HEARINGS

BEFORE A

SUBCOMMITTEE OF THE

COMMITTEE ON APPROPRIATIONS

HOUSE OF REPRESENTATIVES

NINETY-SIXTH CONGRESS

SECOND SESSION

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PART 4

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Printed for the use of the Committee on Appropriations

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U.S. GOVERNMENT PRINTING OFFICE

57-166 WASHINGTON : 1980

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DEPARTMENT OF HOUSING AND URBAN DEVELOPMENT—INDEPENDENT AGENCIES APPROPRIATIONS FOR FISCAL YEAR 1980

WEDNESDAY, NOVEMBER 28, 1979.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WITNESSES

DR. ROBERT A. FROSCH, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE

WILLIAM E. LILLY, ASSOCIATE ADMINISTRATOR/COMPTROLLER

DR. THOMAS A. MUTCH, ASSOCIATE ADMINISTRATOR, OFFICE OF SPACE SCIENCE

Mr. BOLAND. The Committee will come to order.

We are delighted to have with us today Dr. Frosh and Dr. Mutch and Bill Lilly. Dr. Mutch is the new Associate Administrator for Space Science, replacing Dr. Noel Hinners, who is at the Space Museum. We have a biographical sketch of Dr. Mutch and we will place that in the record at this time.

[The information follows:]

BIOGRAPHICAL DATA OF DR. THOMAS A. MUTCH, ASSOCIATE ADMINISTRATOR FOR SPACE SCIENCE

Dr. Thomas A. Mutch became NASA's Associate Administrator for Space Science July 1, 1979. He is responsible for the planning, direction, execution and evaluation of the overall NASA space science program.

Mutch was born in Rochester, N.Y., in 1931. He received his B.A. in history from Princeton University, Princeton, N.J., in 1952, his M.S. in geology from Rutgers University, New Brunswick, N.J., in 1957, and his Ph.D. in geology from Princeton in 1960. He served as a U.S. Army lieutenant from 1952 to 1954.

Until his NASA appointment, Mutch had spent 19 years with the Geological Sciences Department of Brown University, Providence, R.I.

Since 1969 he has made major contributions to NASA space science programs. He was a member of the Lunar Science Review Board from 1969 to 1973, leader of the Viking Lander Imaging Science Team from 1969 to 1977, and he chaired several NASA Committees planning the post-Viking exploration of Mars.

While at Brown University, Mutch taught geological science, first as an assistant professor from 1960 to 1965, then as an associate professor from 1965 to 1970, and finally as a professor from 1970 until joining NASA.

From 1964 to 1965 he was assistant to the Dean, and from 1965 to 1967 served as Associate Dean of the Graduate School. He chaired the Department of Geological Sciences from 1968 to 1971.

Mutch was awarded NASA's medal for exceptional scientific achievement in 1977. He received the agency's Group Achievement Award three times for his work on the Lunar Science Team, the Viking Science Steering Group, and the Viking Undergraduate Intern Program.

The American Association for the Advancement of Science (AAAS) awarded its Cleveland-Newcomb Award jointly to Mutch and all Viking scientists in 1977. He is

a member of the association and became a fellow of the Geological Society of America in 1973.

He has written or coauthored some 30 professional papers and books on a broad range of terrestrial and extraterrestial geology.

Mutch is married to the former Madeline Maurer of Baldwin, N.Y. They have three daughters and reside in Kensington, Md.

EXISTING REPROGRAMMING PROCEDURE

Mr. BOLAND. Before we get into the hearings, I have a few opening remarks that I am sure you are all familiar with, that touch on the reason for this hearing. The reason I say you are all familiar with these remarks is because we have been over this ground before, and you know what the position of this Committee has been with reference to some of the matters that NASA has before us.

I want to express some of the concerns that this Committee has with the existing reprogramming procedure.

We are here today because the shuttle is not capable of supporting the Galileo mission on the original launch schedule of January, 1982. I might also say parenthetically that the first we heard of that problem was when the staff read about it in *The Washington Post,* which does give us some concern.

In order to correct that particular problem, NASA is proposing splitting the mission, with the orbiter and probe being flown on separate Shuttle IUS missions in January, 1984. Flying separate missions will increase the total mission cost, including launch costs, by about $225 million from $350 million to approximately $575 million.

I notice in the letter that you sent to the Speaker and also in your statement, you indicated that the increase in the total mission cost would be $153 million, but I do not presume you include the launch costs in that figure. Is that correct?

Mr. LILLY. The increase of approximately $153 million does not include the cost of either the procurement and integration of an additional IUS or the cost of an additional Shuttle launch.

Mr. BOLAND. If you add the additional launch costs and the additional costs of IUS, what does that total figure come to?

Mr. LILLY. The additional IUS and associated integration efforts would add about $31 million, and our estimate of the cost of the launch in that time period is about $30 million.

Mr. BOLAND. For each launch?

Mr. LILLY. Yes.

Mr. BOLAND. So that would be $120 million for two launches. So you are a little bit higher than we are. $153 and $120 million comes to $173 million, does it not?

Mr. LILLY. Our estimate, to be clear, Mr. Boland——

Mr. BOLAND. The fact of the matter is it is going to be a lot more than $153 million, is that correct, Dr. Frosch?

Dr. FROSCH. Yes, if you include the launch costs.

Mr. BOLAND. Why don't you include the launch costs? That is a cost that has to be paid.

Dr. FROSCH. It is included in the total funding impact, but it falls into a separate budget line item, and the $153 million only relates

to the additional funding needed for the Galileo development and operations.

GALILEO REDIRECTION VERSUS REPROGRAMMING

Mr. BOLAND. If you cannot launch it, you cannot get it up there. One of the most troubling aspects of this $225 million overrun, $225 million plus, is what role Congress should play in approving the additional funds. I think it is pretty safe to say that if the House had not included the special Galileo reprogramming language in the NASA amendment for the 1980 Appropriation Bill, we would not even be here today, because NASA originally had no intention of sending this overrun forward as a Section 4 reprogramming.

You were calling it a redirection, and you felt that since it was redirection, it wouldn't be necessary to inform the Committee; it would be proper to inform the Committee of the redirection but no obligation to inform it as to reprogramming. Is that correct? You were going ahead with the redirection instead of the reprogramming, is that so?

Dr. FROSCH. We were certainly intending to inform the Committee of the change.

Mr. BOLAND. That is right, but there is a difference between redirection and reprogramming, is there not?

Dr. FROSCH. Yes.

Mr. BOLAND. You would prefer to redirect rather than reprogram?

Dr. FROSCH. Yes, of course.

Mr. BOLAND. Don't you think, don't you really believe, that there is a redirection and that it is so different from the original concept that this Committee approved that it ought to be termed a reprogramming effort?

Dr. FROSCH. I think particularly the way the Committee report language is written, it is not strictly a reprogramming.

Mr. BOLAND. All right.

Dr. FROSCH. I think I entirely agree that the Committee should be informed about this level of change.

Mr. BOLAND. There is no question about that?

Dr. FROSCH. There is no question about that.

Mr. BOLAND. There is no question about the fact that NASA is committing the taxpayers to a considerable additional expense, because of the redirection; is that correct?

Dr. FROSCH. I agree with that.

Mr. BOLAND. All right.

Dr. FROSCH. And I think it is clear that the Congress should be informed of it, and should have an opportunity to take action if it so desires.

Mr. BOLAND. It is easy for those in the agencies and the administration to sit there and talk about costs, and talk about redirection and reprogramming, but the responsibility on this part of the table is to be sure that we have some concern about the spending of money.

Dr. FROSCH. Yes.

Mr. BOLAND. I am not sure that those who direct the agencies, the departments of the federal establishment, always have that same concern, and so we have that responsibility. Consequently, a change in any program that is going to cost somewhere between $225 million to $300 million extra certainly is a change that ought to be brought to the attention of the Committee, and the Committee ought to have some input into it. Otherwise the agencies and departments can go ahead on their merry way and spend the money as they see fit.

Dr. FROSCH. Mr. Chairman, I entirely agree with what you have said.

Mr. BOLAND. I know you always agree with it. They always agree with it when they get on that side of the table, but the fact of the matter is that that agreement sometimes is not shown by its willingness to come to this Committee and to ask for additional funds in a manner where we can get a look at it, and get some oversight of it. That is the purpose of the Subcommittee on Appropriations. I think all of the Subcommittees do their jobs very well. That is our real concern. You understand what that concern is too?

COMMITTEE REPORT LANGUAGE ON REPROGRAMMING AND REDIRECTION

Dr. FROSCH. Yes.

Mr. BOLAND. We had problems, as you know, with the language. It was not one of our happiest hours when we went to conference with the Senate on this matter. We had some difficulty with the Senate. It isn't that we exercise our oversight a little bit more closely and cautiously than the Senate, but the fact of the matter is that they were not interested in having NASA come back to the Committee on a reprogramming effort that would require the expenditure of these sums of money.

Mr. TRAXLER. Mr. Chairman.

Mr. BOLAND. Yes.

Mr. TRAXLER. What was the position of the agency in connection with that House language? Did you oppose it in the conference Committee?

Dr. FROSCH. We took the position, as I recall, that we would certainly come back to the Committee, whether there was language or not.

Mr. BOLAND. Yes, but you were not willing to come back to the Committee asking for prior approval of the change that you were making. That is what you were objecting to. Let me read the language that we had in the House bill. You are familiar with it, all of you are familiar with it, I am sure.

Dr. FROSCH. Yes, I am.

Mr. BOLAND. The House language, when it left the House, and it was approved by the House, and it was approved by the House incidentally with the approbation of the Science and Technology Committee, reads: "Provided that no funds may be obligated for development of separate orbiter and probe missions on Project Galileo without the prior approval of the Committee on Appropriations."

You objected to that language in the Senate, and the Senate went along with you. Then there were conversations back and forth with some of the Senate conferees and also with NASA, and we finally came out and deleted the language. We dropped the language when there was an indication on the part of NASA that it would be willing to come up and tell us about it when you were going to institute, when they had finally settled on the redirection of the program itself. That is correct, isn't it?

Dr. FROSCH. Yes. One of the problems with regard to the matter of reading about it in *The Washington Post,* and I frequently read about things in *The Washington Post.*

Mr. BOLAND. We read about it all the time.

Dr. FROSCH. I had not decided on the redirection at that point.

Mr. BOLAND. You are not the only agency that is responsible for having *The Washington Post* or *The Evening Star* writing stories long before a Committee gets it. It happens all the time.

Dr. FROSCH. Yes.

Mr. BOLAND. I happen to chair the House permanent Select Committee on Intelligence. Sometimes it happens there.

Dr. FROSCH. I might make a comment that it frequently happens before the matter comes to me.

Mr. BOLAND. With respect to the reprogramming procedures, we are concerned and I am concerned now, about the reprogramming procedures. Perhaps we ought to get another look or a closer look at the reprogramming procedures in the House. I am aware also that in recent days there has been some concern expressed by the Senate regarding a reprogramming of funds for the purchase of a NASA U-2 research aircraft. In both that case and in the Galileo case, it seems to me that NASA just doesn't understand some of the concerns of this Committee.

In short, it simply is a problem of committing the Congress and the executive branch to the expenditure of funds in the out years with what starts out to be a very small reprogramming of dollars in the budget year. That is the problem, and perhaps we can come to some resolution with respect to the reprogramming procedures in the House, after we get a look at it.

Now turning to the Galileo reprogramming, I know you have a statement, Dr. Frosch, and we would be pleased to hear you.

STATEMENT OF DR. ROBERT A. FROSCH, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. FROSCH. Thank you, Mr. Chairman. I propose to read most of the statement, leaving out some parts, in the interests of time.

[The information follows:]

STATEMENT OF ROBERT A. FROSCH, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. Chairman and Members of the Subcommittee:

I am here today to discuss the Galileo program: a program which, through the use of a remote-sensing orbitor and an atmospheric entry probe, will mark a major advance in the systematic exploration of Jupiter. Since the program's inception, the Administration, the Congress and the scientific community have supported the importance of Galileo in maintaining U.S. leadership in space exploration.

In this statement I will describe the program's status; review the mission objectives; discuss the options we studied when it became necessary to restructure the

mission; and outline the program modifications necessary for a 1984 launch. I will also discuss the importance of both the probe and orbiter, and comment upon estimated program costs.

PROGRAM STATUS

Galileo, approved by the 95th Congress, was originally scheduled to be launched as a single spacecraft in January 1982. The baseline 1982 mission plan called for the Galileo orbiter to carry the probe to Jupiter and relay its data back to Earth before starting a twenty-month orbital tour. The program was planned to be completed in July 1987. However, when it became questionable whether a single Space Shuttle and Inertial Upper Stage combination could provide the performance required for the launch of Galileo in 1982, several alternate plans for the mission were reviewed. The most economical and efficient alternative for the Galileo mission is to utilize separate Space Shuttle launches for the Galileo orbiter and probe, and to shift the launches to the earliest subsequent opportunity, February and March 1984.

Galileo is the only approved planetary program still under development and the 1984 mission will preserve the science content of the original mission as recommended by the National Academy of Sciences (Space Science Board) and approved by the Administration and the Congress—with the lowest increase in total cost.

The baseline 1982 mission is currently on schedule and within our previous cost estimate and would be ready if the Shuttle/IUS launch capability were available. The total science objectives, however, can still be accomplished with two Space Shuttle/IUS launches in 1984: one launch for the orbiter, utilizing a powered Mars flyby, and one launch of a probe and probe carrier directly to Jupiter.

Management of the Galileo mission will remain with the Jet Propulsion Laboratory. The project team is working now to replan the delivery schedules for all subsystems. They have started the redesign of the orbiter propulsion system and structure, and preparation of a request for proposal for the probe carrier has been initiated. In the next few weeks, we will review all of these plans carefully, to assure that the revised Galileo program can be accomplished within its new constraints.

The Federal Republic of Germany has been informed of our revised plan and has agreed to continue with its cooperative effort on this mission for the 1984 launch opportunity.

The restructured mission makes maximum use of the development effort expended to date and is the lowest cost alternative for achieving the original science objectives. The 1984 mission will result in a delay in science return of only one year although the launch is delayed by two years. This is a result of the faster trip time available in the 1984 opportunity.

PROGRAM OBJECTIVES

The science objectives of the Galileo mission are:

—To determine the chemical composition and physical state of Jupiter's atmosphere.

—To determine the chemical composition and physical state of the satellites of Jupiter.

—To define the topology and behavior of the magnetic field and the energetic particle fluxes.

Accomplishing these science objectives necessitates delivery of an entry probe into the atmosphere of Jupiter and insertion of an orbiter around Jupiter that will have the ability to provide imaging, remote sensing and magnetospheric investigations of Jupiter and its satellites during its planned eleven encounters and its twenty-month tour. The highest priority science objective as defined by the Space Science Board involves determining the chemical composition of the atmosphere and demands that direct measurements of the atmosphere be taken. The probe measurements of Jupiter's atmosphere fulfill this objective, and therefore are crucial from a science standpoint.

The recent Voyager encounters with Jupiter and its satellites have reemphasized the importance of these objectives and have shown that an exploratory mission to the Jovian system—namely Galileo—can be expected to return vast quantities of scientific information which will not only advance our basic understanding of the origin and evolution of the solar system, but will also contribute to our studies of meteorological, magnetospheric and geological processes on Earth.

We believe that Jupiter contains a much more representative sample of the material from which the solar system formed than the Earth and other planets. This material will be sampled directly by the Galileo probe. Jupiter's atmosphere

can also serve as a laboratory in which the Galileo orbiter will observe the dynamics and physical processes which occur in the Earth's atmosphere—but on a vastly different scale. Mapping Jupiter's magnetosphere from orbit will provide us with in-depth data to compare with the information that we have been collecting near the Earth and will give us another way to examine magnetospheric behavior. Based on the Voyager results, we are confident that the four Galilean satellites, when examined in the detail made possible by the Galileo orbiter, are outstanding targets for the study of volcanism, plate tectonics, and the evolution of the solid planets.

In the view of the National Academy of Sciences, the single most important set of data will be returned when the probe samples the Jovian atmosphere. The data will be unique and cannot be obtained by remote sensing techniques. The Space Science Board has also laid great emphasis on the aquisition of orbital data, stressing the importance of many satellite encounters, in order to meet the other fundamental objectives of Jovian exploration.

Remote sensing of the probe entry site by the orbiter is essential to proper interpretation of the probe data. We need to know whether the probe data was taken in the eye of a hurricane, an area of upwelling gases, or elsewhere. Conversely, the probe data will provide the equivalent of "ground truth" for the interpretation of the orbiter data—the value of which has been demonstrated by the Pioneer-Venus mission.

If the Probe segment of the Galileo mission were terminated, we thus would not only lose the crucial in situ measurements including composition, but ambiguities would be introduced into a number of the Orbiter investigations. Included in this category are measurements of global cloud properties, the structure and atmospheric dynamics. Loss of the Probe portion of the Galileo mission would also disrupt the technological capability to accomplish automated entry into planetary atmospheres which was developed in the Viking and Pioneer Venus projects. Termination of this effort now would break up the industry and scientific teams whose work has been so productive in the past and which is essential for future missions.

The Galileo mission was designed to return the maximum amount of information possible for what we expect to be our only mission to Jupiter in the forseeable future. It is a mission that, as reconfigured, has retained the strong endorsement of the planetary science community.

ALTERNATIVE GALILEO OPTIONS STUDIED

Three alternative launch vehicle options for accomplishing the Galileo mission with relatively fast trajectories to Jupiter were studied. The first was the use of an expendable launch vehicle, namely the Titan-Centaur combination. The second was the development of the new upper stage to assist the Shuttle (adaptation of the Centaur stage was considered). The third was the retention of the Shuttle and IUS combination.

The Galileo spacecraft could be launched by a single Titan-Centaur launch vehicle in 1982, thereby maintaining the schedule. However, it is not possible to procure a Titan-Centaur in time for the 1982 launch opportunity. Nor is it possible to accomplish the Galileo mission with a single launch on the Titan-Centaur in 1983. Only the probe can be launched by the Titan-Centaur in 1983. The total cost of this expendable launch vehicle, the maintenance of the Titan-Centaur capability, and the delay in the Galileo schedule is a very expensive option. There is no further requirement for the Titan-Centaur after this launch, and we need to continue the development of the planetary-configuration IUS for other deep space missions. In the light of these considerations, it was determined that the cost of this option was excessive.

The second option studied was the development of a Centaur upper stage for the Space Shuttle. The liguid-fueled Centaur appears to be a more capable upper stage than the solid-fueled IUS for deep space missions. It could provide over twice the performance for synchronous orbit missions. Although the integration of the Centaur into the Space Shuttle was not found to involve major technical difficulties, additional costs would be considerable. Moreover, we are concerned about the effect on Shuttle itself of initiating a major development program at this late date. If the Centaur upper stage were pursued, the planetary-configuration IUS could be discontinued. This would have had no effect on the development of the two-stage IUS for use with synchronous orbit payloads, but it would force the slip of the International Solar Polar Mission to the 1985 launch opportunity and affect the cooperation of the European Space Agency in this joint mission.

Based on all these considerations, the decision was made to select the third option, the Shuttle/IUS in 1984, using separate Shuttle/IUS launches for the Galileo orbiter and probe. Let me mention at this time that the International Solar

Polar Mission (ISPM) will not be impacted, because the projected capability of the Space Shuttle and IUS will allow us to launch ISPM on schedule in 1983.

The next fast-trajectory launch opportunity for the Galileo orbiter after 1984 does not occur until 1987. This is a marginal opportunity because an assist from Mars is not possible at that time. A delay of this length would force us to terminate the present orbiter development and reinitiate it later. Such an action would have serious consequences to the progress of the planetary program. There would be no other spacecraft project in development which would retain those highly specialized skills essential to a planetary mission.

A Galileo mission conducted with two launches in 1984 will retain all of the science objectives originally planned. Although, as the Subcommittee is aware, a two-year slip in the orbiter and probe development schedules will require contracts so that there will be maximum return on the $112 million already invested. There is no increase in the amount of funds required in fiscal year 1980.

GALILEO MODIFICATIONS FOR A 1984 LAUNCH

The Jupiter launch opportunity in 1984 is not as favorable as 1982. But because of the position of Mars, it is the best remaining opportunity in this century. The Galileo orbiter mission can only be accomplished in 1984 by adopting a powered Mars fly-by trajectory which reduces the performance required from the Shuttle and IUS. In order to accomplish the powered maneuver at Mars, the amount of fuel on board the orbiter must be doubled and there must be some redesign of the propulsion system. In the 1984 configuration a larger fraction of the weight of the orbiter is in the propulsion system; therefore, the supporting structure must be strengthened. Those electronic subsystems and structural elements of the orbiter which were intended solely to support the probe will be deleted. Otherwise, the orbiter does not need to be changed. All of the design and development effort on science instruments and electrical subsystems are still valid. Most of the current contracts for development of orbiter subsystems will remain in force. Delivery schedules will be adjusted to minimize the additional costs. Because of the increase in the spacecraft mass caused by the additional fuel, mass margins are still tight. However, we consider them to be adequate.

The probe spacecraft need not be modified. All science instruments can be retained. The delivery schedule on present contracts will be adjusted to achieve the most efficient use of funds.

The launch of the probe separately from the orbiter requires the development of a probe carrier spacecraft. Since this spacecraft will simply fly past Jupiter after delivering the probe, no large propulsion system is required. Thus, the spacecraft is relatively light and can adopt a direct trajectory to Jupiter. The demands on electronic subsystems are not severe. Since there are existing spacecraft designs on which the probe carrier can be based, and since one operation team can be used for both the probe and the orbiter, the cost should be relatively low for a 1984 mission. The development schedule now appears to be comfortable.

ESTIMATED PROGRAM COSTS

Our preliminary estimate of the change in the funding for a 1984 launch is an increase of approximateely $153 million over the $450 million previous estimate for both the Galileo development ($295 million) and the mission operations data analysis ($155 million) or 34% increase. The increase is made up of a development increase of $154 million, and a minor net decrease in mission operations and data analysis. The development increase is due primarily to the required two-year delay in the development program.

Additional funds are also required for the development of a probe carrier. We recognize that this is a significant increase and a proper matter of concern for NASA and the Congress. We consider our plan to be a responsible one—a plan that does take full advantage of the $112 million obligated to date and does preserve the science from this important mission with the least increase in total cost.

In conclusion, the Galileo scientific objectives can be achieved in the most efficient and economical manner by proceeding with the 1984 mission. This mission will sustain the U.S. capability in planetary exploration, a capacity that is recognized worldwide for its technological achievements, scientific discoveries, and tremendous impact on how we view new worlds and our place in the universe.

We have every expectation that the Galileo mission will fully meet the goals that I have described. In doing so, it will provide a demonstration of the Administration's firm commitment to maintain U.S. leadership in space science, a commitment

affirmed by the President in his Space Policy Statement. We believe that the restructured Galileo program fully merits the continued support of the Congress.

Dr. FROSCH. I am here today to discuss the Galileo program: a program which, through the use of a remote-sensing orbiter and an atmospheric entry probe, will mark a major advance in the systematic exploration of Jupiter. Since the program's inception, the Administration, the Congress and the scientific community have supported the importance of Galileo in maintaining U.S. leadership in space exploration.

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Management of the Galileo mission will remain with the Jet Propulsion Laboratory. The project team is working now to replan the delivery schedules for all subsystems. They have started the redesign of the orbiter propulsion system and structure, and preparation of a request for proposal for the probe carrier has been initiated. In the next few weeks, we will review all of these plans carefully to assure that the revised Galileo program can be accomplished within its new constraints.

The Federal Republic of Germany has been informed of our revised plan and has agreed to continue with its cooperative effort on this mission for the 1984 launch opportunity.

The restructured mission makes maximum use of the development effort expended to date and is the lowest cost alternative for achieving the original science objectives. The 1984 mission will result in a delay in science return of only one year although the launch is delayed by two years. This is a result of the faster trip time available in the 1984 opportunity.

GALILEO PROGRAM OBJECTIVES

The science objectives of the Galileo mission are:

To determine the chemical composition and physical state of Jupiter's atmosphere.

To determine the chemical composition and physical state of the satellites of Jupiter, and

To define the topology and behavior of the magnetic field and the energetic particle fluxes.

Accomplishing these science objectives necessitates delivery of an entry probe into the atmosphere of Jupiter and insertion of an orbiter around Jupiter that will have the ability to provide imaging, remote sensing, and magnetospheric investigations of Jupiter and its satellites during its planned 11 encounters and its 20-month tour. The highest priority science objective as defined by the Space Science Board involves determining the chemical composition of the atmosphere and demands that direct measurements of the atmosphere be taken. The probe measurements of Jupiter's atmosphere fulfill this objective, and therefore are crucial from a science standpoint.

The recent Voyager encounter with Jupiter and its satellites has reemphasized the importance of these objectives and has shown that an exploratory mission to the Jovian system—namely Galileo—can be expected to return vast quantities of scientific information which will not only advance our basic understanding of the origin and evolution of the solar system, but will also contribute to our studies of meteorological, magnetospheric, and geological processes on Earth.

We believe that Jupiter contains a much more representative sample of the material from which the solar system formed than the Earth and other planets. This material will be sampled directly by the Galileo probe. Jupiter's atmosphere can also serve as a laboratory in which the Galileo orbiter will observe the dynamics and physical processes which occur in the Earth's atmosphere—but on a vastly different scale. Mapping Jupiter's magnetosphere from orbit will provide us with in-depth data to compare with the information that we have been collecting near the Earth and will give us another way to examine magnetospheric behavior. Based on the Voyager results, we are confident that the four Galilean satellites, when examined in the detail made possible by the Galileo orbiter, are outstanding targets for the study of volcanism, plate tectonics, and the evolution of the solid planets.

In the view of the National Academy of Sciences, the single most important set of data will be returned with the probe samples the Jovian atmosphere. The data will be unique and cannot be obtained by remote sensing techniques. The Space Science Board has also laid great emphasis on the acquisition of orbital data, stressing

the importance of many satellite encounters, in order to meet the other fundamental objectives of Jovian exploration.

Remote sensing of the probe entry site by the orbiter is essential to proper interpretation of the probe data. We need to know whether the probe data was taken in the eye of a hurricane, an area of upwelling gases, or elsewhere. Conversely, the probe data will provide the equivalent of "ground truth" for the interpretation of the orbiter data—the value of which has been demonstrated by the Pioneer-Venus mission.

If the Probe segment of the Galileo mission were terminated, we, thus, would not only lose the crucial in situ measurements including composition, but ambiguities would be introduced into a number of the Orbiter investigations. Included in this category are measurements of global cloud properties, the structure and atmospheric dynamics. Loss of the probe portion of the Galileo mission would also disrupt the technological capability to accomplish automated entry into planetary atmospheres which was developed in the Viking and Pioneer Venus projects. Termination of this effort now would break up the industry and scientific teams whose work has been so productive in the past and which is essential for future missions.

The Galileo mission was designed to return the maximum amount of information possible for what we expect to be our only mission to Jupiter in the foreseeable future. It is a mission that, as reconfigured, has retained the strong endorsement of the planetary science community.

ALTERNATIVE GALILEO OPTIONS STUDIED

Three alternative launch vehicle options for accomplishing the Galileo mission with relatively fast trajectories to Jupiter were studied. The first was the use of an expendable launch vehicle, namely the Titan Centaur combination. The second was the development of a new upper stage to assist the Shuttle—adaptation of the Centaur stage was considered. The third was the retention of the Shuttle and IUS combination.

The Galileo spacecraft could be launched by a single Titan-Centaur launch vehicle in 1982, thereby maintaining the schedule. However, it is not possible to procure a Titan-Centaur in time for the 1982 launch opportunity. Nor is it possible to accomplish the Galileo mission with a single launch on the Titan-Centaur in 1983. Only the probe can be launched by the Titan-Centaur in 1983. The total cost of this expendable launch vehicle, the maintenance of the Titan-Centaur capability, and the delay in the Galileo schedule is a very expensive option. There is no further requirement for a Titan-Centaur after this launch, and we need to continue the development of the planetary-configuration IUS for other deep space missions. In the light of these considerations, it was determined that the cost of this option was excessive.

The second option studied was the development of a Centaur upper stage for the Space Shuttle. The liquid-fueled Centaur appears to be a more capable upper stage than the solid-fueled IUS for deep space missions. It could provide over twice the performance for synchronous-orbit missions. Although the integration of

the Centaur into the Space Shuttle was not found to involve major technical difficulties, additional costs would be considerable.

Moreover, we are concerned about the effect on the Shuttle itself of initiating a major development program at this late date. If the Centaur upper stage were pursued, the planetary-configuration IUS could be discontinued. This would have had no effect on the development of the two-stage IUS for use with synchronous orbit payloads, but it would force the slip of the International Solar Polar Mission to the 1985 launch opportunity and affect the cooperation of the European Space Agency (ESA) in this joint mission.

Based on all these considerations, the decision was made to select the third option, the Shuttle/IUS in 1984, using separate Shuttle/IUS launches for the Galileo orbiter and probe. Let me mention at this time that the International Solar Polar Mission—ISPM—will not be impacted, because the projected capability of the Space Shuttle and IUS will allow us to launch ISPM on schedule in 1983.

The next fast-trajectory launch opportunity for the Galileo orbiter after 1984 does not occur until 1987. This is a marginal opportunity because an assist from Mars is not possible at that time. A delay of this length would force us to terminate the present orbiter development and reinitiate it later. Such an action would have serious consequences to the progress of the planetary program. There would be no other spacecraft project in development which would retain those highly specialized skills essential to a planetary mission.

A Galileo mission conducted with two launches in 1984 will retain all of the science objectives originally planned. Although, as the Subcommittee is aware, a 2-year slip in the orbiter and probe development schedules will require additional funds, it is prudent to continue our current contracts so that there will be maximum return on the $112 million already invested. There is no increase in the amount of funds required in fiscal year 1980.

GALILEO MODIFICATIONS FOR A 1984 LAUNCH

The Jupiter launch opportunity in 1984 is not as favorable as 1982. But because of the position of Mars, it is the best remaining opportunity in this century. The Galileo orbiter mission can only be accomplished in 1984 by adopting a powered Mars fly-by trajectory which reduces the performance required from the Shuttle and IUS. In order to accomplish the powered maneuver at Mars, the amount of fuel on-board the orbiter must be doubled and there must be some redesign of the propulsion system. In the 1984 configuration, a larger fraction of the weight of the orbiter is in the propulsion system; therefore, the supporting structure must be strengthened. Those electronic subsystems and structural elements of the orbiter which were intended solely to support the probe will be deleted. Otherwise, the orbiter does not need to be changed. All of the design and development effort on science instruments and electrical subsystems are still valid. Most of the current contracts for development of orbiter subsystems will remain in force. Delivery schedules will be adjusted to minimize the additional costs. Because of the increase in the spacecraft mass caused by the addi-

tional fuel, mass margins are still tight. However, we consider them to be adequate.

The probe need not be modified. All science instruments can be retained. The delivery schedule on present contracts will be adjusted to achieve the most efficient use of funds.

The launch of the probe separately from the orbiter requires the development of a probe carrier spacecraft. Since this spacecraft will simply fly past Jupiter after delivering the probe, no large propulsion system is required. Thus, the spacecraft is relatively light and can adopt a direct trajectory to Jupiter. The demands on electronic subsystems are not severe. Since there are existing spacecraft designs on which the probe carrier can be based, and since one operation team can be used for both the probe and the orbiter, the cost should be relatively low for a 1984 mission. The development schedule now appears to be comfortable.

ESTIMATED PROGRAM COSTS

Our preliminary estimate of the change in the funding for a 1984 launch is an increase of approximately $153 million over the $450 million previous estimate for both the Galileo development—$295 million—and the mission operations and data analysis—$155 million—or a 34 percent increase. The increase is made up of a development increase of $154 million, and a minor net decrease in mission operations and data analysis. The development increase is due primarily to the required 2-year delay in the development program.

Additional funds are also required for the development of a probe carrier. We recognize that this is a significant increase and a proper matter of concern for NASA and the Congress. We consider our plan to be a responsible one—a plan that does take full advantage of the $112 million obligated to date and does preserve the science from this important mission with the least increase in total cost.

In conclusion, the Galileo scientific objectives can be achieved in the most efficient and economical manner by proceeding with the 1984 mission. This mission will sustain the U.S. capability in planetary exploration, a capacity that is recognized worldwide for its technological achievements, scientific discoveries, and tremendous impact on how we view new worlds and our place in the universe.

We have every expectation that the Galileo mission will fully meet the goals that I have described. In doing so, it will provide a demonstration of the Administration's firm commitment to maintain U.S. leadership in space science, a commitment affirmed by the President in his Space Policy statement. We believe that the restructured Galileo program fully merits the continued support of the Congress.

We thank you, Mr. Chairman.

Mr. BOLAND. As all of us know, the Congress has just approved the second budget resolution which sets the ceilings for total outlay, total budget authority and the deficit. That resolution, as all of us recognize, is very tight. In fact, there is no doubt that the Congress will have to work next year on a third budget resolution increasing those ceilings, but the second resolution does not assume

any of the $300 million that you will request as a supplemental for the Shuttle. That $300 million is part of an overrun on the Shuttle program of about $1 billion through fiscal year 1981.

I have indicated strong support and this Subcommittee has indicated strong support for the $300 million supplemental, because we believe strongly that we must get the Shuttle flying, and get that program operational. So, Dr. Frosch—and you have been asked this question before, and I think I can anticipate the answer—if you had to choose on a budget priority basis, as we have to do on this side of the table, between that $300 million for the Shuttle and the $225 million plus additional costs for the Galileo program, what would be your first priority?

Dr. FROSCH. I would obviously have to support the Shuttle, but of course the two dollar figures don't occur in the same year.

Mr. BOLAND. They may not occur in the same year, but there are a lot of years that follow for Galileo; isn't that true?

Dr. FROSCH. Yes.

Mr. BOLAND. What are you projecting in fiscal year 1981 for Galileo? In any event, in the out years there is a considerable amount of money being spent in this area?

Dr. FROSCH. Yes.

Mr. BOLAND. So that is kind of a non-answer that you have given me, except that you do place the top priority on the Shuttle, on the space transportation system. Now, this Committee has suggested in its reports in the past two years that the Shuttle was underfunded, and we have been saying that for the last couple of years, and the actions of this Committee with respect to the request for supplementals clearly indicate that it was underfunded, and it also clearly indicated the support of the STS for the program.

I have indicated, as I did at the time that I originally opposed the Jupiter orbiter probe, now the Galileo program, that it didn't make much sense to spend hundreds of millions of dollars on Galileo and the large space telescope if we didn't have anything to fly them in. That is pretty much what has happened now, isn't it, at this point in time?

Dr. FROSCH. It has happened with Galileo, not completely in the sense that, of course, we have the option of flying it slightly later, in a split mission, so it is certainly possible to fly it.

Mr. BOLAND. That is true, but the increase in cost, of course, is substantial?

Dr. FROSCH. Yes.

PROGRAM COST DISCREPANCIES

Mr. BOLAND. Dr. Mutch, in testifying before Chairman Fuqua's Committee, the authorizing Committee, you were asked if it would be better to cancel Galileo and free up the funds for other missions. You indicated that that would result in a loss of $160 million, $100 million that has already been spent, plus $60 million of close-out costs. That answer is a little bit different from what you told the staff concerning the Galileo problem.

The staff's notes suggest that of the $100 million spent on Galileo through fiscal year 1979, you indicated that roughly $50 million could be salvaged for future Jupiter missions, and approximately

$50 million would be lost. The close-out costs were estimated to be about $50 million—with $30 million from 1980 funds. What accounts for the difference in those answers to Mr. Fuqua's Committee on this one, and the staff of this Committee?

Dr. MUTCH. I did not believe that there was any difference. Those close-out costs and the sunk costs are simply that money which would be physically spent, and then temporarily lost. The future in that regard is very uncertain. If we had an approved mission, and we do not, that mission might benefit from some inheritance from Galileo work. We always have that situation where the previous missions give us a certain amount of technical experience and in some cases hardware, which can be utilized again.

IMPACT OF CANCELLATION VERSUS DEFERRAL OF GALILEO

Dr. FROSCH. Mr. Chairman, I think there are two different questions and, therefore, you get two different answers. One is, "What happens if one cancels Galileo and does not in the foreseeable future do any Jupiter mission?" Then more or less all of the Galileo specific investment has vanished. If on the other hand, one cancels Galileo or in effect delays it, and says we are going back to Jupiter in several years, then that part of the preparation which would be applicable to the later Jupiter mission would be regarded as salvagable. Therefore, it is a question of whether cancellation means you never go back to Jupiter, or whether the cancellation is temporary and we go back later.

Mr. BOLAND. So if we cancel completely the loss would probably run $100 million, plus the close-out costs?

Dr. FROSCH. Yes.

Mr. BOLAND. But if there was an opportunity, if there was a salvagable element in the program?

Dr. FROSCH. Then that would be creditable to another mission.

Dr. MUTCH. We have always been straightforward on that. That would not prevent deferral, say to 1987.

SPACE SCIENCE COMMUNITY'S CONCERN ON DEVELOPMENT OF THE PROBE

Mr. BOLAND. It has also been suggested to us that the space science community have not been happy with the probe's development. The suggestion was made that at meetings of the Space Science Board, which is a board of the National Academy of Sciences, that an issue was raised concerning whether or not the probe should be improved, and perhaps even flown at a later date. My understanding of some of the objections was that the probe of the Jovian atmosphere was not sufficiently deep enough to give you the best data that could be obtained.

Dr. FROSCH. One would like to get chemical data on both inorganic and organic molecules. It is not currently possible to make this probe heavy enough to do both, and there was some discussion about what the best tradeoff compromise ought to be. The conclusion was that the inorganic molecules which dominate the atmosphere as a physical atmosphere were the lines to emphasize, and that, in any case, it would be very difficult to make instruments to

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measure the small trace organic components, and that would simply not be a reasonable thing to try to cram into the probe as well.

Mr. BOLAND. Is the position of the Space Science Board unanimous in the recommendations you make on the split mission now?

Dr. FROSCH. I doubt it. I don't think the Space Science Board is ever unanimous.

Dr. MUTCH. Could I answer?

Mr. BOLAND. Yes.

Dr. MUTCH. Those discussions, in fact, that you allude to have been taking place, and they have been taking place in the COMPLEX Committee which is a subcommittee of the Space Science Board which is responsible for planetary exploration. In addition to the matter which Dr. Frosch referred to, there has been continuing concern that the probe should penetrate the water clouds in order to measure oxygen in the vapor.

We believe that we have successfully developed a probe that will do this, and an interesting point is that the margins, if you will, the communication times, the ability to survive deeper depths are in fact improved in the 1984 configuration over the 1982 configuration, and so it is an improved mission at that point. I think clearly it meets the requirements of the scientists.

The only other point I would like to make is that, I have been a scientist involved with planetary exploration myself, and it is a natural state of mind for the investigator to be always attempting to improve his experiment. There are many, many such situations which come to my desk now in the ordinary course of events, so I think this is a situation that is well in hand. The scientists have never to my knowledge suggested that we should delay the probe, and Dr. Cameron, who is the Chairman of the Space Science Board, has recently reaffirmed to me in writing his endorsement of the 1984 mission as we have it configured.

Mr. BOLAND. I presume that your position and Dr. Cameron's position with respect to the delay of the probe is probably the same with respect to the cancellation of the probe, that you do not favor the cancellation of the probe?

Dr. MUTCH. That is true.

IMPACT OF CANCELLATION OF PROBE

Mr. BOLAND. I know you have talked about it in your statement about the dual mission. What if the probe were canceled; how significant is the orbiter?.

Dr. FROSCH. We have been saying that the orbiter data comprises approximately 60 percent of the science return from Galileo and the probe data 40 percent. That is obviously not a very precise number, because it is a qualitative estimate. I guess I would view it myself as not a very good either/or for the reasons mentioned in the statement, namely, a key thing is to have a handle on the chemistry, which the probe gives us, which enables us to interpret the broader view of the atmosphere, which the orbiter gives us with remote sensing. If one does not have the chemical tie-down, then it is partly speculative as to exactly what the chemical composition is that one is looking at.

On the other hand, if one does not have the orbiter remote sensing to identify what particular piece of the atmosphere the probe went into, then it is difficult to generalize the chemical, so the two fit together very well as a system, but if one tries to take them apart, then you get something like a 60-20, 50-50 instrument for the value of the two.

SPACE SHUTTLE IMPACT ON GALILEO

Mr. BOLAND. Among the reasons that John Yardley recommended against flying the Galileo mission in 1982 were 109 percent full thrust is required for the launch, and the 109 percent full thrust will not be available by January of 1982. That is correct, isn't it?

Dr. FROSCH. I think John's reasoning was that it would probably be available by then. But in any case, this would mean that, very early in the availability of the light-weight system and the uprated engine, we would have to do a very expensive planetary mission. The recommendation was that since it was on the edge of getting that capability all the way up, it would be much more sensible not to put all of that risk together at one time, but instead to split mission. I think that we still anticipate getting the 109 percent by about that time, but it is very much on the edge.

Mr. BOLAND. That is interesting. There are some who believe you will never get the 109 percent.

Dr. FROSCH. Oh, I know that, but I think it likely we will in fact get the 109 percent, although it may be something of an engineering struggle to demonstrate.

Mr. BOLAND. Because of the continuing Shuttle delay, the operational missions are not scheduled to begin until November of 1981. That is correct, isn't it?

Dr. FROSCH. That is right.

Mr. BOLAND. The test flights will occur in August of 1980?

Dr. FROSCH. The most likely date for the first flight is around August-September of 1980.

Mr. BOLAND. But the operational missions are not to begin——

Dr. FROSCH. Between a year and 14 months later.

Mr. BOLAND. So that would mean that the Galileo flight would have to occur on the second operational mission?

Dr. FROSCH. Yes.

Mr. BOLAND. When would the second operational mission occur?

Dr. FROSCH. That would be in January or February.

Mr. BOLAND. But you don't intend to fly the Galileo; you would not fly the Galileo on that operational mission, as I understand it, because a night flight is required, and I understand NASA would not be keen to take on such a complicated mission so early in the operational schedule; is that correct?

Dr. FROSCH. It is that, and it is an all-out mission so early in the schedule. It just seems unwise to put that expensive and complicated a mission in that basket.

IUS—INERTIAL UPPER STAGE

Mr. BOLAND. That fills us in on the problem with the Shuttle. Let's talk for a minute about the IUS, the Inertial Upper Stage.

Let's assume for a minute that the Galileo mission did fly on time in January of 1982. It is a fact, is it not, that without substantial additional funding in 1980, the IUS could not possibly meet the weight requirement of the current Galileo mission?

Dr. FROSCH. We don't know what the precise additional requirement will be. As you know, it is an Air Force program, and they are in negotiation with the contractor. We understand that they are in an overrun status, and we expect that we would be required to have additional funding in fiscal year 1980. For that reason, in addition to performance improvements we do not have a precise number. We are guessing that it might be as much as $20 million.

Mr. BOLAND. But the weight requirement of the current Galileo mission clearly indicates that there would be substantial additional funding required, if the launch schedule was January 1982?

Dr. FROSCH. There would be additional funding required for the IUS, but we don't know how much.

Mr. BOLAND. Let me ask—and perhaps Bill Lilly can give us an answer; he always has—wouldn't it cost an additional $20 million in 1982, in the fiscal year 1980 budget, to upgrade the IUS to meet a combined orbiter-probe mission?

Mr. LILLY. If the information we have on the contract negotiation status is correct, I believe that answer is about right, Mr. Boland.

Mr. BOLAND. With a split mission, and this is what you are asking, splitting the mission, will NASA have to spend that additional development money to upgrade the IUS?

Mr. LILLY. Our current information, is that there will still have to be an increase of approximately $20 million for IUS improvements, but not in fiscal year 1980. It will come primarily in fiscal year 1981.

Mr. BOLAND. Isn't the IUS really insufficient for future planetary missions?

Dr. FROSCH. The three-stage IUS will accommodate all of the missions that we are now considering, although some of them will require the combined IUS and the solar electrical propulsion system.

Mr. BOLAND. But the three-stage IUS would cost considerably more money, would it not?

Dr. FROSCH. It is the IUS which has always been planned for the planetary missions. The additional money is required because of overruns in both the two-stage and the three-stage IUS.

ALTERNATIVE GALILEO OPTIONS STUDIED

Mr. BOLAND. It is clear that when the Galileo problem first arose, there were a number of options that NASA could have recommended, and you talk about them in your statement and review them?

Dr. FROSCH. Yes.

Mr. BOLAND. One, of course, would be to cancel the mission. I don't know of anybody on that side of the table that wants to cancel the mission. Is there anybody here from NASA who would like to cancel the mission?

Mrs. BOGGS. Speak now or forever hold your peace.

Mr. BOLAND. Is there anyone on this side of the table? Bill?

Mr. YOUNG. Mr. Chairman, I am curious. Since we have raised this issue of who wants to cancel or not, is there any other program that would be contingent upon the Galileo? In other words, if you cancelled Galileo, would it affect some other planned program or ongoing program?

Dr. FROSCH. No, I do not think it would.

Mr. BOLAND. This is the only planetary mission that is available to them now?

Dr. FROSCH. Nothing else is directly dependent on it that I can think of.

Mr. YOUNG. I was thinking not only of other interplanetary probes but any technological developments that would be an offshoot from Galileo that you plan to use for something else. I was just curious if it were cancelled whether or not it would have an adverse effect on some other program.

Dr. FROSCH. I don't think there is anything significant that would have an effect on future IUS costs.

Mr. BOLAND. I think it is a good question. It would have no effect upon any effort to explore Haley's Comet or Uranus?

Dr. FROSCH. Only in the sense that if the mission is cancelled, and there is no ongoing planetary mission currently under development, and if we propose in the fiscal year 1981 budget or the fiscal year 1982 budget a mission, we will not have the scientific community and the technological capability that we can put together on time, we will have that kind of an effect, yes.

Mr. BOLAND. I thought the scientific community and NASA had it all laid out, that this is what we are going to do?

Dr. FROSCH. We have it all laid out, but it is not clear that the Congress has it all laid out in the same way as you emphasized in your opening statement, Mr. Chairman.

Mr. BOLAND. But it is pretty clear that the cancellation of Galileo would not really impact upon other missions?

Dr. FROSCH. It would not directly impact on other missions.

Mr. STEWART. Mr. Chairman.

Mr. BOLAND. Yes.

SPACE SHUTTLE PERFORMANCE FOR A 1982 GALILEO LAUNCH

Mr. STEWART. I wanted to raise a question, which you touched upon several times, especially in your letter when you said, "It recently became questionable whether or not the Shuttle would provide the performance required for 1980 launch."

Dr. FROSCH. For a 1982 launch.

Mr. STEWART. 1982. Is that questionable now? Does a politician use the term "questionable" in the same manner that a scientist uses that term?

Dr. FROSCH. I can speak for scientists, Mr. Stewart. I think it is really questionable rather than a fact. We are not certain that we will not have the orbiter capability to do this mission in 1982, but the odds are against it. It is questionable, and the odds are against it sufficiently so that we think it is unwise to plan on it happening.

Mr. STEWART. The other question is, what were some of the variables that entered into this decision that were not present when we first set the date for 1982?

Dr. FROSCH. The principal thing that has happened is that we have had delays in first manned orbital flight (FMOF). Had we had FMOF as scheduled, let's say originally in the spring of this year, then we would have expected to be operational by the end of 1980, rather than the end of 1981, and that would have had two effects: One, we would then have had a year of operational flying before the Galileo mission; and the whole schedule for getting the lightweight tank, the second orbiter, and the up-rating of the engines would have gone along faster, because we would have completed the basic work. So, it is basically a schedule delay problem that does not allow us to feel comfortable doing this mission in early 1982.

Mr. STEWART. And you do not anticipate that same kind of slippage in 1984?

Dr. FROSCH. No, we do not anticipate the same kind of slippage in 1984.

Mr. TRAXLER. Any other questions? Let's talk for a moment about what would happen if Galileo did fly as scheduled in 1982. Is it true that without additional funding in 1980, that IUS could not possibly meet the weight requirements?

Dr. FROSCH. Yes.

Mr. TRAXLER. You have already answered that question?

Dr. FROSCH. Yes.

COST OF THREE-STAGE IUS

Mr. TRAXLER. Do you believe that it would cost an additional $20 million to upgrade IUS?

Dr. FROSCH. The best information we have now indicates that it will cost an additional $20 million between now and fiscal year 1984, pending the Air Force negotiations, to bring the three-stage IUS into existence. I am a little puzzled at the reference to that as an upgrading in the sense that the IUS plan from the beginning was that there be two versions at least, namely a basic two-stage version that would be Air Force and NASA used for many purposes, and an additional three-stage version for planetary purposes. It is an upgrading of the basic two-stage IUS, but it was planned from the beginning of the program.

Mr. TRAXLER. With the split mission, are you still going to spend the additional development money to do this?

Dr. FROSCH. Yes, we will need to do this for planetary purposes anyway.

Mr. TRAXLER. One question before I go to vote. Do you believe that IUS is really sufficient to accomplish this mission? Can it really handle the job?

Dr. FROSCH. We believe if it comes out as it is expected to, it will handle the job.

TITAN-CENTAUR VERUS IUS FOR LAUNCH

Mr. BOLAND. Bob, let me ask, following up on that question, whether or not you believe the Titan-Centaur could perform the mission better.

Dr. FROSCH. The Titan-Centaur can launch a probe only mission comfortably, if it were available at the time. However, it cannot launch the orbiter mission comfortably.

Mr. BOLAND. We are talking about the options here. I guess no one thinks that we ought to cancel it. We recognize the fact that you have indicated that this mission does sustain the United States capability in planetary exploration.

Mr. COUGHLIN. Mr. Chairman, could I ask one question?

Mr. BOLAND. Sure.

GALILEO PRIORITY AS A PLANETARY MISSION

Mr. COUGHLIN. If you did cancel this mission, are there other missions that would have an equal priority in your scale of things that would use this money?

Dr. FROSCH. This is certainly the program which I think has the highest planetary priority.

Mr. COUGHLIN. In the whole NASA program?

Dr. FROSCH. In the NASA planetary program.

Mr. COUGHLIN. Of course, in the planetary program. Are you going to come next year to us with another program that has a higher priority than this program?

Dr. FROSCH. No. I hope that next year we will request initiation of a new start, but I do not think it will be higher priority.

Mr. COUGHLIN. In the field other than planetary?

Dr. FROSCH. There will, I hope, be new starts in fields other than planetary.

Mr. COUGHLIN. That would have priorities equivalent to this program?

Dr. FROSCH. Very possibly, yes, but it is a little hard to compare because you are talking about different fields of science and different subjects.

Dr. MUTCH. If I may, these are two missions that were approved, the Space Telescope and Galileo, and are singularly important missions, I would say. Galileo is a very, very important planetary mission. Frankly, if we are unsuccessful, we will attempt to recover and to do the best we can with the funds that are available, but I think this is a singularly important planetary mission. The other mission that comes to mind is the Space Telescope which we are currently developing.

Mr. COUGHLIN. I am just concerned with what is coming up next year that we will be told is a new start and is an extraordinarily high priority.

Dr. FROSCH. If we come up with a new start in the next budget, it would be the next kind of high priority rating.

Mr. COUGHLIN. Do you think it will have an equivalent priority to this or a higher priority?

Dr. FROSCH. I think it would not be higher priority.

Mr. COUGHLIN. Thank you, Mr. Chairman.

Mrs. BOGGS. Mr. Chairman.

Mr. BOLAND. Yes.

Mrs. BOGGS. I was wondering if you could expand a little bit on why the Titan-Centaur program has not been considered.

Dr. FROSCH. The basic reason was that our evaluation of the availability of a Titan-Centaur in time for a 1982 launch was simply that we could not get there from here. That is why we couldn't buy it, and get it suitably integrated in the configuration required for Galileo, and have a high probability that it was ready. Added to that was the fact that it made the job even more expensive than the mission we are now discussing.

Mrs. BOGGS. And do you think that the priority of the project being launched in 1982 is sufficient to say that we should go ahead and cancel the Titan-Centaur?

Dr. FROSCH. We do not have a Titan-Centaur in the program. It was an alternative that was considered for 1982 Galileo that was determined not to be feasible, so it is not really a matter of forgetting it. The Titan-Centaur was canceled after the 1977 Voyager launches but it could be reactivated, if necessary.

Mrs. BOGGS. Thank you very much.

Mr. BOLAND. The second option would be to cancel the probe, and to fly it at a later date, perhaps in 1988 or 1989. You do not like that option?

Mr. FROSCH. It breaks the connection between the probe and the orbiter in understanding the chemistry and meteorology.

Mr. BOLAND. The third option—and you talked about this too; I don't know whether NASA looked at it in fact closely—but the third option is one which I believe should have been looked at a little bit more closely by NASA, for a number of reasons, and that was to go ahead and develop the Centaur. I think NASA recognizes the fact that the Centaur has a number of advantages. It has flown, has been developed and been flown successfully I think beyond 50 missions?

Dr. FROSCH. Yes. Fifty-one missions as an upper stage on Atlas. There were also seven launches of Centaur on the Titan booster.

Mr. BOLAND. And it can lift 12,000 pounds into synchronous orbit, and it could launch a combined Jupiter-orbiter probe in any year, because of its substantially greater weight-carrying capacity as compared with the IUS. And then the Centaur also has a potential reuseable capability from synchronous orbit. Finally, one of the things that originally mitigated in favor of the Boeing IUS over the Centaur was the fact that the Boeing IUS was going to cost only about $6 million a copy. Isn't it true that that cost will now be more like $16 million to $18 million a copy for the NASA version, and that that cost compares quite favorably with the Centaur cost, particularly when you look at what you get with Centaur?

Dr. FROSCH. The $6 million estimate represents a design to cost target that was used in the past for the two-stage IUS configuration and was in fiscal year 1978 dollars. However, there is no question that the three-stage IUS will cost more than the original estimated price. I am not sure we know what the price will be yet due to the ongoing negotiation the Air Force is having. The Centaur does potentially have some real advantages, and we did look

at it in some detail. In fact, it was looked at in enough detail that I made the decision to continue with the IUS.

Mr. TRAXLER. Why?

Dr. FROSCH. There are several reasons. One is that we have an agreement with DOD to develop the IUS. We would have to tear that up. It would affect our termination costs, affect Air Force termination costs, and affect their ongoing costs in the IUS program. They could decide to cancel the two-stage development which would impact the TDRSS and Spacelab launches. Two, there is a significant additional development cost for the Centaur over the IUS, not counting the question of what the termination liabilities would be for the IUS, and it is not clear whether the number of uses of the Centaur versus the three-stage IUS will be such that one can amortize the difference in initial cost sufficiently to make it clear that it was not a more expensive option than the IUS. However, those are not the fundamental reasons for the difficulty.

The fundamental reason is this. We were unwilling to undertake the Centaur integration into the Shuttle at this time, and the difficulty is simply this. The difference between the IUS and the Centaur is that the IUS is essentially independent of the Shuttle, whereas the Centaur stage is a liquid hydrogen-liquid oxygen stage, and, therefore, has to be integrated into the Shuttle with some new plumbing, because it has to be possible to vent those tanks and to be prepared to dump them at any time, in the event of an abort situation. We do not have plumbing in the Shuttle to accommodate the scale of venting and draining that might be required of a liquid oxygen-liquid hydrogen stage in the Shuttle cargo bay. This would mean that in this stage of the construction of the first or second tier, we would have to undertake the redesign and the insertion of that plumbing and those systems into the tail end of the orbiter. We felt that, at this point, it would be unwise to take on this additional task, and to contribute to the problems we are having in completing the development of the STS.

I have one other point that I would like to make. There are certain Air Force payloads for which the Centaur, as currently configured, could not replace the IUS, because the combination of the Centaur and some of the Air Force payloads would be too long for the payload bay. Therefore, there would have to be changes made in the Centaur, in order to accommodate certain payloads, so that there would then be at least two versions of the Centaur.

Now those changes, as I understand it, don't involve the engine, but they involve a reconfiguration of the whole tank structure, so while they are probably not gigantic, they are nontrivial items. So, putting all of this together, it looked as though taking on the new task and throwing away the existing one was not quite the right thing to do at this point.

IMPACT OF AIR FORCE EXAMINATION OF IUS ON GALILEO

Mr. TRAXLER. Is it your understanding that the Air Force is taking a hard look at IUS and perhaps within the next six months decide whether or not they are really going to go with it?

Dr. FROSCH. It is my understanding that the Air Force is now examining the IUS program and negotiating with Boeing as to

what contract changes will be made. This leaves me with incomplete information relative to how the NASA costs and launch schedule will be effected. It is my understanding that they are going to come to some definite conclusion on what they will do in the next few months.

Mr. TRAXLER. You are really the tail on this dog though, are you not?

Dr. FROSCH. We are really the tail. We are dealing with an extension to the basic IUS and incidentally, we are a user but it is an Air Force development.

Mr. TRAXLER. If they strike the IUS, I assume they would go to Centaur and you would go to Centaur?

Dr. FROSCH. That would probably be the logical thing to look at, yes. It would be something of a scramble too.

Mr. TRAXLER. Is the Air Force consulting with you in connection with this option?

Dr. FROSCH. We have talked back and forth with the Air Force, but at the moment we are sort of staying out of their way on the IUS, because they have a considerable problem to deal with.

Mr. BOLAND. Still on the Centaur, the Jupiter orbiter and the separate surface probe, they are two new spacecraft of course, and they must be launched on two separate shuttles?

Dr. FROSCH. Yes.

TIME CONSTRAINTS ON GALILEO LAUNCH

Mr. TRAXLER. The launch must be two separate Shuttle launches, within a relatively tight time frame—I understand, within a 33-day launch opportunity in 1984?

Dr. FROSCH. I believe it is a 44-day launch window.

Mr. TRAXLER. All right, 44.

We understand that this is expensive and risky. Is that correct?

Dr. FROSCH. Well, it is expensive in the sense that it is two launches as opposed to one. It is risky in that we would have to be able to make that two-launch schedule, but by 1984 our assessment is that a 44-day turnaround does not seem all that unlikely. At any rate in 1984, we will have two Shuttle orbiters.

Dr. MUTCH. I might add here that there is an obligatory risk attached to all planetary missions, single or double launch. We always have to shoot for a particular time frame in which that launch can be accomplished. So, this is not an unusual situation as far as a planetary launch is concerned as opposed to Earth orbital launches.

COST OF AN IUS SPLIT MISSION

Mr. BOLAND. We understand that the cost of integrating Centaur with the Shuttle, $131 million, is approximately the same as the cost to redesign the Galileo spacecraft and integrate the two new spacecraft with the IUS. Is that correct?

Dr. FROSCH. Our estimate of the difference is that the cost of doing the Centaur instead of the IUS as opposed to doing the split mission IUS is more than an additional $100 million. It is about $250 million for the IUS split as opposed to an additional $380 million for the Centaur split.

Mr. BOLAND. Of course, the expenditure of that extra $100 million does buy you a lot more capability, does it not?

Dr. FROSCH. There is no question that it does.

Mr. BOLAND. Larry, do you have some questions?

NOTIFICATION OF REDIRECTION AND REPROGRAMMING TO CONGRESS

Mr. COUGHLIN. Mr. Chairman, I do have some questions.

I would like to go back a little bit if I might. You indicated in response to the Chairman's earlier questions that you felt that Congress should be informed of the redirection that you are proposing here, and I guess that implies that you do not think you have to request the funds from Congress when you have a substantial increase in cost, just inform the Congress?

Dr. FROSCH. We would both inform and request. We would be informing the Congress in this year of what the consequences of the change would be. If there were no funding increases this year, we would not request additional funding, but the information would be saying that in the subsequent budget years, it would be our intention to request, as part of the authorization and appropriation process, the changes in funding implied by the total change.

Mr. COUGHLIN. Then you think that some change in our reprogramming procedures would be necessary in order to prevent you from essentially committing the Congress to additional funds just simply by your redirecting the program; is that correct?

Dr. FROSCH. If the Committee were to come back, if we were to inform the Committee of the Galileo redirection and the Committee were to come back and say, "Yes, we know it is not a reprogramming, but we do not want you to do that, come and talk about it," obviously I would not make the change. I would come and talk about it, and expect to consult with the Committee over what the Committee's desires really were.

That was expressed to another Committee as the difference between a legal requirement and a politically sensible requirement. I do not think it is sensible for me to argue with this Committee on a matter of that sort.

Mr. BOLAND. We would like to know what you are going to do after talking about it, though. All this does is give us an opportunity to have NASA talk about it.

Mr. COUGHLIN. I guess my question is, under your interpretation of the existing requirements for redirecting or reprogramming, do you feel that you can redirect funds that would commit the Congress essentially or commit the program to additional funds without the approval of Congress?

Dr. FROSCH. If I understand the meaning of the legal language—and I cannot be sure that I do, because I am not a lawyer and I have not consulted counsel on the matter—my understanding is that what we could do would be to redirect the program. We could expend the money already authorized and appropriated in that year for the redirected program. We would then be in a position of coming and asking the Congress in the next year for whatever authorization and appropriation was required for continuation of the program as redirected.

The Congress could agree or not agree. It could then decide, "No, we don't like your redirection of the program, and we don't authorize and appropriate and we discontinue the program."

At that point, we would have done whatever it was in the original year for something that came to a dead end.

Mr. COUGHLIN. It is clear that we need some change in our procedures to prevent the Congress from being committed to a larger program, without the consent of the Congress or this Committee.

Dr. FROSCH. My point is that I do not think it commits the Congress to continue, but it does not leave the program as it was.

Mr. BOLAND. Except we could save a lot more money if we know about it on time.

Dr. FROSCH. If you were able to take action.

1987 LAUNCH WINDOW FOR ORBITER ONLY

Mr. COUGHLIN. Back when we started the whole Jupiter orbiter probe-Galileo question, it was emphasized very strongly to this Subcommittee that the 1982 launch was absolutely vital, because of the window at that time, and that the next window I guess as you pointed out in your testimony is in 1987. Is that the next window?

Dr. FROSCH. The 1982 launch window is the last opportunity for an all-up tandem launch, that is a single orbiter and probe launch.

Dr. MUTCH. Orbiter only.

Dr. FROSCH. In 1987 it couldn't be all up, an all-up single launch as 1982 is the last all-up launch opportunity until when?

Mr. COUGHLIN. Until 1987?

Dr. MUTCH. No; 2016.

Mr. COUGHLIN. That is not what we were informed at that time. What we were informed at that time was that you had approximately a 7-year delay before you would have another window where this mission would be available, and it was at least clear that that was the same mission.

Mr. BOLAND. To my mind, too, Jupiter would be hanging up eight years from now. It is not going to go away.

Dr. MUTCH. This was some years back.

Mr. COUGHLIN. It was when we authorized the program.

Dr. FROSCH. It was in 1977.

Dr. MUTCH. I hope we made that point clear that the 1987 launch opportunity could support the orbiter only.

Mr. COUGHLIN. Boy! It sure was not clear to me. It was my impression that we could have done the mission in 1982, or then it was off for 1987, and we could do the same mission in 1987.

Dr. FROSCH. Since 1977, there have been some changes in the orbiter and the probe, and I don't know whether we are talking about exactly the same set of weights that we were talking about in 1977. I simply don't know.

Dr. MUTCH. I am not familiar with the details of the 1977 discussions. I was not here but I am familiar with the recent decisions.

SEPARATE LAUNCH OPPORTUNITIES IN 1987

Mr. COUGHLIN. I am familiar in detail with the 1977 discussions, and I am concerned that we seem to get led down—this Subcom-

mittee recommended at that time that as a matter of priority we put off this mission until the 1987 window, and that was an option at the time. I am trying to make clear, is that option still here?

Dr. FROSCH. I think considering those who are here now, we will have to go back and answer that for the record.

[The information follows:]

During early 1977, NASA's Administrator, Dr. Fletcher, recommended in his testimony to Congress that the Jupiter Orbiter Probe (Galileo) mission be launched by the Shuttle/IUS in 1982. The 1982 opportunity was unique in that minimum launch energy was required to deliver the orbiter and probe spacecraft directly to Jupiter. This allowed the orbiter and probe to be launched together providing the lowest cost option for the mission. Based on the estimated mass of the orbiter/probe spacecraft and the projected Shuttle launch vehicle capability (65,000 pounds), the next opportunity for such a single, direct trajectory launch was 1987. However, this opportunity had associated with it a reduced mass margin for the mission, making the 1982 option the optimum launch opportunity of the early/mid 1980's. Single, direct trajectory launches were not possible in 1984–1986 due to far more severe launch energy requirements.

Subsequent to the 1977 testimony, the Galileo spacecraft weight increased and the Shuttle schedule was delayed. In order to assist in solving these problems, while maintaining the 1982 single launch, the trajectory was altered to include an unpowered swingby of Mars which provided the additional energy necessary to deliver the heavier spacecraft to Jupiter. Since this new trajectory is not available in 1987, because Mars is not in the proper position, a single launch of the combined orbiter and probe spacecraft on the Shuttle/IUS in 1987 was now precluded. An opportunity similar to the 1982 single launch opportunity (i.e., minimum launch energy and the availability of Mars for a swingby of the spacecraft to provide additional energy) does not, in fact, occur until 2016.

Due to these developments, alternative approaches involving split orbiter and probe Shuttle/IUS direct trajectory launches, Shuttle Centaur direct trajectory launches of the combined orbiter and probe spacecraft and alternative trajectories using the Earth for gravity assist have been considered. The latter option, of alternate trajectories using the Earth for gravity assist, has always been available every year but has the disadvantage of a significantly increased trip time to Jupiter, making them a higher cost option than the single, direct trajectory launch Shuttle/IUS missions.

In summary, the 1987 single, direct trajectory launch option was believed to be available at the time of Dr. Fletcher's statement. Subsequent to his testimony, changes in the Shuttle schedule and a better understanding of the spacecraft weight required the use of an unconventional trajectory for the baseline 1982 launch. This trajectory involved use of the gravity assist of Mars to provide the additional energy required to deliver the spacecraft to Jupiter. The option for a single 1987 direct trajectory launch of combined orbiter and probe was no longer possible under these conditions due to the unavailability of Mars for gravity assist in that year.

Mr. COUGHLIN. Are you telling me now that we do not have the option of going in 1987?

Dr. FROSCH. With both orbiter and probe?

Mr. COUGHLIN. With both orbiter and probe.

Mr. GUASTAFFERO. We have separate launch opportunities in 1987.

Dr. MUTCH. In 1987 we could fly the orbiter only, or the probe only.

Dr. FROSCH. We could do in 1987 what we are planning to do in 1984, namely to utilize two separate launches, one for the orbiter and one for the probe, but we cannot launch both the orbiter and probe on a single launch.

Mr. COUGHLIN. This is an enlightenment to me because it is certainly not what we were told at that time. In the 1987 timeframe, I never heard of a window being available in 1984 at the time we were talking of it.

Dr. FROSCH. Not all up; that is only by splitting the mission.

Mr. COUGHLIN. So we are talking of this mission and its order of priorities, a couple of years back we could have had it in 1984, this program?

Dr. FROSCH. We could have had this option, the split option, in 1984.

Mr. COUGHLIN. Which certainly was not apparent at the time?

Dr. FROSCH. Let me continue on why all these complications arise, because I have found myself exactly, as I believe you are, due to the way things change. It depends on what kind of path you use in the orbital mechanics, namely we have gone through the stage of saying we can go directly to Jupiter. We can go to Jupiter via Mars, by just passively going around Mars. We go to Jupiter via Mars at a different time by a powered flyby of Mars that changes angles, and there is a version in which you go around and intersect the Earth again, and then either do or do not intersect Mars, so it depends on times and complications.

Mr. COUGHLIN. Just for the record, let me quote from the statement of Dr. Fletcher at the time. He said,

> We must launch the Jupiter orbiter probe during a low-energy window in order to ensure that we will have the capability to send a sufficient payload to Jupiter. This low-energy launch opportunity occurs in late 1981 to early 1982, and does not reoccur until 1987.

Dr. FROSCH. That is right.

Mr. COUGHLIN. That would imply that the same mission could be launched in 1987 and in 1982?

Dr. FROSCH. They are certainly the two low-energy windows, but they are different energies.

Dr. MUTCH. That is true. As a general statement, there are certain opportunities which come at approximately a yearly basis, which are more favorable than others. 1987 is a relatively favorable time but not nearly as favorable as 1982.

COST INCREASES IN GALILEO MISSION

Mr. COUGHLIN. Let me turn to another question. You indicated that the 1982 mission as far as the Galileo program was concerned was still on schedule. I understand that just in the Galileo portion of the mission there are already significant cost overruns. Am I incorrect in that assumption or understanding?

Dr. FROSCH. There was a restructuring of the program that we testified to, I believe in the preparation of the fiscal year 1980 budget, but since that time there have not been any overruns or changes.

Mr. COUGHLIN. But the original 1982 mission that was proposed is already over the originally proposed budget?

Dr. FROSCH. Yes. We have restructured the program and we have testified to that.

Mr. COUGHLIN. It has been restructured and the record is clear as to that point?

Dr. FROSCH. Yes.

IMPACT OF GALILEO MISSION DELAY ON JPL

Mr. COUGHLIN. At the time that this Subcommittee considered the original Jupiter orbiter probe-Galileo mission, one of the ques-

tions was keeping the team together at JPL, and to some extent this was a make-work project for JPL to keep that organization together. With the delay that you anticipate with the split schedule, does this still keep JPL operating, or what happens to that organization?

Dr. FROSCH. I think the delay keeps JPL operational.

Mr. COUGHLIN. And they keep their full complement aboard?

Dr. FROSCH. Yes, I believe so.

Mr. COUGHLIN. Strung out over a longer period of time?

Dr. FROSCH. Yes.

Mr. COUGHLIN. Is that one of the reasons for the additional cost involved?

Dr. FROSCH. It is time, time throughout the program. It is not only JPL but it is the contractors.

Mr. COUGHLIN. So that this keeps those contractors——

Dr. FROSCH. It keeps the basic team going.

Mr. COUGHLIN. Keeps them there even though they are on a strung-out schedule?

Dr. FROSCH. Exactly. They will be somewhat lower in some areas of the labor force.

Mr. COUGHLIN. Less to do?

Dr. FROSCH. On this program, but they will be there.

Mr. COUGHLIN. Basically there?

Dr. FROSCH. Yes.

Mr. COUGHLIN. And JPL will be able to operate.

Just one further question so I am clear. You indicated this would cost $153 million additional for the probe, additional funds. Is that total additional funds, $225 million, that includes the probe carrier?

Dr. MUTCH. The $153 million includes development of a probe carrier. The $153 million you mentioned are costs which are budgeted by the Office of Space Sciences.

Mr. COUGHLIN. What is the difference between $153 million and the $225 million?

Dr. MUTCH. The $225 million includes the cost of upper stages, and their integration with the payload, and the estimated additional cost to NASA for the development of the IUS. These costs are in addition to those which are billed directly to the Galileo mission.

Mr. COUGHLIN. The $225 million is the total additional costs?

Dr. MUTCH. Yes, except for the cost of the Shuttle launch.

Mr. COUGHLIN. That would be incurred as a result of the split mission?

Dr. MUTCH. Yes, sir.

DETRIMENTAL EFFECT OF NOT HAVING SIMULTANEOUSLY RECEIPT OF DATA

Mr. COUGHLIN. And if you do not proceed with the probe itself, you indicted that you did not have the simultaneous receipt of data from both the flyby and the probe? What is the detrimental effect of not having that simultaneously?

Dr. FROSCH. One of the things we are trying to do is understand the atmospheric chemistry and the meteorology that goes with that chemistry. If you have just the orbiter, then all you know about the

chemistry is what you can get by remote sensing and the patterns of change, but you have no ground truth there. You have no actual chemical data taken in situ that you can tie that down with, so that you unambiguously know what you are looking at.

What the probe does is give you data on the chemical profile of the atmosphere in a place, and then you use the orbiter data to generalize that. It is very much like the kind of procedure we use with Landsat where you take for agriculture some ground data in certain places as to what the crops are really doing. That calibrates what you see with the remote sensing, and then you can generalize that to other areas. It is an analogous process.

Mr. COUGHLIN. And if you had a gap of a couple of years between receipt of one and the other——

Dr. FROSCH. The problem there is where did the probe go, and what did the condition of the atmosphere look like to the orbiter when the probe went in? In order to generalize what you have learned from the probe chemistry, you want to know what part of the atmosphere it went into from the point of view of the remote sensor, so that it can look at that, if one can extend it to the rest of the atmosphere.

If one had the probe several years later when the orbiter was not there, then one would not know what atmospheric condition it went into. The analogy would be to say one would not know whether the probe went into the eye of a hurricane, into a heavy rainstorm, or into an air mass over a desert. One simply would not know whether it was characteristic or peculiar measurements. The orbiter and the probe support each other very strongly.

Mr. COUGHLIN. The reason I am asking this, Dr. Frosch, is that I am sure once the Jupiter launch goes, we are going to be again faced with the proposition, What do we do to keep JPL going? And so we have to have a follow-on, something for them to do. It occurs to me that perhaps one of the options this Committee has to look at is taking the planetary program and perhaps striking it out over a longer period of time, in order to make the yearly costs less, is there an option that is available in keeping JPL going maybe at a lesser level, and just lengthening the programs?

Dr. FROSCH. The reason why JPL is important is because it is a big piece of the technical and scientific and technological underpinnings of having a planetary program. If there were to be a national decision that we weren't going to have a planetary program, the decision I think would be unwise, but if there were to be such a decision, then I think the question of JPL would be a different kind of question.

The purpose of this is not to keep JPL going, but to keep the planetary exploration program going.

Mr. COUGHLIN. I understand that, but assuming that we wanted to look at keeping planetary exploration going, but at perhaps a little lower level, is there a possibility of phasing that through having the probe and the orbiter go in different time frames?

Dr. FROSCH. That would be a way. I think if that were really the question, it would be best to address that question and try to see whether there was a plan that could do that. In the past, when we have looked for a way to do that, we have not been able to find a

plan that had very few starts in it, that really kept the planetary exploration going.

Mr. COUGHLIN. Supposing you launched the orbiter first, and the orbiter failed enroute, would you still launch the probe?

Dr. FROSCH. It would have to fail within the window. I think if the orbiter failed, we would probably not launch the probe but I am not sure. It would be a difficult decision to make.

Mr. COUGHLIN. Thank you, Mr. Chairman.

Mr. TRAXLER. Marty, do you have any questions? Mr. Stewart?

Mr. STEWART. No.

NASA SOLAR POLAR MISSION AND IMPACT ON EUROPEANS

Mr. TRAXLER. Moving on then, is it correct that when the Galileo program arose, one of your principal reasons for opting for the split mission in 1984 instead of developing the Centaur is that you would have had to delay the Solar Polar mission from 1983 to 1985?

Dr. FROSCH. There was a conflict between the Solar Polar mission and the Galileo mission, because they both go to Jupiter, and, therefore, they have the same launch windows. As I recall, the real problem had to do with what happened in 1983. It was one of the reasons why 1983 wasn't really considered as an option for Galileo, because it is really occupied by the International Solar Polar Mission. The two do interfere with each other in that sense.

We would not try to do both Galileo and Solar Polar in the same year, and in fact one of the rather complex options we looked at and rejected was one in which we split the two Solar Polar spacecraft, and we split Galileo and we launched one of the Solar Polars with one of the Galileo ones, and had three launches instead of four. There were a whole set of those types of options, but those ended up not making a great deal of sense.

Mr. TRAXLER. How do the Europeans feel about the possibility—perhaps as you looked at the development of the Centaur and delaying the Solar Polar to 1985, what would be their response to that?

Dr. FROSCH. They are not happy about it.

Mr. TRAXLER. Give us some of their views.

Dr. FROSCH. It is not clear that they would stay part of the program, largely because of the cost to them of the lengthening the development period.

Mr. TRAXLER. They seem to be quite cost conscious.

Dr. FROSCH. We are too.

Mr. TRAXLER. But Dr. Frosch, recently in this Committee I will tell you there have been some serious doubts about that. Let's talk about the Solar Polar. As you said, it is a dual mission. It has identical satellites. One is built by us, one by the Europeans, and it is scheduled on the Shuttle IUS in January of 1983. That also requires a 109 percent engine. I think that is correct?

Dr. FROSCH. Yes.

Mr. TRAXLER. Staff has inquired of NASA if you intend to split that mission because the Shuttle will not be capable of supporting both satellites on a combined mission. What is your thought on that?

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Dr. FROSCH. We now do not intend to split the mission, but I think it is fair to say that we are looking at that possibility just in case.

Mr. TRAXLER. If you had to split it, what would you think the extra cost would be?

Dr. FROSCH. As I recall, the extra cost would be basically only the cost of the additional launch and the additional IUS.

Mr. TRAXLER. Which is——

Dr. FROSCH. I believe the additional IUS and launch cost will be approximately $50 million.

Mr. TRAXLER. John Yardley is not here this morning?

Dr. FROSCH. No, he is out on the West Coast.

Mr. TRAXLER. Smart.

Dr. FROSCH. He is worrying about other problems.

SPACE SHUTTLE THRUST REQUIRED FOR SPLIT GALILEO

Mr. TRAXLER. I am curious. The 109 percent thrust required for the orbiter portion of the split Galileo mission—it is true that you need that in January of 1984, don't you, for the split Galileo? You have got to have that 109 percent?

Dr. FROSCH. Yes.

Mr. TRAXLER. Are we going to be able to perform at that level? You have touched on this a little earlier, but it really troubles us.

Dr. FROSCH. We believe we will be able to have the engine perform at that level. But as you know, we have not tested the engine beyond about 102 or 103 percent at this point, and we have purposely been concentrating on getting the 100 percent fully tested or the 102 percent, with a 2 percent margin fully tested before we start to push the engine harder.

Mr. TRAXLER. What happens if you do not get your 109 percent?

Dr. FROSCH. If we cannot get to 109 percent at all, then I think we will have to do something in the way of thrust augmentation.

Mr. TRAXLER. Did I read somewhere that the Air Force was already considering this?

Dr. FROSCH. We and the Air Force have been talking about thrust augmentation as a possibility, and as you may recall, we had requested some study money in the fiscal year 1980 budget.

Mr. TRAXLER. But to your knowledge, do you know whether they have made a decision in connection with thrust augmentation?

Dr. FROSCH. I have no indication of a formal decision. I believe from informal conversations that they feel that in terms of their long-range plans, they will want thrust augmentation. There was a time when they felt they would not, but I think they have concluded that they are going to go in directions that will require it.

Mr. TRAXLER. I keep reading *Aviation Week,* and it is much like those newspaper stories we were talking about earlier.

Dr. FROSCH. Yes. Both the Air Force and NASA are large organizations and lots of people have lots of ideas.

Mr. TRAXLER. Who would pick up the tab for thrust augmentation, you or the Air Force?

Dr. FROSCH. I think basically we would, on the grounds that it was part of enhancing the basic national Space Transportation System capability, and that both of us would be using it. Other

arrangements could be made, but our assumption has been that we would pick that up, particularly if it turned out that we would not get to the 109 engine capability, then I would have to say it was a failure to meet the original performance spec, and it is NASA's responsibility to do what is required to get to the performance. We have absolutely no reason now to believe that we will not get to the 109, but we have not really tested it at that level.

Mr. TRAXLER. Do you think that 109 thrust level required by Solar Polar in January of 1983 will be available at that time?

Dr. FROSCH. We expect it will be available by then.

COST DIFFERENTIAL BETWEEN IUS AND CENTAUR

Mr. TRAXLER. Coming back to one of the areas that we discussed before, that is, which of the upper stages would best serve both NASA and the nation's requirements in the next 10 to 15 years? Clearly the current IUS being developed by Boeing has some limitations, and some strong points also, perhaps in the economic sense, but we are not really sure. You have not been able to firm us up in that area. We don't feel comfortable with that answer about what the cost differential would be between the IUS and Centaur?

Dr. FROSCH. I am lacking data on the IUS because the data does not exist. That is the trouble. Let me add that at this point it would be hard for me to be sure that the cost data for putting the Centaur in the Shuttle is any firmer than the IUS data. It is also a preliminary design estimate.

IUS COSTS AND SCHEDULE PROBLEMS

Mr. TRAXLER. Looking at the current issue of *Aviation Week*, they have an interesting box that deals with the question of the Air Force looking at their costs and schedule problems with the IUS. Quoting from *Aviation Week*, it says, "Systems Command is studying the cancellation of the IUS project and the use of an alternative upper stage to boost spacecrafts from the Space Shuttle."

The article goes on to say that "both the Administration and NASA are cool to the idea of replacing the IUS with the Centaur because of severe near-term space program disruption that may result." Is that a fair statement?

Dr. FROSCH. Yes, that is a slightly colorful way of describing my worries about what would have to be done to the Shuttle orbiter in order to accommodate Centaur.

Mr. TRAXLER. From a long-term standpoint, 10 or 15 years, if NASA, the Air Force-NASA, were to substitute the Centaur for IUS over a 10-to-15-year period, are the costs substantially reduced?

Dr. FROSCH. That is what I am not quite sure of. I do not think we have determined yet what the total number of uses would be. Part of the virtue of the Centaur is that it could do a number of things that the IUS cannot do, in the business of restarts, the geostationary area starts, and so on. That is a real capability and one that would be certainly nice to have. What we have not looked at is how often do we think we would really use that, but that

speaks not to whether it is a good idea to have it, but to whether it is an economical idea.

Mr. TRAXLER. I think we both already agreed that in a sense we are the tail here.

Dr. FROSCH. Yes.

Mr. TRAXLER. The decision will be made not by this Committee but elsewhere. It seemed to me, though, that the Centaur offers from a cost standpoint one certain advantage, that is, we do know what its costs are. We do know of its reliability.

Dr. FROSCH. We know its reliability as a stage, and we know its current costs as a stage. What we know less about is what it will really cost us to integrate it with the Shuttle, and if a short version has to be made by changing the configuration of the tanks. That is also a preliminary estimated cost.

Mr. TRAXLER. You would not be responsible for the costs on the shorter version of Centaur? That would be Air Force?

Dr. FROSCH. That would be like the IUS situation in reverse. The Air Force would presumably have to undertake that part of it.

Mr. TRAXLER. This Committee is always looking for ways to reduce its share of the budget.

Dr. FROSCH. I understand.

IMPLICATIONS OF USING CENTAUR AND IMPACT ON SHUTTLE

Mr. TRAXLER. To what extent have you really looked at the option here of the Centaur? Neither of us, no one on this Committee, knows what the Air Force is going to be doing over the next several months. I suspect that it is not impossible that they could scrub IUS, but let me ask you this question: To what extent are you seriously looking at that possibility, and what do the implications mean to the Shuttle, and cost analysis on it?

Dr. FROSCH. We have looked at it enough to lay out what the change requirements would be in the Shuttle, to talk to the contractor who builds Centaur about what would be involved in any development or redevelopment or change, and to estimate as best we can, without going into a detailed design, what the costs would be, and I have given some estimates of that in this hearing. The next stage would be to go into a detailed design and start the development changes. I think we are really waiting to see whether, in fact, there is any Air Force action that forces us in that direction.

Mr. TRAXLER. Do you think a 6-month time figure here is——

Dr. FROSCH. My impression is that it will be decided in less than 6 months, because I believe there is a requirement for a completion of negotiation on the contract in the next couple of months, and I do not know of anything in the situation that would force the decision to take longer than that.

CURRENT STATUS OF SPACE SHUTTLE AND FMOF

Mr. TRAXLER. Moving on to another area, let us talk for a few minutes about the current status of the Shuttle, and give the Committee your current estimate of the first manned orbital flight and when that will occur. When do you think that is probable?

Dr. FROSCH. I have been giving estimates in terms of odds, not to everybody's satisfaction, but it is the best I know how to do.

Mr. TRAXLER. Like trying to start up a nuclear plant, you are really not too sure when that can occur.

Dr. FROSCH. I think we are better off than that.

Mr. TRAXLER. I think so, too.

Dr. FROSCH. We are estimating the 50–50 probability point as being August-September, and perhaps, 70–80 percent by the end of the year. At the moment the long pole in the tent appears to be the main propulsion testing of the engine.

Mr. TRAXLER. In the 1980 supplemental request now before OMB, which is in the area of $300 million, is that sufficient to maintain the current delivery schedule of Orbiter 99 and 103?

Dr. FROSCH. Yes, it is calculated to support that.

Mr. TRAXLER. That would be for June of 1982 and September of 1983?

Dr. FROSCH. Yes.

Mr. TRAXLER. How critical are those delivery dates to the key defense missions in 1983 and 1984, and what is the impact of Shuttle launch and delivery delay on a backup requirement of expendable boosters for the Air Force?

Dr. FROSCH. That is several questions.

Mr. TRAXLER. Yes.

Dr. FROSCH. Those deliveries are calculated to meet the Air Force requirements, and they are pretty critical to Shuttle launch of those missions. The Air Force has some backup expendable launch vehicles for some of its missions, that is, it has fewer boosters than total number of missions, so they have some backup. I know they are considering in their budget the question of whether that is sufficient assurance against the problem, so I think that question of hedging is being looked at.

Mr. TRAXLER. We would like as precise an answer as possible. By what date must FMOF occur before the Air Force will feel it must go back to the expendable launch vehicles for its key defense requirements that are currently scheduled for launch in 1983?

Dr. FROSCH. It is a little hard for me to give an estimate of somebody else's psychological state.

Mr. TRAXLER. Sure.

Dr. FROSCH. I think in terms of assurance, of having expendable launch vehicles in process which could be used. They have to some extent already arranged that assurance for the first couple of flights, so that that is a little bit easier for them to look at. Our estimate is that the connection between the date of the first manned orbital flight and the ability to launch the Air Force missions is not very tight, in the sense that it probably could occur as late as the late Spring of 1981, before one began to have a situation where one would not be sure there would have been enough orbital flight tests to make it comfortable to launch the new orbiters. That is really the way it goes. What we are assuming is that we have the first manned orbital flight, and we have something like a year to 18 months' worth of flight tests, and that is the point at which we certify commencing operations. So, that if you back up from their dates by 18 months, at the outside, then you get

sort of a last date at which people would be comfortable, and that comes out to be something like the Spring of 1981.

Mr. TRAXLER. I wonder what Dr. Marks' answer is to that question.

Dr. Frosch. I think it is the same from our discussions with him.

Mr. TRAXLER. Is there anything further? Larry?

CRITICAL TIME FACTOR FOR JUPITER ORBITER PROBE

Mr. COUGHLIN. I realize this was before your time, but I do want to go back to the Jupiter orbiter probe, because it is the whole reason we have these hearings. From the hearings on the fiscal year 1978 appropriation, let me just say that I asked a question as to the Jupiter orbiter probe about priorities and about when this probe had to go, and here is a response from Dr. Fletcher on page 54 of those hearings:

In the case of the Jupiter orbiter probe there is a critical time problem. If we do not start development in fiscal 1978 it would take another 50 years before you do that unique type of mission again, so it is important to start that now if we are to take advantage of the low-energy-launch window.

Then again on page 76 of those hearings, the chairman asked:

Is Fiscal Year 1978 the year to start the Jupiter orbiter probe? When is the next available window to launch the Jupiter orbiter probe?

Dr. Fletcher said:

The next low-energy-launch window will not occur for about 5 years, Mr. Chairman. It is necessary to start the Jupiter orbiter probe in Fiscal Year 1978 to meet unique low-energy-launch window in 1981–82.

I guess what I am trying to say is that the clear implication to this member of the Committee at least, I do not know how many times you have to ask the question, whether you could launch the same mission in 1987–88 that you could launch in 1981–82, and the reason that is important in my mind is the whole question of planetary exploration, what priority that has, what can be done with that, to give this Subcommittee the ability to make the judgments, we need accurate answers. Perhaps at times we do not know the followup questions to ask, but it is important that we have full and complete information so we can make the judgments as to how these programs are to go. That bothers me considerably.

Dr. FROSCH. I agree with that. That is why I sometimes say more than the answer to the question, because I am trying to answer what I think may be behind it. I do not know exactly what Jim Fletcher had in mind, but I think what he was saying is that there are opportunities in 1981–82. There are also opportunities in 1987, but I suspect he was not thinking that there were opportunities to do the identical mission, but to do a Jupiter orbiter probe.

Mr. COUGHLIN. He talks about the same unique mission. That is pretty clear, at least from this side of the table it is pretty clear.

Thank you, Mr. Chairman.

Mr. TRAXLER. Are there any other questions?

Thank you very much, Dr. Frosch.

Dr. FROSCH. Thank you.

Mr. TRAXLER. We appreciate your appearance here this morning. You are enlightening as always, and we look forward to your

appearing here and telling us one day that you want to return money to the Treasury.

Dr. FROSCH. I would like to do that, Mr. Chairman. Thank you, Mr. Chairman.

[Whereupon, at 1:15 p.m., the Subcommittee was adjourned, to reconvene at the call of the Chair.]

Mr. TRAXLER. The Committee stands adjourned.

TUESDAY, MARCH 25, 1980.

WITNESSES

DR. ROBERT A. FROSCH, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

DR. ALAN M. LOVELACE, DEPUTY ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

WILLIAM E. LILLY, COMPTROLLER, NASA

JOHN YARDLEY, ASSOCIATE ADMINISTRATOR FOR SPACE TRANSPORTATION SYSTEMS, NASA

GEN. BILLIE J. McGARVEY, DIRECTOR OF FACILITIES, NASA

EDWARD KILGORE, ASSOCIATE ADMINISTRATOR FOR MANAGEMENT OPERATIONS, NASA

Appropriation	Fiscal year	
	1980	1981
Research and development	[1] $4,107,500,000	$4,569,500,000
Construction of facilities	$156,100,000	$120,000,000
Research and program management	[2] $1,006,186,000	$1,047,154,000
Total	$5,269,786,000	$5,736,654,000
Positions	22,613	22,713

[1] Includes proposed supplemental of $300,000,000 for Space Shuttle.
[2] Includes proposed supplemental of $46,286,000 for pay costs.

Mr. BOLAND. The Committee will come to order. We are pleased to have with us today witnesses for the National Aeronautics and Space Administration. We welcome Dr. Frosch, the Administrator, and Dr. Alan M. Lovelace, Deputy Administrator; Mr. William Lilly, Comptroller; Mr. John Yardley, Associate Administrator for Space Transportation Systems; General Billie McGarvey, Director of Facilities, and Mr. Edward Kilgore, Associate Administrator for Management Operations.

The original 1981 budget request for the National Aeronautics and Space Administration was $5,736,654,000. That broke down into three major accounts as follows:

Research and Development—$4,569,500,000; Construction of Facilities—$120,000,000; Research and Program Management—$1,047,154,000.

That is an increase of $466,868,000 above the 1980 level—when both the pay cost supplemental of $46.2 million and the Shuttle supplemental of $300 million are considered as enacted.

We understand, however, that the most recent budget exercise, the results of which should be announced shortly, will reduce NASA's total request on the order of approximately $220 million in 1981. I might point out that if that proves to be the true reduction from the original request—it is larger by a factor of four than any reduction enacted by Congress over the past ten years.

What we plan to do today is to have a number of general questions dealing with the Shuttle and one or two other related areas—then proceed to a detailed hearing on the 1980 Shuttle supplemental and the 1981 Shuttle request—both of which are not affected by the budget reductions.

We are glad to have all of you here today. You have appeared before this Committee many times before.

Two years ago this month, I gave a talk before the American Association for the Advancement of Science. The budget exercise of the past two or three weeks reminded me of one or two things I touched on in that speech. I was talking about the outlook for agencies like NASA, the National Science Foundation, for the coming years—how they would fare in the budget allocations.

I don't say this in criticism of NASA. I only say it to indicate that even two years ago all the Members of this Subcommittee were looking at some of these programs and indicating that somewhere down the road we would have to come to a judgment as to what the highest priorities would be, not alone at NASA but also other agencies that come within the purview of this Committee.

Let me quote briefly from those remarks:

> Ten years ago, roughly 50 percent of the Federal budget was defined as uncontrollable. Today, roughly 75 percent is classified as uncontrollable. The driving force behind that increase has been a tremendous growth of what we call Federal entitlement programs. These are medicare, medicaid, social security, food stamps, veterans benefits, unemployment insurance, subsidized housing programs, revenue sharing, et cetera. As those programs are proposed, become law, they lock up a larger and larger percentage of the total budget.
>
> What does that mean? It means that each year the President has less and less maneuverability to channel Federal spending—or in other words—to manage the budget.
>
> But it also means something else—something that is vital to NASA's future. After all the uncontrollables are funded—the remaining 25 percent comes under increasing pressure to make cuts. NASA is one of those agencies that is in that 25 percent—and any President who is struggling to balance a budget, whether it is 1980, 1981 or 1982, or 1983, will continue to squeeze nearly all controllable programs.

Now, nobody would disagree with that analysis.

Dr. FROSCH. No.

Mr. BOLAND. How does that analysis stack up against what NASA has actually experienced in the past two or three years?

Dr. FROSCH. In the past two or three years I think your opening comment is correct. The budgetary pressures have generally been with OMB and the Administration. The Congress has on the whole passed the budget for NASA that the Administration has sent up. In the past few weeks, the budget exercise has demonstrated precisely what you said in the speech. It has been the controllables that have had to be reviewed.

Mr. BOLAND. In looking at the controllables I suppose you would have to first look at the priorities. That would be an essential part of the evaluation, would it not?

Dr. FROSCH. Of course.

SPACE SHUTTLE AS FIRST PRIORITY

Mr. BOLAND. During that talk I indicated that I had received a letter from a very prominent American Astronomer who suggested that—and I'm going to quote it now—suggested "With the Shuttle system now developed it makes sense to use it to do some space astronomy."

I tried to point out that the shuttle system was not developed—and that it didn't make much sense to build a large space telescope and not have an operational Space Shuttle to put it in.

I guess the point I was trying to make two years ago in that talk—and the point we have made over the past two years in our reports—is that the Shuttle should have first priority.

I think the NASA people agree with this now, do they not? I am sure that must be the consensus of the Administration too. This has been the one area that has not been touched.

If only so many dollars are available—then those should have been allocated first to the Shuttle at the expense of other projects.

I know that approach and that position is not one that is universally popular—but I think the experience with the budget for the Shuttle program over the past year—the experience of the last two to three weeks—and the conclusions of Dr. Lovelace's own report on the Space Transportation System—all support what we have been trying to get across.

Would you like to comment on that?

Dr. FROSCH. I think the best time to comment on that will be when we can discuss all of the changes in the budget. I think the general point is that we have carried the Shuttle as first priority throughout the discussion of budget changes.

One of the problems that had to be discussed early, is the question as to how large the total cut would be. At certain sizes of cuts it would be impossible to hold the Shuttle program without being touched until we would have a Shuttle program only and no other NASA program. While it might fit a priority, that would not make complete sense. Those discussions led to the conclusion that the cuts might have to be adjusted and that the Shuttle should be held inviolate in this cut. I think the other details would have to wait for a final resolution of what the President's budget amendments will be.

Mr. BOLAND. One of the problems is that looking at the budgets from agencies like NASA, and National Science Foundation, and some others in the scientific field, one would come to the conclusion that they don't want to share in the cuts, no matter what the problem is facing the Nation or the inflationary rate or what programs ought to enjoy the highest priority and what ought to be postponed or even scrubbed.

In another area we find with the NSF that the resolution of the scientific community isn't quite like other areas across the spectrum of American life, in their inability to cooperate with the

Soviet Union in particular agreements, we find they don't want to cut any of that money out. There is about $3.5 million in the NSF budget to implement the cooperative agreements between the United States and the U.S.S.R. I think it is an area where the spirit of this Nation ought to send a message to them.

It has been our feeling that is not quite the way the scientific community looks upon it. You don't have to respond to that. That is an analysis of my own, probably joined in by others.

With that we come to your statement so why don't we go ahead with it?

Dr. FROSCH. Thank you, Mr. Chairman. I would propose to summarize parts of my statement and submit the entire statement for the record.

Mr. BOLAND. Fine.

GENERAL STATEMENT

Dr. FROSCH. I want to begin by thanking the Subcommittee for proceeding with this hearing in the face of the current uncertainties. These uncertainties are in a good cause: the Administration and the Congress are seeking ways to reduce or eliminate the Federal budget deficit in fiscal year 1981, and that requires reductions in the outlays planned in the budget as originally submitted.

As you know, Mr. Chairman, the President soon will announce a set of amendments to his budget. Until he does, we are not in a position to discuss possible changes in the budget estimate submitted in January. Because of the great importance of action by June on the $300 million supplemental request for fiscal year 1980 Space Shuttle funds, we have been authorized to testify here today on the fiscal year 1980 and 1981 requirements for Space Shuttle, and the construction of facilities request.

To the extent you wish, Mr. Chairman, we are prepared today and later this week to discuss the other portions of the fiscal year 1981 NASA budget as submitted in January. As soon as the President's overall budget revisions are determined and released, we can discuss the budget in the context of any changes he proposes.

The budget as submitted in January included $300 million in supplemental fiscal year 1980 research and development funding for the Space Shuttle, and $1.873 billion for fiscal year 1981. Also included, as construction of facilities items, was a total of $10.1 million in Space Shuttle facilities. These amounts, and the corresponding outlay estimates, are not being reduced in the current reexamination by the President.

HIGHLIGHTS OF SIGNIFICANT PROGRESS MADE ON SPACE SHUTTLE

Mr. Chairman, as you know, the Space Shuttle is an extremely complex system whose development has required significant successes at the frontiers of technology. We have had many successes, and we have had some problems, although I believe those problems are of a technological nature that should not be unexpected in a program of this magnitude. Before reviewing our budget request for the Space Shuttle, let me highlight a few items that demonstrate the significant progress we have made.

1. All elements for the first orbital flight test have been delivered to KSC.

2. All seven scheduled development and qualification firings of the solid rocket motor have been successfully completed.

3. The eighth in a series of main propulsion test firings was successfully completed on March 20, 1980. These tests, involving the firing of the three engine cluster, included 3-full duration firings at rated power level.

4. Engine testing has exceeded 70,000 seconds of firing time, out of the 80,000 seconds required. Included in this total was a 10-second engine test at full power level (109 percent) on March 13.

5. The Thermal Protection System installation on the orbiter has achieved an average rate of about 500 per week for the past eight weeks.

6. An Orbiter Integrated Test at KSC has been successfully completed.

FISCAL YEAR 1980 SHUTTLE SUPPLEMENTAL REQUIREMENTS

The technical progress of the Space Shuttle Program at this critical phase of the development effort has been substantial, but has not sustained the pace necessary to accomplish the schedule presented in our fiscal year 1980 budget plan, thus making it necessary to adjust program schedules and request a Supplemental Appropriation of $300 million.

Let me briefly review the elements of this request.

The orbiter project requires $140.1 million supplemental funding in fiscal year 1980. This has been caused by additional engineering and subcontractor activity due to problems encountered in the qualification and certification programs, delays in the main propulsion test program, and the additional effort required to complete the application and testing of TPS tiles, and other subsystem installations at KSC. Other funding increases have been experienced in support areas caused by schedule delays, and in systems areas due to additional vehicle system testing planned for fiscal year 1980.

The Solid Rocket Booster project requires $3.7 million in supplemental funding in fiscal year 1980, and External Tank project requires $11.0 million more. Launch and landing project activities require $45.2 million in supplemental funds for fiscal year 1980.

The recent management and cost reviews at various levels throughout the Space Shuttle Program at NASA, and with major contractors, have emphasized the need for an adequate allowance for likely changes and potential systems modification to meet performance requirements. Funding of $100 million is included in the fiscal year 1980 supplemental request to provide for this need in fiscal year 1980. The current fiscal year 1980 production estimates are the same in total as projected in the fiscal year 1980 budget. There has been a rebalancing to reflect the revised delivery schedules and the acceleration of engines to provide backup hardware to support the development program, but no additional funds are requested for the production program in fiscal year 1980.

Mr. Chairman, I would like to emphasize that the effects of not receiving the supplemental funds requested would be significant.

We would be forced to lay off a significant number of skilled workers currently employed in Shuttle related activities across the country. Our best estimate at this time is that some 20,000 skilled workers would be affected. In addition, the Shuttle first flight would slip about three or four months, and we would be forced to curtail significantly our work on the three follow-on production orbiters. This curtailment would slip those orbiter deliveries by about nine months.

As you know, a delay in the delivery of the follow-on orbiters would impact our ability to meet critical civil and defense requirements. We estimate that the consequences of not obtaining the additional funds requested would increase total program costs by $600–900 million. Thus, we request the Subcommittee to act favorably on the pending supplemental request.

SPACE SHUTTLE FISCAL YEAR 1981 BUDGET REQUEST

Let me turn now to a review of our fiscal year 1981 budget requests for the Shuttle.

For fiscal year 1981 we are requesting $683.0 million for Space Shuttle Program Design, Development, Test and Evaluation efforts, $150.0 million for Changes and Systems Upgrading, and $1,040.0 million for Production activities, for total program funding of $1,873.0 million.

SHUTTLE DESIGN, TEST, AND EVALUATION

In fiscal year 1981, we require $320.9 million for the orbiter project. Testing on Columbia will be completed in mid-1980. Fiscal year 1980 activities support preparations for the first orbital flight. Orbiter 102, Columbia, which will be used for the OFT program, is in final assembly and checkout at the Orbiter Processing Facility at KSC. After completing the TPS installation and integrated tests, the orbiter will be delivered to the Vehicle Assembly Building for assembly with the ET and SRBs in the launch configuration.

The emphasis for fiscal year 1981 will be on initiation of the OFT Flight Program and conducting the follow-on OFT flights scheduled for launch during this period. Orbital flights are planned on an average of every four to five months. Post-flight analysis, redesign engineering, and incorporation of necesary changes will be the major requirements during this period. The Mission Control Center (MCC) will support integrated simulations with the Space Shuttle mission simulator and the OFT flights.

Life-demonstration tests on critical orbiter subsystems will continue in fiscal year 1981, and development of an improved TPS for follow-on vehicles will be pursued.

Since the last two OFT flights are programmed for maximum dynamic pressure environments, the development of the Manned Maneuvering Unit (MMU) has been accelerated in order to have on-orbit inspection and repair capability for the TPS. A qualification unit and two flight articles will be produced, and crew training will begin on the contractor's simulator.

A total of $145.7 million is being requested for the Space Shuttle main engine development effort for fiscal year 1981. During FY 1981, continuing engine support will be required for the OFT. This

effort will include a full complement of component and full engine test capability and analytical support for the flight missions. Single engine testing will continue in order to accomplish preliminary flight certification of the engine at full power level (FPL). During the certification program, the engine must demonstrate reliability and performance at FPL which is 109 percent of rated power.

For fiscal year 1981, we are requesting $48.0 million for the fabrication and testing of the external tank. The first flight tank has been delivered to KSC, but some changes are currently being completed in the VAB prior to mating with the solid rocket boosters. A second flight tank is in the process of having the thermal protection system applied.

We are requesting $14.0 million for the SRB in fiscal year 1981. Development testing will be completed and SRBs for the OFT flights will be delivered in 1981.

Funding requirements for the launch and landing activities total $154.4 million for fiscal year 1981. The funding for changes and systems upgrading efforts in fiscal year 1981 total $150.0 million. It is anticipated that changes and systems modifications will be identified during final flight preparations. From our flight test experience, this funding will be required to provide an adequate allowance to implement any modifications needed.

We are requesting $1,040 million in fiscal year 1981 for production activities. Space Shuttle production provides for modification of Orbiter 099 to orbital flight configuration refurbishment of Orbiter 102 after the OFT program and early operations period, and the fabrication and assembly of two additional orbiters. The modifications of Orbiter 099, scheduled for delivery in June, 1982, have been started. Fabrication and assembly of major subsystems and structural elements of Orbiter 103 have begun and will continue through fiscal year 1981, with vehicle delivery scheduled for late 1983. Long lead ordering of critical parts is underway for Orbiter 104, scheduled for delivery at the end of calendar year 1984.

FISCAL YEAR 1981 BUDGET REQUEST FOR CONSTRUCTION OF FACILITIES

We are requesting $120 million for Construction of Facilities which is a decrease of $37.6 million from the amount requested in fiscal year 1980. Our 1981 request includes only the minimum essential facility requirements for supporting high priority programmatic and institutional needs. The program requested, in a major sense, continues and completes facility work that was initiated with prior years' resources.

This concludes the summary of my prepared statement. We will be pleased to answer any questions you may have.

[The statement follows:]

Mr. Chairman and Members of the Subcommittee:

I want to begin by thanking the Subcommittee for going ahead with this hearing in the face of the current uncertainties. These uncertainties are in a good cause: the Administration and the Congress are seeking ways to reduce or eliminate the federal budget deficit in fiscal 1981, and that requires reductions in the outlays planned in the budget as originally submitted.

As you know, Mr. Chairman, the President soon will announce a set of amendments to his budget. Until he does so we are not in a position to discuss possible changes in the budget estimate submitted in January. Because of the great importance of action by June on the $300 million supplemental request for FY 1980 Space Shuttle funds, we have been authorized to testify here today on the FY 1980 and 1981 requirements for Space Shuttle, and the construction of facilities request.

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Mr. Chairman, as you know, the Space Shuttle is an extremely complex system whose development has required

significant successes at the frontiers of technology. We have had many successes, and we have had some problems, although I believe those problems are of a technological nature that should not be unexpected in a program of this magnitude. Before reviewing our budget request for the Space Shuttle, let me highlight a few items that demonstrate the significant progress we have made:

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FY 1980 Supplemental Requirements

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Let me briefly review the elements of this request.

The orbiter project requires $140.1 million supplemental funding in FY 1980. This has been caused by additional engineering and subcontractor activity due to problems encountered in the qualification and certification programs, delays in the main propulsion test program, and the additional effort required to complete the application and testing of TPS tiles, and other subsystem installations at KSC. There have also been a number of changes required to make the system

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hardware and software operate properly as determined by the comprehensive test programs. In addition, there have been a number of subcontractor cost increases due to development and producibility problems. Examples include TPS tiles, auxiliary power unit, orbiter maneuvering system pod, the KU-band rendezvous radar, S-band communications subsystems, and extravehicular suit development. Other funding increases have been experienced in support areas caused by schedule delays, and in systems areas due to additional vehicle system testing planned for FY 1980.

Supplemental funding of $11.0 million is necessary to offset the FY 1980 increase in External Tank project requirements. This increase was principally caused by changes, particularly to protect against protuberance icing and to accommodate additional air loads.

The Solid Rocket Booster project requires $3.7 million in supplemental funding in FY 1980. This additional funding requirement will cover technical changes, and qualification test problems, as well as DDT&E flight hardware delivery delays to support the slipped development flight schedule.

Launch and landing project activities require $45.2 million in supplemental funds for FY 1980. The primary reason for this added funding is the additional time and effort required to prepare for the launch of STS-1. This has impacted the funding requirements because Orbiter 102 has been in processing in the OPF longer than planned while the test and checkout phase of launch preparation is being completed. In addition, the test and checkout phase is proving to be more complicated and requires much more contractor manpower and overtime than had originally been estimated. The capacity of Launch Processing System (LPS) computers required expansion, and many changes continue to be required to prepare the Ground Support Equipment (GSE) for operational use. These modifications of the ground station sets throughout KSC are the result of the actual checkout and handling of flight hardware during processing for the first Shuttle launch.

The recent management and cost reviews at various levels throughout the Space Shuttle Program at NASA, and with major contractors, have emphasized the need for an adequate allowance for likely changes and potential systems modification to meet performance requirements. Funding of $100 million is included in the FY 1980 supplemental request to provide for this need in FY 1980. These funds are necessary, particularly at this time, to provide for the modifications which are most likely to result from the intensive testing and checkout for the flight test phase, necessary changes to increase reliability and safety, and changes designed to lower operating

costs of the space transportation system. As these requirements develop and are approved, they will impact the funding estimates for either development or production and the funding will be applied accordingly.

The current FY 1980 production estimates are the same in total as projected in the FY 1980 budget. There has been a rebalancing to reflect the revised delivery schedules and the acceleration of engines to provide backup hardware to support the development program, but no additional funds are requested for the production program in FY 1980.

Mr. Chairman, I would like to emphasize that the effects of not receiving the supplemental funds requested would be significant. We would be forced to lay off a significant number of skilled workers currently employed in Shuttle related activities across the country. Our best estimate at this time is that some 20,000 skilled workers would be affected. In addition the Shuttle first flight would slip about three or four months, and we would be forced to curtail significantly our work on the three production orbiters. This curtailment would slip those orbiter deliveries by about nine months. As you know, a delay in the delivery of the follow-on orbiters would impact our ability to meet critical civil and defense requirements. We estimate that the consequences of not obtaining the additional funds requested would increase total program costs by $600-$900 million. Thus we request the Subcommittee to act favorably on the pending supplemental request.

Let me turn now to a review of our FY 1981 budget request for the Shuttle.

FY 1981 Budget Request

For FY 1981 we are requesting $683.0 million for Space Shuttle Program Design, Development, Test and Evaluation (DDT&E) efforts, $150.0 million for Changes and Systems Upgrading, and $1,040.0 million for Production activities, for total program funding of $1,873.0 million.

Design, Development, Test and Evaluation

In FY 1981, we require $320.9 million for the orbiter project. Testing on Columbia will be completed in mid-1980. FY 1980 activities support preparations for the first orbital flight. Orbiter 102 (Columbia), which will be used for the OFT program, is in final assembly and checkout at the Orbiter Processing Facility (OPF) at KSC. After completing the TPS installation and integrated tests, the orbiter will be delivered to the Vehicle Assembly Building (VAB) for assembly with the ET and SRBs in the launch configuration.

Avionics verification tests are underway at the Space Shuttle Avionics Integration Laboratory (SAIL) at Johnson Space Center (JSC) for ascent and at the Flight Systems Laboratory (FSL) at Rockwell in Downey for entry. Final flight software initial conditions for the specific launch day data, and vehicle configuration will be demonstrated prior to the first Space Shuttle flight (STS-1), and landing simulations on the Ames Research Center moving base simulation facility are planned to provide further verification of STS-1 landing capabilities and techniques.

Support activities managed by JSC will continue, including software modifications in the Mission Control Center (MCC), use of crew training simulators, development of government furnished equipment such as space suits, and the performance of test to support the orbiter project.

The emphasis for FY 1981 will be on initiation of the OFT Flight Program and conducting the three OFT flights scheduled for launch during this period. Orbital flights are planned on an average of every four to five months. Post-flight analysis, redesign engineering, and incorporation of necessary changes will be the major requirements during this period. The MCC will support integrated simulations with the Space Shuttle mission simulator and the OFT flights.

Life-demonstration tests on critical orbiter subsystems will continue in FY 1981, and development of an improved TPS for follow-on vehicles will be pursued.

Since the last two OFT flights are programmed for maximum dynamic pressure environments, the development of the Manned Maneuvering Unit (MMU) has been accelerated in order to have on-orbit inspection and repair capability for the TPS. A qualification unit and two flight articles will be produced, and crew training will begin on the contractor's simulator.

A total of $145.7 million is being requested for the Space Shuttle main engine development effort for FY 1981. During 1979, problems with several main engine components continued to stretch out the test program causing the main engine project to accumulate fewer test seconds than planned. In spite of these problems, progress this year has been significant, and we are close (70,000 seconds) to achieving the 80,000 test seconds required before the launch of STS-1.

During FY 1981, continuing support will be required for the OFT. This effort will include a full complement of component and full engine test capability and analytical support for the flight missions. Single engine testing will continue in order to accomplish PFC of the engine at FPL. During the certification program, the engine must demonstrate reliability and performance of 109% of rated power. The last two main propulsion test assemblies will be run in FY 1981 to demonstrate this 109% power level operation of three engines in a cluster. FY 1981 main engine funding will also support the engine system simulation laboratory, engine software integration, and procurement of propellants for the test programs at Santa Susana and at NSTL.

In addition to the development and test work, procurements of propellants for test firing the engine and its components, the maintenance of the engine systems hardware simulation laboratory, logistic support, and the evaluation of materials and processes will continue in FY 1981.

For FY 1981 we are requesting $48.0 million for the fabrication and testing of the external tank (ET). The first flight tank has been delivered to KSC, but some changes are currently being completed in the VAB prior to mating with the solid rocket boosters (SRBs). A second flight tank is in the process of having the thermal protection system (TPS) applied. Delivery to KSC of this tank is planned for the third quarter of FY 1980. The third and fourth tanks will be assembled, the TPS applied, and will be readied for shipment to KSC during the year for delivery in FY 1981.

During FY 1980, a major engineering and manufacturing effort will be expended on the lightweight tank design. The goal of reducing the weight of the tank by 6,000 pounds will be achieved by optimizing the thickness of the basic skin, ribs, and chords of the intertank, liquid oxygen tank, and liquid hydrogen tank. The first lightweight tank is scheduled for delivery in January 1982.

In FY 1980 and FY 1981, efforts are being undertaken to improve the producibility of the ET. The basic objective is to develop new techniques and processes to build the ET more efficiently and economically.

We are requesting $14.0 million for the SRB in FY 1981. Development testing will be completed and SRBs for the OFT flights will be delivered in 1981.

The booster assembly contractor will assemble and checkout the SRBs for all flights, and will be involved with refurbishment and checkout of recovered hardware. During FY 1981, major activities will consist of assembly and checkout of the SRBs for the OFTs, and refurbishment and checkout of recoverable hardware.

Funding requirements for the launch and landing activities total $154.4 million for FY 1981. The Space Shuttle landing sites at the Edwards Air Force Base and the Kennedy Space Center (KSC), and the OPF and launch processing system at KSC were activated in FY 1979, and were operational at the beginning of FY 1980.

About 98% of the required KSC provided ground support equipment (GSE) (approximately 290 models) and 90% of the contractor provided GSE (approximately 680 models) have been delivered and installed in the processing stations. Both GSE and flight systems replacement spares are being provided, processing fluids are being supplied to support checkout and testing, and propellants are being accumulated for the first launch.

During FY 1981, the principal activities in the launch and landing project will focus on processing flight elements and vehicles for STS-1 through STS-3. This FY 1981 processing activity is supported with the LPS, logistics, transportation, propellants, and spares provisioning. There are also provisions for facility and equipment modifications and required changes throughout this development period.

Changes and Systems Upgrading

The funding for changes and systems upgrading efforts in FY 1981 total $150.0 million. During FY 1981, orbital flights will be scheduled about every four to five months. It is anticipated that changes and systems modifications will be identified during final flight preparations and from our flight test experience and this funding is required to provide an adequate allowance to implement any modifications needed. The need for these funds is strongly supported by the recent Space Shuttle program management and cost reviews.

Production

We are requesting $1040 million in FY 1981 for production activities. Space Shuttle production provides for modification of Orbiter 099 to orbital flight configuration refurbishment or Orbiter 102 after the OFT program and early operations period, and the fabrication and assembly of two additional orbiters. Production activities also include fabrication of main engines, preparation of the second series (second line) of Space Shuttle ground processing and launch support equipment at KSC to permit simultaneous processing of two Space Shuttle vehicles, and the necessary Space Shuttle spares and equipment

required. The modifications to Orbiter 099, scheduled for delivery in June, 1982, have been started. Fabrication and assembly of major subsystems and structural elements of Orbiter 103 have begun and will continue through FY 1981, with delivery scheduled for late 1983. Long lead ordering of critical parts is underway for Orbiter 104, scheduled for delivery at the end of CY 1984. Fabrication and assembly of major elements for 104 will begin in FY 1981.

Production engine materials and component procurement will continue during FY 1981. Component deliveries will be phased to support the fabrication and assembly operations. Fabrication and assembly of engines for installation into Orbiter 099 and refit for Orbiter 102 will be well underway for the required delivery dates in 1982. Fabrication and assembly of engines for installation into Orbiter 103 will be underway by the end of FY 1981. Early delivery of production engines will provide additional hardware in the event it is needed for development testing.

CONSTRUCTION OF FACILITIES

We are requesting $120 million for Construction of Facilities which is a decrease of $37.6 million from the amount requested in FY 1980. Our request includes only the minimum essential facility requirements for supporting high priority programmatic and institutional needs. The program requested, in a major sense, continues and completes facility work that was initiated with prior years' resources.

Approximately $10 million is requested for Shuttle unique projects, primarily at the Michoud Assembly Facility in New Orleans and the Thiokol Plant in Wasatch, Utah. The request also includes $8.4 million for Energy Conservation projects in continuation of our concerted efforts to reduce energy consumption. The minor facility program includes projects under $500 thousand per project for essential repairs, modifications, and rehabilitation necessary to keep the NASA physical plant operational, reliable, and responsive to our research, development, and testing needs. The level requested is the very minimum necessary to sustain present operations.

Funding for the National Transonic Facility at Langley and the modifications to the 40 X 80 foot Subsonic Wind Tunnel at Ames was completed in FY 1980. I am pleased to report that both projects, which will become invaluable national aeronautical test facilities, are currently on schedule, within cost, and scheduled for operations in 1982.

SHUTTLE DELAY AND IMPACT ON USERS

Mr. BOLAND. Thank you very much for your statement. It is a general statement concerning your request of $1.873 billion for the fiscal year 1981 Shuttle budget.

The first launch of the Shuttle comes next February. Is that correct?

Dr. FROSCH. I would say that February is about in the middle of the probable period, for the first orbital flight. Not earlier than the end of November, but I expect it before the end of March. I think February is a good estimate.

Mr. BOLAND. So that schedule has slipped almost two years, hasn't it?

Dr. FROSCH. It will have slipped about a year and a half.

Mr. BOLAND. What has been the impact of the delay on the users of the Shuttle?

Dr. FROSCH. With regard to the DOD, we are holding the production schedule so there would not be an impact on the key DOD missions. With regard to the commercial users, a number of the commercial users will have to use backup expendable launch vehicles, and we have been working with them to arrange that where necessary.

A number of them had already planned backups in case we did have a delay, and they will move to those backups. We moved to extend the availability of Delta launch vehicles for additional users who will be pushed out of the early part of the originally proposed manifest. We are now in discussions with INTELSAT with regard to the possible continued availability of an Atlas/Centaur for certain of their launches.

Mr. BOLAND. How many payloads have had to be transferred back to expendable boosters?

Mr. YARDLEY. About five, I think.

Mr. BOLAND. What has the impact of the delay of the Shuttle been on the cost of the system?

Dr. FROSCH. The growth of the development estimate measured in constant 1971 dollars is about $1 billion.

Mr. BOLAND. What is the total cost of the Space Transportation System (STS)—both NASA and DOD in 1981 dollars?

Mr. LILLY. The total STS investment in dollars of the fiscal year 1981 budget is $17,313 million of which NASA is $14,043 million.

EFFECT OF SHUTTLE DELAY ON EXPENDABLE LAUNCH VEHICLES

Mr. BOLAND. It is interesting to note that the Shuttle is supposed to drive out expendable boosters, but in the past year we have found that the Air Force has ordered two additional Titans for its own missions—a new upgraded Delta is being developed—and most recently you have advised the Committee of your intentions to continue the production of Atlas/Centaurs. What has happened to the promise of the Shuttle?

Dr. FROSCH. The promise can't be fulfilled until development is completed and we are into operation. These actions are intended to carry us through the transition period required to complete Shuttle development.

Mr. BOLAND. That was really one of the objectives.

Dr. FROSCH. That was the objective, and still is. What we are seeing is a delay in getting to that point. We still expect the operational phase of the Shuttle system to be as it was originally predicted with about a dozen years in the mission model. It means only that we will start ELV replacement later.

DELIVERY SCHEDULE OF ORBITERS 099 AND 103

Mr. BOLAND. Two weeks ago we talked with you concerning the delivery dates of Orbiters 099 and 103. The current delivery date for Orbiter 099 is June, 1982—is that correct? And the current delivery date for Orbiter 103 is September, 1983—is that correct?

Mr. YARDLEY. Yes.

Mr. BOLAND. Does the 1980–1981 budget for the Space Shuttle, as it is presently constituted, guarantee delivery of those two orbiters within the time frame you just discussed?

Dr. FROSCH. As presently constituted it supports the delivery of those two orbiters in that time frame, and I think it guarantees them against all ordinary circumstances but there could conceivably be some major unknown problems.

Mr. BOLAND. So if everything goes on schedule, that will be the time frame within which both Orbiter 099 and 103 would be delivered?

Dr. FROSCH. Yes, Mr. Chairman, assuming the fiscal year 1980 supplemental, and assuming that we know soon enough that we are going to get the fiscal year 1980 supplemental so we don't have to take any action to slow things down.

Mr. BOLAND. The maintenance of the delivery system is very crucial in appropriating dollars, as you recognize, and the rationale behind the justification for this supplemental is targeted on the delivery dates.

Dr. FROSCH. Exactly.

CONSTRUCTION OF VANDENBERG WESTERN TEST RANGE

Mr. BOLAND. We have been advised as was indicated in the hearing which we attended a few weeks ago, that the Air Force is short some $75 million to meet the construction schedule of an operational Western Test Range at Vandenberg by December, 1983.

If that is correct, and I understand that it is, would you agree that a slip in the operational schedule for Vandenberg would likely result in the key defense mission scheduled for the third quarter of 1984 being launched on a conventional vehicle?

Dr. FROSCH. Unless the Air Force can find a way to keep that schedule, it is my understanding from the Secretary of the Air Force that he intends to come to the Congress for reprogramming permission within his military construction budget in order to support that availability for Vandenberg. If they are unable to complete it on time, then that 1984 operation presumably will be delayed.

Mr. BOLAND. Mr. Traxler?

Mr. TRAXLER. Thank you, Mr. Chairman. I want to congratulate you in that you have brought back on board a person from my District, Brian Duff. I look forward to meeting him.

Dr. FROSCH. We are delighted to have him back on board.

EFFECT ON SHUTTLE IF SUPPLEMENTAL IS DENIED

Mr. TRAXLER. Let me ask a question concerning the fiscal year 980 supplemental request. There has been a study that projects a ost increase in the future of some $1.1 billion for Shuttle develop- nent and production if the supplemental request is not granted by une 1, 1980. Is that a fair figure? Is that in the ball park?

Dr. FROSCH. That is a ball park estimate of the impact on NASA nd the effect on others.

Mr. TRAXLER. Do we have any operating room there?

Mr. LILLY. That number is the estimated impact if we did not get he supplemental in fiscal year 1980. If it is delayed beyond June 1, ike a few weeks but we are certain that it will be enacted, we then would try to take the additional risk for a few more weeks; and it probably will have no impact. Beyond June, we start seriously mpacting the production and the cost penalty.

Mr. TRAXLER. If I understand you correctly, if the supplemental is not a matter of dispute in the House and Senate, and if the supplemental went to June 14 you wouldn't see any unfavorable consequences as a result?

Dr. FROSCH. It is a question of the risks we can take without the supplemental appropriation. I think in the circumstance you describe, we would move forward very carefully and we would not have that risk. As someone put it in the previous hearing that the Chairman referred to, "a yes can come late but a no can be disastrous if it comes late."

$200M REDUCTION IN SPACE AND GENERAL SCIENCE

Mr. TRAXLER. The House Budget Committee authorized in their resolution a $200 million reduction in the space and general science category. Assuming that was apportioned between NSF and NASA, what would your share of that be?

Dr. FROSCH. We don't know how it would be apportioned.

Mr. TRAXLER. I understand that. Assuming it is apportioned proportionate to your budget.

Dr. FROSCH. Our budget is almost six times the NSF budget. There was also a single item from DOE, which was the high energy physics project. I presume if one did it strictly in proportion, we would take about five-sixths of it.

Mr. TRAXLER. It has been suggested—purely speculation—there are several levels that might be considered by the Administration in connection with your budget. One would be a level 1 cut of $224 million, a level 2 perhaps of $303 million and a level 3 of $383 million.

We don't know precisely, and I am sure you are not in a position to tell the Committee at this point in time, what the Administration's proposal relative to your budget will be. One thing that troubles me about any and all of those figures is that if any of those are proposed, space science is going to take a drastic cut, assuming your priority is maintained, which is funding for the Shuttle.

It leaves us, then, with an impression that the civilian space effort is going to be a definite casualty in the budget cutting process and that we are developing the Shuttle primarily, if this

holds true, if accepted by the Congress, we would see a Shuttle which is primarily oriented toward military uses.

Is this a fair statement?

Dr. FROSCH. Even if we were to suffer budget cuts such that there were almost no NASA program, then the use of the Shuttle would be something like two-thirds commercial, principally in the area of communications satellite and one-third defense. That is if one wiped out all of NASA's use. That taking the speculations you have described at the third level of $38.3 million, we would be nearly in the position I just described. There would be very little NASA use. In the case of the smallest of the three you described, I think there would still be some significant NASA use, but there would be certainly some things that would have to be deferred or curtailed.

EUROPEAN COMPETITION TO SPACE SHUTTLE

Mr. TRAXLER. How are the Europeans doing? They have launched what is referred to as the Ariane in December of 1979. Can you tell us a bit about this rocket? How serious in competition will it be for the Shuttle and will we lose some customers as a result of the Shuttle delay to the Ariane and have any customers switched thus far and is this a matter of concern to us? There are several questions.

Dr. FROSCH. I think Ariane is best described at this point by analogy to the Atlas/Centaur. It has about that capability, perhaps slightly more. It has had one flight and there is a program for increasing its capability. It will not be in operation for another year. For the first several years, it will be limited to a flight rate of four per year. It can basically accommodate the conventional communications satellites and satellites that can be tailored for the Altas/Centaur size payloads.

We do face some loss of business that might otherwise have come to the Shuttle. I think we face that loss in any case whether we were delayed in starting the Shuttle or not because the Europeans, having developed a system for themselves, are clearly likely to use it for many, if not all of their own launches, and I think that would have happened in any case.

They would certainly try to sell it and presumably sell it competitively if they can. We believe that they will have trouble in price competition when we get the Shuttle operational because we will simply be able to sell space within the Shuttle payload bay in a way which competes below their rates.

The delay has certainly led some potential customers to look at Ariane. I believe two customers who are signed up for Shuttle and are also signed up with earnest money for U.S. expendable launch vehicle backups have put down earnest money for a possible Ariane launch. So we face that potential loss of business. I think that is the situation.

Let me make one further comment. I think there is no question that from a business point of view we face competition with Ariane. In the long run, we may face it from the Japanese as they build up their own launch technology. From Shuttle point of view, that takes away some business. From the point of view of the global interests in space, it is probably advantageous and signals to

us a general interest in the space business beyond that which the U.S. and the U.S.S.R. originally carried.

I think it marks a stage in the European space business where they have confidence and complete capability so they will consider themselves to be a space-using continent if not a space-using nation.

Mr. TRAXLER. It is interesting that the French are the prime supporters. They are project managers for Ariane. There is some advantage, especially from their launch site which is within five-and-a-half degrees of the Equator.

Dr. FROSCH. They have some advantage from that regard. I think it remains to be seen whether the advantage in lift-off is overbalanced by the logistics problems that they face from the remoteness of their site from France where they have a rather long logistics chain to Guyana. That is one of the cost problems they are going to face.

One other item that ought to be considered in looking at the competition and one that I think the customers for anybody's launch vehicle has to look at in considering Shuttle. In choosing between Ariane, and U.S. expendable launch vehicles in the interim, is that while the Shuttle has not flown, Ariane has only flown once, however, we have completed the 150th flight of Delta and the 50th flight of Atlas/Centaur. We know something about the reliability of those vehicles. They are somewhere in the 92 to 95 percent category. In the next couple of years, I think any customer for any of the systems has to face some question of what reliability has been demonstrated and what risks the customers want to take.

ARIANE COSTS VERSUS SHUTTLE COSTS

Mr. TRAXLER. It is fair to characterize Ariane as conservative technological design whose costs are going to be lower than those of the Shuttle in terms of operation.

Dr. FROSCH. One has to be very careful about that. The cost of an Ariane launch will be lower than the cost of a Shuttle launch. But the amount of Shuttle launch that a customer has to buy is a fraction of the total launch costs. With Ariane it is either half or all of the launch costs.

Looking at the equivalent for Delta or Atlas/Centaur payloads it appears that the Shuttle will be competitive with our announced pricing policy.

Mr. TRAXLER. Will that hold true in the case of geosynchronize orbiting?

Dr. FROSCH. You will have to add the cost of the transfer vehicle. I think it is still true in the case of the Delta class or an Atlas/Centaur class for communication payload to geosynchronous orbit.

Mr. TRAXLER. Clearly Ariane is a commercial threat to the Shuttle operation.

Dr. FROSCH. There is no question that it is.

Mr. TRAXLER. I have some other questions for later, Mr. Chairman.

Mr. BOLAND. Mrs. Boggs?

SHUTTLE DELAY ON U.S. AND FOREIGN MILITIARY COMPETITION

Mrs. BOGGS. Thank you, Mr. Chairman.

I was very interested in that line of questioning. The general interest of the space business is something all of us have to think about. When we do, we have to recognize that not only in the commercial use but also in the defense use of space it is imperative that the United States remain preeminent in the field.

We are talking about competition in the business area and we also have to think about the competition in the military area, particularly with the Soviet Union.

I was reading the testimony of the Secretary of Defense before the Senate Committee on Commerce, Science and Transportation in February. He does say that, "We are, of course, concerned about timely delivery of Orbiters 103 and 104. Any further delays in the delivery dates for these Orbiters could delay our plans to activate VAFB."

Then he goes on to say: "In our review of the Shuttle program, we also examined our backup booster strategy. The importance of our payloads to national security makes it essential that we maintain a minimum number of current boosters in inventory during the period when we plan to transition our spacecraft to Shuttle launch, to provide a backup for our highest priority spacecraft in the event of delays or any unanticipated problems in Shuttle operational availability."

Do I understand your answer to the question that these additional current boosters that the Air Force and Defense Department are going ahead with are merely there in the event the Space Shuttle program is further delayed?

Dr. FROSCH. They are essentially buying them as backup insurance so that if there is some further problem and we are not able to launch on the dates they require, they will have backups.

They are doing this at a rate where they have expendables that are fewer in number than their expected launches. As I understand it, they are viewing it as an insurance backup in case there are further serious problems.

Mr. TRAXLER. The Secretary also said that, "Despite some concerns over Shuttle technical problems and schedules, we are committed to its use and firmly believe that the Shuttle will provide major new capabilities which will make our space operations more effective in the future.

That was why I was trying to clarify just a few spare tires, if you will, in the event of difficulties because they do expect to use the Shuttle program apparently to its full capability.

One of the things that was pointed out by the Secretary was that the benefits would be the reduced launch cost, increased reliability, increased weight and volume for our payloads and most important of all, increased flexibility.

Apparently all those very fine aspects of the Space Shuttle would also be true of commercial use of the Shuttle as well, would they not?

Dr. FROSCH. Yes, I think so. I think in the long run the flexibility of manned operation and being able to deal with certain kinds of problems in orbit to do maintenance and refurbishment will be a

capability that the Defense Department will use a great deal, and that the commercial operators will begin to use when it is demonstrated.

I think that is likely to change the nature of satellite design and construction but we need to demonstrate those capabilities.

Mr. TRAXLER. I think that we have to recognize that not only is space technology and the use of space absolutely necessary to the frontiers of the future generations as well as this generation, as evidenced by the tremendous interests in the space business as well as space military uses, but the Space Shuttle is really a whole new era in space programs, and I don't see how we can delay in any way the program without impacting severely upon our commercial and our military uses of it.

Dr. FROSCH. We are trying to get there as fast as we can with the cooperation and backing of the Congress.

Mr. TRAXLER. Thank you, Mr. Chairman.

Mr. BOLAND. Mr. Sabo?

Mr. SABO. Nothing.

Mr. BOLAND. Mr. Stewart?

Mr. STEWART. Mr. Chairman, I want to congratulate the whole operation of the program for keeping faith in the many times that you have scheduled launches and didn't get them; that you still stayed on top of them. I want to congratulate you for keeping faith.

Dr. FROSCH. Thank you, sir.

SPACE SHUTTLE CROWDING OUT SCIENCE MISSIONS

Mr. STEWART. The Wall Street Journal in an article entitled "America's Space Shuttle Lemon," says about the American Space Shuttle, "But what probably caused more resentment against the Shuttle than anything is its brutal crowding out of the science missions from the space budget." Do you agree with that assessment?

Dr. FROSCH. No, I don't, Mr. Stewart. I think we have had budgetary problems but budgets are not constructed from the top down. We don't get a figure and then have to allocate it entirely between programs.

I think the writer's assumption is that, were there no Shuttle program the science program would be much larger. My own assessment is that if there were no Shuttle operation, the NASA budget would be much smaller and the science program would be about the same size. I think each program gets more or less determined by its own budgetary logic and by the arguments for it and the arguments against it.

Where we do see something that looks like that problem is in the current kind of budget crunch where it looks as if the Shuttle will be funded and perhaps if there are budget cuts some science things that were in the budget will have to be removed. But as I described in my earlier testimony, that was not the logic of the fiscal year 1981 budget reductions was that we started out with a certain target. Under that target we had to include the Shuttle. It was decided that the Shuttle was exempted, not that the Shuttle was held in and allowed to crowd out other things. I don't think that is really what happened.

EFFECT OF DEFENSE REQUIREMENTS ON SHUTTLE SCHEDULE

Mr. STEWART. General Allen, Air Force Chief of Staff, is quoted in a speech given at Vandenberg Air Base in 1979 as stating, . . ."whatever else the Shuttle does and whatever other purpose it will have, the priority, the emphasis and the driving momentum now has to be those satellite systems which are important to national security."

Then he continues, "It is a change from what has been true a year or so ago." Do you agree with this assessment? How has this change manifested itself and what are the implications for the future of the space program?

Dr. FROSCH. The priority questions that drive our necessity to stay on schedule and to ask the Congress for additional funding to stay on schedule, are largely the need to finish the production in time to meet those crucial defense missions that the Chairman mentioned earlier.

To that extent, the schedule is in fact being driven principally by the defense requirement. The earlier situation was one in which we developed and produced as fast as we could within an earlier Admistration's constrained budget. When we could not complete the work within the money allocated, it was necessary to slip the schedule in order not to ask for additional funding. When it became clear that if that continued we would not have an ability to meet the defense requirements, it was decided that the defense priority should lead to a request for the funds that were necessary to keep the program on schedule. That is what we have been doing.

That is the background for General Allen's comment about the defense requirements being dominant. They are dominant in terms of holding us to the current schedule. It has always been the case that national security requirements have an overriding priority over everything else when they have emergencies or schedule restraint requirements. We have announced that priority to all of our customers. Nevertheless, the defense requirements as we project them are something like 20 to 25 percent of the total use of the Shuttle, with the other portions being a fair amount of commercial, including foreign satellite use and the NASA or civil program use. Three-quarters of the use of the Shuttle will be for civil purposes part of which is non-government commercial and NASA will use part for science applications and development.

We continue to be the national agent for developing and operating the Shuttle for the civil government program, for the civil commercial and foreign program, and for the national defense program.

COMPARISON OF U.S AND U.S.S.R. TECHNOLOGICAL ACHIEVEMENTS

Mr. STEWART. An article in the Christian Science Monitor, February 8, 1980, states, "While the U.S. Space Shuttle—and with it the U.S. space program—has been chugging and stalling through its pre-launching tests, the Soviet Union has gained steadily on the large lead the United States built from its astronautical successes of the 1960s and early 1970s."

Do you think that is a fair assessment of the U.S. space program as compared with that of the U.S.S.R.?

Dr. FROSCH. While the Shuttle has had delays and problems which have had an impact on our program, we have succeeded in continuing the rest of the program in a vigorous way. The only area in which I would say the Soviets have made tremendous progress has been in the area of manned operation in low Earth orbit, that includes some of the technology and science and operations that go with that. They have made some very nice technological improvements. We continue to have a much more vigorous program than they have had in space science, both planetary science and deep space astronomy. I believe we have had a more vigorous and successful program in applications in the Landsat, meteorology and related matters. They probably have more experimental data than we do now on zero-g materials processing, and they have had a fairly extensive biology program. On the whole, we remain both technologically and scientifically ahead of them. The one area in which they have done much more is the long duration manned space flight in low Earth orbit. It will be some time before we even try to catch up with that. We have been emphasizing the Shuttle in terms of easy access to orbit rather than systems that provide long stay in orbit.

ALLEGATIONS OF SHUTTLE FUNDING MISMANAGEMENT AND MISUSES

Mr. STEWART. A report in the Washington Post indicated that Federal agencies were investigating reports that a certain company was hiding cost overruns on NASA's Shuttle projects. How many investigations does your Inspector General's office have under way at this time and how many of those investigations are concerned with allegations of mismanagement or the misuse of Federal funds?

Dr. FROSCH. I would have to get the number for the record. I am familiar with two investigations of contractors in which there was an allegation of mischarging. And I believe both of those have now passed out of the hands of our Inspector General and into the hands of the Justice Department. I believe one of them will lead to an indictment. There are probably several others in an earlier stage but I would have to supply the details for the record.

Neither of these two have involved large sums of money or large proportions of any program. Nevertheless, they may be both improper and annoying in the sense that they are evidence that there are problems in those contracts, and we want to deal with them.

[The information follows:]

As of March 31, 1980, the pending investigation workload for the Office of the Inspector General consisted of 173 cases broken down as follows:

Currently under active NASA IG investigation	124
Currently under active FBI investigations	19
Currently under active investigation by other agencies	2
Currently in prosecution or Grand Jury stage	4
Pending audit action	9
Pending advice of administrative or management action taken	11
Investigation completed, pending report preparation	4

Of the 173 cases, 46 relate to all allegations of fraud, mismanagement and misuse.

INCREASE IN PERSONNEL ASSIGNMENTS FOR INSPECTOR GENERAL

Mr. STEWART. Mr. Chairman, I have another question which will probably come up when we go into the budget, but I notice in your budget that you are requesting an increase in the Inspector General's office from 84 to 114. Why is that increase of 30 persons essential?

Dr. FROSCH. You will recall last year the Congress passed an Inspector General Act. Under that Act for the first time we had an Inspector General. Prior to that we had an Office of Audit and an Office of Investigations both of which separately reported to my office.

The new Inspector General changed the audit group and made some realignments in the investigation section and concluded that he needed more people in his office. We examined what he intended to do and the rate of auditing and inspection and agreed to request additional slots for the Inspector General in this budget cycle. It is not related to any particular case or kinds of cases.

I am in pretty good touch with what the Inspector General does. Aside from seeing him directly at staff meetings on a regular basis, we meet every 2 weeks for general discussion and he has access to me whenever he would like to. I think I am fairly current with the work he is doing. At this point, I do not think there is anything that he would describe as a major problem or a major collection of problems, although there is a continual number of cases as I would expect in an operation as large as ours.

Mr. STEWART. Thank you, Mr. Chairman.

Mrs. BOGGS. Mr. Chairman, may I ask a question about that?

Mr. BOLAND. Surely.

Mrs. BOGGS. Last year in the October 1979 hearings, one of the questions proposed was to describe the goal of the NASA Inspector General with regard to the Shuttle program. The answer was the duties and responsibilities as set forth in the Inspector General Act apply to the Shuttle program as well as all other NASA programs. Later on in the answer, it says "internal audits and investigations are conducted by the Office of the Inspector General personnel. Contractor audits are performed primarily by the Defense Contract Audit Agency." Is that still the case?

Dr. FROSCH. It is still the case and has been for a number of years. The argument for doing that has been that most of the industrial operations that NASA uses are also industrial operations that contract to the Department of Defense.

It seemed pointless years ago for us to have two Government agencies with separate audit operations, working on the same contractor. We came to an agreement that the sensible thing to do was for the much larger operation, that of the Defense Department, to provide services to NASA on a reimbursable basis. In effect, we increased the size of our audit system by contracting with the Department of Defense to do that external auditing work for us. Our Inspector General and our procurement people keep track of what they do for us.

Mrs. BOGGS. I was just going to ask that question. Do you have as much intimate knowledge of that auditing situation as you do with

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your own Inspector General which has this function under his purview?

Dr. FROSCH. The DCAA audits provide reports to us just as our own auditors would do.

OPERATIONAL SCHEDULE OF VANDENBERG

Mrs. BOGGS. Let me ask a few more questions as to the operational schedule at Vandenberg and whether or not that slippage will affect the December 1985 date.

Dr. FROSCH. If there was to be a significant slippage at Vandenberg, it would be possible for a slip in Orbiter 103 without affecting the DOD mission. Those two things hold each other together. Of course, if we were to slip that third Orbiter, we would begin to have an impact on the commercial and NASA flights in that part of the mission manifest.

Dr. LOVELACE. We would consider Orbiter 103 to be a very important part of the fleet to support the east coast launch part of our space traffic. The east coast launches are about 75 percent of the total operational flights. Certainly I think it would be most prudent to try to maintain the schedule on Orbiter 103, even if there were some impact on the Vandenberg buildup.

Mr. BOLAND. You have estimated $668 million for the two orbiters but you do not break it down.

Let me ask you whether or not—the Secretary of Defense or the Secretary of the Air Force has indicated to you in writing that there will be a transfer of funds to be sure there is no slippage in the operational schedule at Vandenberg?

Dr. FROSCH. I do not know that there has been anything in writing, but he has made it clear that he proposes to do whatever is necessary.

Mr. BOLAND. "Propose to do what is necessary" means dollars.

Dr. FROSCH. He tells me that he intends to come to the Congress for a reprogramming action within his military construction budget so he will have the funds to complete with Vandenberg as scheduled.

Mr. BOLAND. I want to know whether or not he can assure you, and in turn this Committee, that he will ask for a transfer of funds to be sure the operational schedule does not slip. The supplemental and the 1981 budget request is targeted to these delivery schedules.

Dr. FROSCH. The two things are tied together.

Mr. BOLAND. Can I tell the Chairman of another Subcommittee that he can probably cut one or two of the extra Titans from his budget since the operational schedule is not going to slip?

Dr. FROSCH. I do not think I could properly speak for the Defense Department.

NOTIFICATION OF REPROGRAMMING PROCESS

Mr. BOLAND. At the Galileo reprogramming hearing last fall, we touched on a problem that needs some resolution in this year's appropriation bill—and that is the question of a formal reprogramming process. Clearly, under the current procedures, NASA can commit the government to a $250 million overrun without the Congress having any legal opportunity to review that decision. The

problem, simply put, is committing the Congress and the Executive Branch to the expenditure of funds in the out years with what starts out to be a very small reprogramming of dollars in the budget year. We would like to correct that situation. We think we can do it through a limitation on the appropriation bill itself. Would you object to that limitation?

Dr. FROSCH. I think it would cause a certain number of problems depending on how it is worded.

Mr. BOLAND. It also depends on the basic Space Act which does not require you to obtain approval of the House and Senate Appropriations Committees in certain areas.

Dr. FROSCH. I was only going to comment on the question of committing future appropriations. It is at most an implied commitment which the Congress would have an opportunity to examine and would have to deal with in the ensuing budget years.

Mr. BOLAND. You indicated in a letter to me on January 11, that you plan to devote somewhere between $9 and $12 million to initiate development of an upgraded Delta launch vehicle. This is a new program and is not carried in the 1980 budget justifications. It involves the reprogramming of a lot of money.

Dr. FROSCH. We are right now in the center of what the dilemma really is. We could call such a thing a new expendable launch vehicle which we did and give it another number, 3920. Over the years as I understand it, there have been changes to past launch vehicles at least as extensive and which cost as much over the period of time, which were viewed as changes to the launch vehicle.

One of the real questions is: "is it the size of the money involved in a shift or the nature of a program involved in a shift?" In many large programs, within the Congressional line items and within the Congressional understanding of what is in the budget, we frequently make shifts of money as large as that. The Congress is, I think, generally aware of that. Neither we nor the Congress regard this upgraded Delta as a program change.

In the case of the 3920, we were faced with a sudden problem because of the Shuttle slippage and the need to deal somehow with the customers. We viewed that initially as an upgrading of an existing system, rather than a new system. We became worried how this Committee and others would view it and decided the best thing to do was treat it as a reprogramming and inform you. There may be a problem with definition.

Mr. BOLAND. You say whether it is the size of the shift or nature of the shift. But isn't it really both?

Dr. FROSCH. It could be both. I think the most important first step, Mr. Chairman, if I may suggest it, before one tries to write legislative language would be for us to try to understand much better with the Committee, what set of rules to use for what should be brought to the Committee.

Mr. BOLAND. This is an area that should be looked at very closely and some type of appropriation language needs to be divised which prohibits the development of a new project or program without the approval of the Congress.

Dr. FROSCH. That would certainly not be a problem. We believe you are doing that. It is a question of whether you agree whether we are or whether we are not.

Mr. BOLAND. At present, there is no requirement in the Space Act which requires you to come to the Congress. Is that right?

Dr. FROSCH. There is a requirement in the Authorization Act for us to do that.

FIRST MANNED ORBITAL FLIGHT SCHEDULE

Mr. BOLAND. Let us talk for a minute or two about the Shuttle schedule. The 1973 budget request assumed the first manned orbital flight (FMOF) in March 1978. The 1975 budget request dropped that back to March/June of 1979. In September of 1978, the launch date was announced as September/December 1979 and in the 1980 budget submitted one year ago, the launch date was announced as November/December 1979.

That November/December 1979 estimate has now slipped to December 1980/March 1981. Is that correct?

Dr. FROSCH. Yes.

Mr. BOLAND. Are you calling the February 1, 1981 launch date as 50-50? We will put that right in the middle for you.

Dr. FROSCH. That is about where I would put it.

Mr. BOLAND. In order to launch by December of this year, I assume you must have the orbiter out of the Orbiter Processing Facility by late June or mid-July. Is that correct?

Mr. YARDLEY. A July 31 move date would permit us to launch on November 30.

Mr. BOLAND. Are you still on target?

Mr. YARDLEY. Right now we are actually targeting June 30. We have that 1-month flexibility to July 31, but that is our working schedule and we are on it right now.

STATUS OF THERMAL PROTECTION SYSTEM

Mr. BOLAND. The current "long-pole" in the tent appears to be the Thermal Protection System (TPS). When the staff visited Kennedy in the first week in February—approximately 13,000 tiles remained to be either replaced or removed or applied for the first time.

What is the number remaining as of today? Do you have a schedule?

Dr. FROSCH. What I want to do is to provide a chart for the record and speak to that rather than to describe numbers remaining. There is a planned installation curve, which we have been slightly off of, and there are projections of what happens if we do not achieve the planned installation rate. You will see on the bottom we plan to go as high as 850 tiles per week.

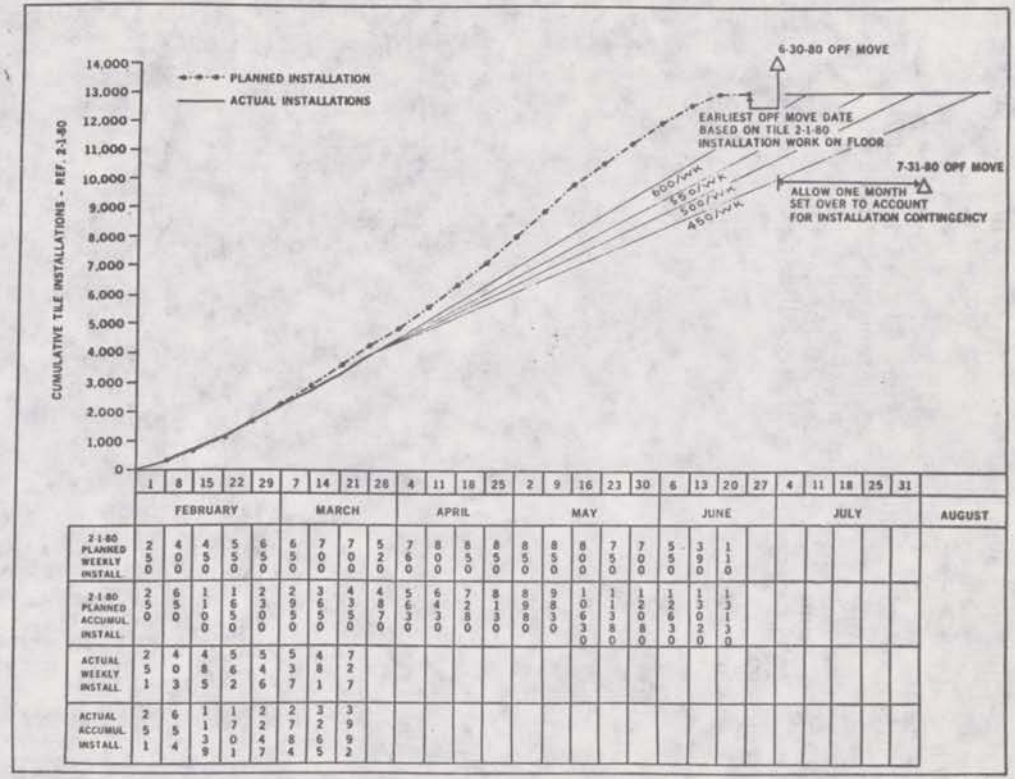
We have in fact been installing at a slightly lower rate. If we project the lower rate all the way out, then we find that instead of meeting a planned move date of June 30, we end up with an end-of-July move. In fact, I think it is fair to say, the contractor would say he still expects to meet a June 30 date. We think the contractor will probably meet something later than that and we predict an end-of-July date. This is assuming that the installations continue,

and we find no new problems. There are still some problems that need to be worked in engineering but this still looks like a good potential schedule.

The uncertainty in engineering could be described as some uncertainty in the total number of tiles. That is not quite literally true, but it is an uncertainty as to whether tiles will have to be removed and put back. So combining all those uncertainties, it is a reasonable prediction we will probably be through by the end of July. To date, it looks to us as though there will not be a major slip in what is going on.

[The chart follows:]

STS-1 TPS INSTALLATIONS – PLANNED & ACTUALS



	1	8	15	22	29	7	14	21	28	4	11	18	25	2	9	16	23	30	6	13	20	27	4	11	18	25	31	
	FEBRUARY					MARCH				APRIL				MAY					JUNE				JULY					AUGUST
2-1-80 PLANNED WEEKLY INSTALL.	250	400	450	550	650	650	700	700	520	760	800	850	850	850	850	800	750	700	550	390	110							
2-1-80 PLANNED ACCUMUL. INSTALL.	250	650	1100	1650	2300	2950	3650	4350	4870	5630	6430	7280	8130	8980	9830	10630	11380	12080	12630	13020	13130							
ACTUAL WEEKLY INSTALL.	251	403	485	562	546	537	481	727																				
ACTUAL ACCUMUL. INSTALL.	251	654	1139	1701	2247	2784	3265	3992																				

Mr. BOLAND. The 1980 supplemental request is $300 million. The obligational plan indicates that you will obligate about $85 million of the $300 million amount in June. Is that correct?

Dr. LOVELACE. That is correct.

Mr. BOLAND. When will the funds have to be made available by OMB in order to obligate that $85 million in June?

Dr. LOVELACE. It would have to be available from OMB by the middle of June.

NASA PLANS FOR OBLIGATION OF $300 MILLION SUPPLEMENTAL

Mr. BOLAND. As I understand it, the $300 million supplemental is divided into two parts—the first is a $200 million package for the various pieces of the Shuttle—and the second is a $100 million "reserve." Do you plan to obligate the full $300 million by the end of fiscal year 1980?

Dr. FROSCH. We cannot be sure of that because some of it is reserved for things that might happen towards the end of the year. Our current projection is that some of that money which was reserved for changes, at least a fair fraction of it, is likely to be obligated by the end of the year. I think the danger is, if we do not have it, we may come up short if there are some unexpected changes at the end of the year. That is the disaster we are trying to avoid.

Mr. BOLAND. Of the $100 million reserve, how much has actually been committed to date?

Dr. FROSCH. None of that has been committed. There are some projections that suggest it may have to be.

Mr. LILLY. In a technical sense, Mr. Chairman, it has not been committed. In the sense of identification of a very probable need, about, between $35 million and $50 million is predicted.

Mr. BOLAND. Are there any outstanding problems that have occurred within the past 10 days or 2 weeks that might impact Shuttle funding in any way?

Dr. FROSCH. Technical problems with the system? I know of none, but John Yardley may want to correct me. There are no new problems in the external tank, in the orbiter structure, avionics, solid rocket, or the main engine.

There is a problem with some of the glued isolation pads in the TPS. In the very earliest tiles put on the vehicle, some of which are still on and which were done under a different set of application rules than we are now using, some of those may have to be removed and be reapplied. But the number is such that I do not think it will change very significantly what we discussed earlier. We see no major new threats.

IDENTIFICATION OF FISCAL YEAR 1981 $150 MILLION SHUTTLE RESERVE

Mr. BOLAND. In addition to the $100 million reserve associated with the $300 million 1980 supplemental—your request of $1,873,000,000 for the Space Shuttle program in 1981 includes a reserve of $150 million. Has any of the $150 million reserve for the

Shuttle in 1981 been identified? Do you know what it is going to be used for.

Dr. FROSCH. No. There we are currently projecting that we would come out of fiscal year 1980 with some of the fiscal year 1980 reserve unused. In fiscal year 1981, we have not gotten any commitments on it that I know of.

Mr. BOLAND. Do we all agree?

Mr. YARDLEY. We are getting data in now.

Dr. LOVELACE. We are identifying areas but it is not fair to say we have identified specific commitments as yet.

Dr. FROSCH. I would expect by the time we come into fiscal year 1981, we will have identified the requirements against that reserve. The question is whether we can predict the total reserve, needed so that it is in fact adequate to go through fiscal year 1981 at the pace we are planning. We think our submission is correct but we are still looking at the latest budget analysis.

LATEST LAUNCH DATE POSSIBLE WITHOUT EFFECTING FISCAL YEAR 1981 BUDGET

Mr. BOLAND. Counting the total of $250 million in program reserves available in 1980 and 1981, what is the absolute latest date that you can have the first launch in 1981—in other words, how long can you slip beyond March of 1981 before you will have to come back for an additional supplemental in 1981?

Dr. FROSCH. That is a fairly complicated computation. As one slips beyond that date, one begins to affect the operations line item, because that affects the whole schedule and we do not have a very precise estimate of what the effect would be. But my estimate would be we could probably go a couple of months beyond that.

The thing that would begin to worry me at that point is that if we had our first flight that late we would have to question whether the orbiters we were building for the later flights would not be affected by what we learned so late. It could be an expensive thing to learn important things late and it could cause production schedule difficulties.

Mr. YARDLEY. I think that is fair. If you went to a June 1981 first launch, we would probably continue on the present schedule but beyond that, I think we would want to begin slacking off on the building of those production orbiters.

NEED FOR FIFTH ORBITER

Mr. BOLAND. Dr. Frosch, both you and Dr. Mark, the Secretary of the Air Force, have testified that at least five orbiters will be required by NASA in the future. Why is that? From all the numbers we see here in the manifest, it continues to indicate that payloads are being dropped. For example, the Defense Department dropped a number of payloads from the tentative schedule after the most recent shuttle slip. Why do we need five orbiters?

Dr. FROSCH. I think Dr. Mark knows better than I what the DOD long-range plans are. But I gather the long-range plans have increased as they look at what they expect to do. We are examining the mission model as it is now developing and the flexibility in

using an orbiter fleet we think will be required. As we begin to look at construction problems in Space Shuttle refurbishment and so on. We think that four orbiters will turn out in the long run to be a marginal number and that five is more likely to be the minimum fleet that will really hold all the operations on a profitable basis.

Mr. BOLAND. Do you know whether or not the budget exercise has removed any payloads from the manifest in the first 3 or 4 years? The reason being, whether or not you need five orbiters. From all the numbers we have seen, the manifest continues to indicate payloads are being dropped by the DOD. Is that correct?

Dr. FROSCH. In the latest revision of their payload plans, what happened is that the number of payloads in the earlier years went down and the number later went up somewhat. That seems to be the current DOD intention. But that would not—unless it goes up markedly, be the dominating factor.

Mr. BOLAND. What is the dominating factor?

Dr. FROSCH. The biggest user is commercial satellites.

Mr. BOLAND. That has been projected?

Dr. FROSCH. That has been projected.

Mr. BOLAND. Do you sense any dropping of those payloads?

Dr. FROSCH. What seems to be coming is an increased amount. That is the consensus of the users. As they put it in a meeting we had in the fall—and I cannot substantiate that with detailed data because they did not present any—it was their consensus that even between now and 1985 the commercial satellite business in the free world will face the possibility of an absolute shortage of launch capability even with Ariane and our launch rate.

Mr. BOLAND. They were including that possibility two years ago when the Committee was told the go no-go decision on a fifth orbiter would occur with the 1981 budget. What about that go no-go decision?

Dr. FROSCH. That was presuming an earlier first orbital launch date and production schedule. Now that that production schedule has slipped, the projection for go no-go has also slipped.

Mr. BOLAND. Until when?

Mr. YARDLEY. If you wanted to tack it on after Orbiter 104 with the 15-month interval we are planning, you would have to start in fiscal year 1982.

SHUTTLE STRUCTURAL MODIFICATIONS

Mr. BOLAND. On page RD–1–7 there is a reference to additional problems beyond the Thermal Protection System such as landing wheels and tires and structural modifications required by the latest derived loads data.

We understand those structure modifications are rather critical—that; without them the orbiter could not lift or return some of the heavier payloads. What about that?

Mr. YARDLEY. That is correct. The restriction we are placing on the first few flights is a 2-g load factor and a 6-foot-per-second landing rate. We are currently designing incremental strengthening that will be made in between earlier flights, on Orbiter 102, so

by the time we make our first operational flight we expect to be up to capability.

Dr. FROSCH. Those changes are being designed into Orbiters 099, 103, and 104. So the actual learning came from 099 as a mechanical test article which indicated we needed some strengthening and we are doing that. The wheel and tire problems have been solved.

Mr. YARDLEY. The wheel, tire, and brake systems have been qualified. However, we have to get an improved certification.

Mr. BOLAND. What do the modifications do to the weight changes?

Mr. YARDLEY. We will pick up maybe 1,000 pounds. However, we have a reserve that will accommodate this.

Dr. FROSCH. The answer to the implied question which I think is, "Are you falling backward faster than you are gaining," the answer is no. I have to say that is a problem that I have seen arise in aircraft and I think everyone here has. That can happen where everything you do to fix it makes it worse. We are not in that situation; everything we do makes it better in this situation.

DETAILED BREAKDOWN OF NASA'S BUDGET REQUEST SUBMISSION

Mr. BOLAND. On page RD-1-21, the justifications detail the $1,040,000,000 requested for Orbiter production. I'm afraid that it is indicative of NASA's problems with estimates and numbers and that the billion dollars is only broken down into the grossest terms. For example, $768,200,000 is the smallest breakdown we have for the orbiter piece of that production beginning on RD-1-22. In the future, we would like to see some detailed breakdowns of where that $768 million is being spent. I might also stress that if we tie any reprogramming appropriation bill language to numbers in the justification—we will need to have substantially more detailed breakdown than offered in this justification.

The National Science Foundation, for example, has a significantly finer breakdown of its activities than NASA does.

Dr. FROSCH. That is an entirely different kind of program.

Mr. BOLAND. Of course it is. I understand that. I have been looking at it for years. But it occurs that Mr. Lilly used to give us finer detail in the past when the NASA budget was $2 billion.

Dr. FROSCH. We give finer breakdowns in the area of science, for example.

Mr. BOLAND. How much do you intend to devote to Orbiter 103 in 1981?

Mr. LILLY. Orbiter 103 is $350 million including engines and government furnished equipment to be installed.

Mr. BOLAND. How much will be devoted to Orbiter 104?

Mr. LILLY. $51 million.

Mr. BOLAND. How much for Orbiter 099?

Mr. LILLY. $272 million.

REDUCTION OF SHUTTLE WEIGHT PROBLEM

Mr. BOLAND. On page RD-1-22, the justifications indicate that during 1979, NASA defined a weight-reduction program for implementation of Orbiters 099, 103, and 104.

We understand that the overweight problem of the Shuttle is extremely severe. How would you characterize that problem?

Mr. YARDLEY. The plans made in 1979 are being implemented and the engineering on the orbiter is quite far along. In fact, they are achieving greater weight savings than targeted. We are also taking weight out of the external tank. As a matter of fact, for our fifth flight we are planning to use a lightweight tank.

Dr. FROSCH. Mr. Chairman, from my experience, not as a builder but as a manager who has had such programs to worry about; my experience with aircraft programs leads me to say this is not a severe weight problem, precisely for the reason I gave earlier. It is a weight problem that seems to come fully equipped with the solutions—a set of actions which we are able to carry out.

A severe problem is one where you cannot figure out how to get the weight out of the machine and still have it meet its required characteristic. Here we are showing in design and are starting to show in manufacturing that we know how to take the weight out. We will not quite get to the original carrying weight and that will have to require in the end some thrust augmentation. That thrust augmentation will carry us way, way over the original requirement.

Mr. BOLAND. I have a table here, which displays the various lift capabilities of the Orbiters 102 through 104 it shows it with and without the weight reduction cabability. It appears as though the most critical immediate problem you face is the launch of TDRS (Tracking and Data Relay Satellite). This table indicates that the launch will occur on Orbiter 102. That is the first operational launch——

Dr. FROSCH. That is, I guess, the most marginal weight launch we have right now.

Mr. YARDLEY. It is marginal without the light-weight tank, but it looks as though we will have the light-weight tank in time.

Mr. BOLAND. That launch is scheduled for May of 1982, and requires a thrust capability of 100 to 109 percent and the current payload margin appears to be only 28 pounds. Has that 28 pound margin disappeared?

Mr. YARDLEY. I am not familiar with the document you have there, but basically with the 100/109 percent engine, and with a heavier tank, we are about at zero margin.

With the light-weight tank, we come up 6,000 pounds, so we are good even if we do not have the 109 percent engine aboard.

We have another thing that we hope to have by that time, and that is a 102 percent, 109 percent engine. We have run our current testing to 102 percent with no problems. Right now on one of our certification engines, we are experimenting with 109 percent to see if we can get that abort capability. So we intend to have sufficient margin by the first operational flight time.

CAPABILITY OF ORBITER 103 TO MEET 1984 CRITICAL LAUNCH

Mr. BOLAND. Can Orbiter 103 lift the critical defense mission planned for September/October 1984, without thrust augmentation?

Mr. YARDLEY. Yes, sir. There is a reasonable margin for that, assuming we get the full 109-percent engine, and assuming we make our weight savings. However, that same program in later years has a requirement to deploy and retrieve. Now when you get to the deploy and retrieve, we are slightly negative on that capability without thrust augmentation.

SHUTTLE THRUST AUGMENTATION

Mr. BOLAND. Now let's get into this question of weight capability in some additional detail and we will turn to page RD-2-11 where the thrust augumentation line item is carried. As the justifications indicate, you requested $15 million in 1980. The Congress provided no funds for that activity. However, we indicate some small level of funding could be used for continuing design work. The Committee was informed about 2 months ago that you planned to use $2,400,000 for this purpose in 1980. That figure is detailed in the justifications.

Last year you indicated you needed the $15 million for design studies in 1980, in order to make a go no-go decision on this $250 million program in 1981. The Committee felt the $15 million was not required because first, thrust augmentation could be delayed at least one year owing to delays of the Shuttle known at that time and two, there were no identifiable or approved payloads which required thrust augmentation.

Now if the Committee had provided the full $15 million for studies in 1980, would you have gone forward with the funding for development of this program in 1981—given the current Shuttle schedule?

Dr. FROSCH. Probably not.

Mr. YARDLEY. It is a hypothetical question.

Mr. BOLAND. So you probably would not have spent the $15 million even if we had provided it?

Dr. FROSCH. Not in fiscal year 1980.

Mr. YARDLEY. It would have saved us from asking for $10 million in fiscal year 1981.

Mr. BOLAND. Last year, the Air Force clearly indicated that there was no foreseen requirement in thrust augmentation in regard to DOD payloads in 1984 or 1985 or even 1986. In the hearings, Mr. Yardley suggested that that was true of DOD payloads but not necessarily true of the Spacelab. Does DOD's statement of last year still stand?

Mr. YARDLEY. I do not believe so. Since that time, I understand from Congressional direction that their critical payload at Vandenberg has had some additions made to it. So the weight requirements have gone up. While they can technically deploy and then on a separate mission retrieve, it takes two Shuttle launches without thrust augmentation.

Mr. BOLAND. Fine, I am familiar with the answer.

Is the Shuttle still about 8,000 pounds overweight including a 3,000-pound margin for safety against reference mission Number 4?

Mr. YARDLEY. Yes; that is after our weight saving program.

Mr. BOLAND. Since the Committee made its decision last year on denying the $15 million for this program, the Shuttle has slipped a full 12 to 15 months.

Is the $10 million requested in 1981 strictly for studies or does it include any development funds?

Mr. YARDLEY. No, sir. It is strictly for the analysis to be ready to commit to development in fiscal year 1982.

Mr. BOLAND. Can we delay this project again given the slippage?

Mr. YARDLEY. The delay in the first flight has not changed the time that the Air Force plans the missions for which this will be required. The first mission, which is scheduled for the fall of 1984, does not require it, although it would be good insurance for shortfalls on engine development or on weight saving. But in 1985, if they do not have it, then they are put in the position of having to make separate launch and retrieval flights.

Mr. BOLAND. On page RD-2-11, there is a statement which indicates that "it has become clear that the required payload capability will not be sufficient for certain important missions, primarily out of Vandenberg Air Force Base."

Does that represent a different assessment than what you knew last year at this time?—and if so, is it because the Shuttle's overweight problem has grown?

Mr. YARDLEY. We have not changed our performance obligation or commitment since last year. That is solely due to payload problems.

SPACE SHUTTLE VERSUS UPDATED TITAN CAPABILITY

Mr. BOLAND. On that same page, the justifications indicate that "however, these limitations reduce the cost-effectiveness and prevent full utilization of the space Shuttle orbiter's design potential and its new and unique capabilities.

One of those new and unique capabilities was supposed to be the Shuttle's ability to lift 32,000 pounds into a 98 degree polar orbit out of Vandenberg. Isn't it true that not only can the Shuttle not do that without thrust augmentation, but actually, the upgraded Titan expendable booster can lift more than the Shuttle into that orbit?

Mr. YARDLEY. I would have to check that for the record. The last I checked, the Shuttle can outlift the Titan by only a small amount for the comparable case, that is, a deploy only mission. The Shuttle, however, can do more things like stay 40 hours in a station-keeping mode while the spacecraft is being checked out. If the spacecraft fails checkout, the Shuttle would retrieve it for ground repair and relaunch. The Titan cannot, of course, perform this function at all. Because you have the Shuttle, you do all these other things that are good to do.

[The information follows:]

The upgraded Titan III expendable launch vehicle cannot lift more than the Space Shuttle in a similar deploy only mode of operation. The upgraded Titan III will have a lift capability of 27,700 pounds of payload into a 98 degree inclined orbit at 150 nautical mile altitude. The Space Shuttle, with Orbiter 103 and without

thrust augmentation at the 109 percent main engine power level, will have a lift capability of 31,300 pounds of payload for a two man per one day deploy only mission to the same orbit. An important additional advantage of the Space Shuttle is the capability to abort in the event of an ascent problem and safely return the payload for reflight. A boost problem during a Titan III launch will usually result in the loss of the payload. The polar/near polar mission requirements from Vandenberg are much more demanding (by some 8,000 pounds payload capability) than the launch energy requirement of the KSC Design Reference Mission. The use of thrust augmentation, adding 12,000 pounds of payload capability, enables the Space Shuttle to fully meet the Performance Reference Mission 4 requirement of delivery of a 32,000 pound payload and retrieval of a 25,000 pound payload on the same four man per seven day mission. This enhanced capability also allows polar Spacelab missions of maximum effectiveness (32,000 pounds payload down weight) and provides much greater flexibility in payload mixing and cargo manifesting. The thrust augumented Space Shuttle, while meeting all know mission requirements, also offers the potential to accommodate payload growth, block changes, and new payloads and concepts.

Mr. BOLAND. I remember that thrust augmentation was discussed in conference last year with the Senate. So, we agreed to some modest funding of $2,400,000. But this program does not have to be rushed, does it?

Mr. YARDLEY. If you are not concerned with the Air Force having a capability; they cannot do business without our equipment.

Dr. FROSCH. There is one additional point. The engine system that has been baselined for the thrust augmentation is a variation of one of the engine systems in the Titan, so that it would provide a continuation of that production and is a useful cross-utilization in the transition period.

Dr. LOVELACE. Mr. Chairman, as you stated earlier, I believe you and the Senate were in agreement last year. You both agreed you would not put money in, but that we could take the money from other sources.

Mr. BOLAND. The Senate had $5 million in the program for thrust augmentation.

PURCHASE OF ADDITIONAL EXPENDABLE LAUNCH VEHICLES

On page 134 of last year's hearings, you provided an insert for the record which indicated that if the $185 million supplemental was not provided, a delay from four to six months in the first launch would occur. Of course, since that time we have not only had the four to six month delay—we have had a delay of from 12 to 15 months. In the insert, you indicated that one of the penalties of the four to six month delay was that planned STS missions on the Shuttle would have to be rescheduled, where possible, to expendable launch vehicles. You estimated that that would cost the users an estimated $400 million.

Well, we had the four to six month slip—in fact, we had a 12 to 15 month slip—Now that the slip has occurred, I want you to detail for us precisely where that $400 million overrun for the purchase of additional expendable launch vehicles is—do you understand the question and can you provide that for the record—or can you give us some idea at this time?

Dr. FROSCH. I think we would have to work out what the total cost to user is expected to be at this point. But the five or six users that were mentioned before, if I assume those to be all Deltas, that is something between $100 and $200 million right there from the ones we already know about. The ones that are still not certain are

probably equal in number. I do not know exactly what the figure will be. We can provide an answer for the record. There is a DOD Titan list that has to be added also.

[The information follows:]

The analysis performed in late 1978 was based on the Shuttle customers who were likely candidates to switch to expendable launch vehicles if the Space Shuttle underwent significant slips in operational readiness. Since that analysis was completed, six of eight potential customers have opted for launch on the expendable systems. In addition, we now anticipate that the other two are very likely to switch. This accounts for about $200 million in additional Delta expendable costs.

The DOD has also switched two of their payloads in the 1982-1983 time frame to Titan expendable vehicles. This adds an additional $150 million. About $80 million is taken in credit for the variable cost for Shuttle flights that were reduced in the early manifest.

The net effect, therefore, is about $270 million in increased costs.

Mr. BOLAND. Mr. Coughlin?

Mr. COUGHLIN. I would like to come back to one question the Chairman has already asked. We are going ahead with a program now to build additional expendable launch vehicles and boosters.

Dr. FROSCH. We are continuing to provide Delta boosters for expendable launch vehicle users who want them because of the delay in the Shuttle; and we have written to INTELSAT with respect to a query, if they wanted to buy additional Atlas/Centaurs, it would be possible.

Mr. COUGHLIN. How many of the missions originally planned are now on expendable boosters?

Dr. FROSCH. So far, approximately five or six.

Mr. COUGHLIN. How many are military——

Dr. FROSCH. We are only talking about the NASA and commercial payloads. The DOD has backed up some of their launches with expendable launch vehicles. At this point, I do believe they have shifted a couple of their launches to expendables.

Mr. COUGHLIN. So we are really building two side-by-side systems.

Dr. FROSCH. We are continuing the older one until we are ready to get the other one working.

Mr. COUGHLIN. You will recall in past years, I have talked of the cost-benefit and so forth, studies that were projected when the Shuttle was originally proposed.

I was a member of the House Science Committee, the authorizing Subcommittee.

What is the slippage of the five or six missions caused by the Shuttle? Have you reevaluated that whole study?

Dr. FROSCH. No. Assuming those would be totally lost from the mission model, that would be six partial launches. If they are all Deltas they would be six-thirds of a launch. So they would correspond for 2 launches out of 487 launches in the current mission model which represents about one-half of a percent.

As a matter of fact, it would probably have less of a change than that because I would consider them to be lost from a continuing flow of missions from just shifting the Shuttle out on-line. I think we are looking at a delay in what actually happened. To the extent the cost-benefit study is dependent on inflation, it might have an effect, but since it was begun in fixed-dollar years, there would not be an effect.

Mr. COUGHLIN. You think there is an economic payoff of the Shuttle?

Dr. FROSCH. Yes.

Mr. COUGHLIN. Any studies to indicate that?

Dr. FROSCH. No new studies.

Mr. COUGHLIN. I think it would be desirable to have them.

Dr. FROSCH. The crossover was 300 missions and we are still projecting more missions than that. So as far as we can tell, it would be a matter of redoing the same study.

ANY ANTICIPATED FISCAL YEAR 1981 SUPPLEMENTAL OR BUDGET AMENDMENT

Mr. COUGHLIN. In your fiscal year 1981 budget request, do you expect to be coming back with a supplemental on that, too?

Dr. FROSCH. I do not, nor with a budget amendment.

Mr. COUGHLIN. Between your supplemental and budget request, you have about $250 million in reserve?

Dr. FROSCH. That part of it is a covered reserve, to be used for whatever has to be done in the program.

Mr. COUGHLIN. So it is a slop?

Mr. LILLY. It is for problems beyond those one can identify in the detailed costs estimates. One can estimate what specific things will cost, but history shows you cannot forecast precisely when changes and problems will occur. It is a prudent thing to provide for these changes that cannot be foreseen.

Mr. COUGHLIN. Is this based on an inflation projection?

Dr. FROSCH. It is based on looking at the history of this program and other programs. We looked statistically and historically at what rate things turned up that were not anticipated in the R&D programs.

Mr. LILLY. When you mention inflation, I might point out, that when we prepared this budget for fiscal year 1981, our assumption on inflation in that time period was about 8.7 percent. The most conservative estimate you see right now from any of the indices and our own, is that what we are facing is probably a minimum rate of around 11 to 11.5. That in itself, if that turns out to be the case, means we are risking an increased cost because of inflation.

Mr. COUGHLIN. But the reserve is not to cover inflation?

Dr. FROSCH. No; we built that in per OMB rules.

Mr. YARDLEY. The 3 years' extra inflation we did not anticipate is an additional problem.

Mr. COUGHLIN. That is covered by the supplemental.

Dr. FROSCH. The question is whether it is covered at all but that is no different for this program than it would be for any other program. We would hope it would be such that we could cover it with the reserve or by managing things so we were not fully hit by it.

Mr. COUGHLIN. Thank you, Mr. Chairman.

Mr. BOLAND. This afternoon, we will get into Construction of Facilities.

Mrs. Boggs?

ADEQUACY OF ORBITER SUPPLY TO MEET DEFENSE NEEDS

Mrs. BOGGS. Will the five orbiters requested for the future supply our primary space defense needs?

Dr. FROSCH. The four are intended to do that. The Defense Department feels that five may be required, but four are intended to cover the defense needs as they are now planned.

Mrs. BOGGS. Are they vulnerable to sabotage?

Dr. FROSCH. Everything is vulnerable to sabotage, and these are no different. We have been working with the Air Force with regard to a protective security plan at Kennedy Space Center, and of course, the Air Force has such a plan for Vandenberg Air Force Base.

Mrs. BOGGS. So security measures are being taken?

Dr. FROSCH. Yes, and we are reexamining them to see if there are additional things that have to be done.

Mr. BOLAND. Mr. Stewart?

Mr. STEWART. No questions.

Mr. BOLAND. The Committee will recess until 2 o'clock this afternoon.

AFTERNOON SESSION

FISCAL YEAR 1981 BUDGET REQUEST FOR CONSTRUCTION OF FACILITIES

Mr. TRAXLER [presiding]. The Committee will come to order. It is my understanding, General McGarvey will be handling the construction program.

Dr. FROSCH. We also have with us, Mr. Chairman, Mr. Ed Kilgore, who is the new Associate Administrator for Management Operations, and so when we come to R&PM he will be joining us in testimony on that.

Mr. TRAXLER. Welcome. We will turn to Construction of Facilities.

The 1981 request for Construction of Facilities is $120,000,000 a decrease of $36,100,000 below the appropriation for fiscal year 1980.

This is one of the smallest construction requests in some years—particularly when viewed on the basis of constant dollar levels. The request for 1981 is detailed for all centers and locations on page SUM-6. What was the NASA budget request to OMB for Construction Facilities in the 1981 budget?

General MCGARVEY. $189,439,000.

Mr. TRAXLER. Would you provide for the record those items which OMB eliminated from your $189.4 million request?

[The information follows:]

As a result of the OMB reduction of the CoF budget request to $120 million, none of the following projects could be accommodated in the program and two other projects had to be reduced by $224,000:

57-166 O - 80 - 6

Construction of Rotorcraft Operations Area, ARC	$2,500,000
Construction of Addition to Technical Processing Facilities, GSFC	6,800,000
Modifications to Various Buildings, JSC	610,000
Construction of Waste Materials Incinerator, KSC	790,000
Modifications to Various Buildings, KSC	2,500,000
Modifications to HVAC Systems for Various Facilities, LaRC	2,300,000
Modifications to Various Facilities, NSTL	1,195,000
Modifications for Enhanced 20-Inch Supersonic Wind Tunnel, LaRC	2,600,000
Modifications for High Pressure Corrosion and Thermal Fatique Testing, LeRC	1,055,000
Construction of Centralized Condenser Water System, JPL	2,200,000
Modifications for Central Chiller System, MSFC	790,000
Construction of Remote Operations Control System for DSN Power Plants, Various Locations	1,000,000
Construction of Large Aircraft Maintenance Dock, DFRC	1,800,000
Modifications to Mach 19 Nitorgen Tunnel, LaRC	1,300,000
Augmentation of DSS–11 Goldstone, CA	17,500,000
Modifications for Small Engine Component Testing, LeRC	8,755,000
Construction of Engineering Building, JPL	13,500,000
Facility Planning and Design	2,000,000

GODDARD SPACEFLIGHT SPACELAB DATA FACILITY

Mr. TRAXLER. Two years ago you requested of OMB $5.9 million for a Spacelab Data Facility addition at the Goddard Space Flight Center. That was denied in the 1979 and 1980 budgets. Did you request that facility in 1981 and, if not, how are you handling the mission that the Spacelab Data Facility was intended to fill?

General MCGARVEY. In the fiscal year 1981 budget program we requested $6,800,000 for a tech processing facility at Goddard which would have handled that same requirement that had been requested in prior years but in addition, it was primarily for expanding programs in the Applications Division at Goddard.

Mr. TRAXLER. How are you going to fulfill the mission since you have been denied the facility?

General MCGARVEY. There have been some work-around provisions since last year. As you may recall additional funding was provided for the data processing itself, and through a rearrangement of the computer systems at Goddard we have been able to work around the problem, but not able to obtain the data rates that will be required in later years in the buildup of the Shuttle program.

In the later years when the flight rates build up, there will have to be some augmentation of the data processing capabilities for that purpose.

Mr. TRAXLER. So what you are doing is really deferring that addition. You are not going to be able to substitute or make do. At some point in the future you will be making a similar request.

Dr. FROSCH. It becomes a question of what the rate of flight for the Spacelab is with the existing work-around. We believe it takes longer to reduce the data from the Spacelab flight in the later years. In the early years when there is a fairly good spacing between Spacelab flights, the existing work-around will be able to keep up but if that flight rate goes up as we would predict it would, then the reduction of data will get farther and farther behind. So at some point, we would need new facilities in order to have a bigger computer facility to keep up with that data. It is in fact a

deferral but at some point we would expect to have to come back and ask for that.

FUNDING OF MAJOR CONSTRUCTION PROJECTS

Mr. TRAXLER. Last year we talked about full funding for construction programs. Mr. Lilly indicated that as a practice you usually fully fund office buildings and certain other kinds of facilities. However, you do not fully fund the larger facilities such as the 40 by 80 wind tunnel at Ames or the National Transonic Wind Tunnel at Langley.

Of the projects detailed on page SUM-6, under Major Construction, most appear to be fully funded. Which projects are not fully funded—and give us the rationale as to why you have not requested the full amount in 1981?

General MCGARVEY. As an example, the first one that you come to is the Jet Propulsion Laboratory modification.

Mr. TRAXLER. We don't need an example. What we want you to do is to start with the first project and go through the list. Tell us which project is not fully funded and give us a brief rationale as to why it does not appear as such.

General MCGARVEY. In that context, Mr. Chairman, all of the items that are requested in fiscal year 1981 are fully funded. Some projects are second and third or final increments of prior years funding. This request completes each and every project except the Plum Brook Reactor.

Mr. TRAXLER. Did you have any new starts there?

General MCGARVEY. Not on partial fundings, except for decommissioning the Plum Brook Reactor.

Mr. TRAXLER. We assume that the ZBB process was applied to your construction appropriation. Is that correct?

General MCGARVEY. That is correct.

Mr. TRAXLER. Give us your prioritized listing of the projects which are listed on page SUM-6, 7, 8 and 9 for the record. Give us that beginning with the highest priority down through the lowest.

[The information follows:]

It is extremely difficult, if not wholly impractical, to prioritize specific projects within a dollar level that is already well below the minimum level of a zero based budget submittal to OMB. In this regard, it should be noted that the $120 million request is $30 million below the NASA request to OMB to cover absolute minimum requirements. However, in an attempt to provide some better feel for priority and impact, we have grouped all projects into one of four specific categories. Each of these categories, their specific functions, and the principal needs and justifications follow:

Category I includes those facility projects that are required in direct support of on-going Space Shuttle development activities and Space Shuttle Payload requirements. Also included in Category I are continuing phases of essential work that was authorized in FY 1980 or prior year programs and are required to complete these requirements. Category I also includes projects that are required to alleviate serious hazards to human life and vital facilities and one project that is absolutely essential for continuing support of deep space operations.

Category II includes the minimum essential repairs, rehabilitation and modifications, minor construction, and necessary facility planning and design required to keep the NASA physical plant reliable, capable, and responsive to on-going research, development and test activities.

Category III includes our highest priority facility items in direct support of programmatic requirements and pressing needs to improve tracking and data acquisition support for deep space missions.

Category IV items are specifically directed at continuing our concerted efforts to reduce energy consumption significantly and meet the National energy goals. Continued prudent investments in effective energy conservation projects such as these are key ingredients in meeting those objectives. Category IV also includes funding required to begin dismantling the Plum Brook Reactor.

A listing of projects by priority category is as follows:

CONSTRUCTION OF FACILITIES
FISCAL YEAR 1981 ESTIMATES
BUDGET PLAN

Location	Project Title	Budget Request $000
	Category I	
	Space Shuttle Facilities	
Thiokol Plant	Modifications to SRM Manufacturing and Final Assembly Facilities	2,700
MAF	Modifications of Manufacturing and Final Assembly Facilities for External Tanks	5,400
VAR	Minor Shuttle Unique Projects	2,000

Location	Project Title	Budget Request ($000)
	Category I	
	Space Shuttle Payloads	
KSC	Rehabilitation and Modification for Payload Ground Support Operations	1,617
MAF	Rehabilitation of Roof, Phase II Building 103	3,800
MAF	Rehabilitation of Chilled Water System	782
Goldstone	Replacement of Azimuth Radial Bearing, DSS-14	950
LeRC	Modifications to Central Air System, Various Buildings	7,655
LeRC	Rehabilitation of Electrical Switchgear, Engine Research Building	1,700
JPL	Modification to Various Buildings for Seismic Protection	2,000
KSC	Rehabilitation of High Temperature Hot Water System, Zone 2, Industrial Area	760
LaRC	Rehabilitation and Modification of Gas Dynamics Laboratory	2,000
	Category II	
VAR	Repair	15,000
VAR	Rehabilitation and Modification	20,000
VAR	Facility Planning and Design	10,000
VAR	Minor Construction	4,000
	Category III	
LaRC	Modifications to Aircraft Landing Facility	15,000
ARC	Construction of Man-Vehicle Systems Research Facility	7,480
LaRC	Modifications for Avionics Integration Research Laboratory	5,756
VAR	Modification of 26-Meter Antenna, DSS-44, Canberra	1,200
	Category IV	
LeRC	Decommissioning of Plum Brook Station Reactor Facility	3,000
ARC	Modification of Steam Ejector System and Thermal Protection Laboratory	2,300
ARC	Modification of the Unitary Plan Wind Tunnel	3,400
JPL	Modifications to Various Buildings for Energy Conservation	1,500
	TOTAL	$120,000

Mr. TRAXLER. I assume that you had some others that went to OMB, of course, that did not make the request to the Congress.

General MCGARVEY. That is correct.

Mr. TRAXLER. You can provide that list also and for the record indicate the rankings in which you had sent them up.

General MCGARVEY. For the total $189.4 million request?

Mr. TRAXLER. Yes.

[The information follows:]

Of the $189,439,000 requested of OMB, $69,439,000 was denied. Included were projects in priority Categories I thru IV as previously defined, and projects in Category V which includes both programmatic and institutional items that need to be done in FY 1981 to provide cost effective and efficient support of fundamental research, development and testing activities.

A listing of the OMB reductions follow:

Location	Title	Reduction ($000)
	Catetory I	
LaRC	Rehabilitation and Modification of Gas Dynamics Laboratory	100*
	Category II	
Various	Facility Planning and Design	2,000*
	Category III	
LaRC	Modification for Avionics Integration Research Laboratory	144*
ARC	Construction of Rotorcraft Operations Area	2,500
GSFC	Construction of an Addition to the Technical Processing Facilities	6,800
	Category IV	
JSC	Modifications to Various Buildings	610
KSC	Construction of Waste Materials Incinerator	790
KSC	Modifications to Various Buildings	2,500
LaRC	Modifications to HVAC Systems for Various Facilities	2,300
NSTL	Modifications to Various Facilities	1,195
	Category V	
LaRC	Modifications for Enhanced 20-Inch Supersonic Wind Tunnel	2,600
LeRC	Modifications for High Pressure Corrosion and Thermal Fatigue Testing	1,055
JPL	Construction of Centralized Condenser Water System	2,200
MSFC	Modifications for Central Chiler System, Various Buildings	790
VAR	Construction of Remote Operations, Control System for Deep Space Network, DSN Power Plants, Various Locations	1,000
DFRC	Construction of Large Aircraft Maintenance Dock	1,800

Location	Title	Reduction ($000)
	Category V	
LaRC	Modifications to Mach 19 Nitrogen Tunnel	1,300
JPL	Construction of Augmentation Facilities, DSS-11, Goldstone, CA (off-site)	17,500
LeRC	Modifications for Small Engine Component Testing	8,755
JPL	Construction of Engineering Building	13,500

*Partial Reduction

AERONAUTICS HUMAN FACTOR RESEARCH FACILITIES

Mr. TRAXLER. On page CF-1-2, you are requesting $7,480,000 for the construction of a man-vehicle systems research facility at the Ames Research Center. The text on pages CF-1-3 and CF-1-4 and CF-1-5 suggest that this facility is more properly related to the responsibilities of the Federal Aviation Administration.

Does the FAA or DOT operate any aeronautics human factors research facilities at this time?

Dr. LOVELACE. I think we might provide a better answer for the record. They do do some work in human factors. NASA has been responsible for the more advanced research in simulators and in human factors research and development. We have FAA people located at Ames working with our research people in those same facilities.

It is complementary to the FAA and managed through joint coordination with that agency.

[The information follows:]

NASA and the FAA (DOT) aeronautical research activities have always been closely coordinated. In the human factors research area the FAA has focused on Air Traffic Control (ATC) issues while NASA has focused on aircraft and flightcrew technology. Human factors research facilities of the two agencies are consistent with this division of responsibility. The FAA's facilities are located at the National Aviation Facilities Experimental Center (NAFEC), Atlantic City, New Jersey, and are designed for evaluating new concepts and capabilities for the ATC system of the 1980's and 1990's. Highly complex and extensive ATC simulations can be created with numerous computer generated aircraft flying in simulated airspace under the control of multiple air traffic controllers. The only piloted simulators at NAFEC are two general aviation trainers (GAT trainers) which have advanced avionics capability. In contrast, the bulk of human factors research in NASA is conducted at Ames Research Center, where there are several major piloted aircraft simulators. Unfortunately, none of the simulators at either location are capable of supporting full mission, full crew research; which is of utmost importance to understanding why aircrew errors occur, what measures may be taken to reduce these errors, and how advanced aeronautical systems may be designed to operate most safely and efficiently by best utilizing the capabilities of the human as well as future hardware and software technology. For several years our human factors researchers have been unable to identify a facility suitable to conduct the necessary studies. In 1978, prior to developing this facility proposal, an extensive survey was conducted to insure that the broad capability required did not exist elsewhere. The Man-Vehicle System Research Facility, when completed, will be a unique National resource for aeronautical human factors research.

Dr. FROSCH. The FAA is a heavy simulator user of the ones at Ames. You will note in the middle of the justification the notation that there is an FAA request that we give special attention to cockpit advanced technology.

Mr. TRAXLER. This is the first year that NASA has requested the project of OMB. Did you indeed ask for the project or was that an OMB decision?

Dr. FROSCH. I think it was a NASA request.

General MCGARVEY. Yes. It was a NASA initiative.

Mr. TRAXLER. When we see your priorities would this be a project that ranked at the top or near the top?

General MCGARVEY. It is very high on the priority list in the aeronautics technology package.

RESEARCH FACILITIES MODIFICATIONS FOR ENERGY CONSUMPTION

Mr. TRAXLER. Looking again at page SUM-6, the other two projects at Ames—modification of the steam ejector system and modification of the unitary plan wind tunnel, are both directed at energy consumption? Is that correct?

General MCGARVEY. Yes, sir.

Mr. TRAXLER. Both?

General MCGARVEY. Part of them are. As an example, of the $2.3 million for the steam ejector system, $1,165,000 is for energy conservation. The remainder is for modification and repair to the overall system.

Similarly on the second project for the unitary plan tunnel, $2.5 million of the $3.4 million total is for energy conservation. The remainder is for modifications to the tunnel systems themselves but without any energy impacts.

Mr. TRAXLER. The projects at the Jet Propulsion Laboratory are also directed at energy conservation or seismic protection, and the project at the Kennedy Space Center—rehabilitation of the high temperature hot water system—is also directed at energy conservation. You have had a number of this type in recent years and we assume they are paying off. Is that a fair statement?

General MCGARVEY. Yes, sir. Overall to date, in prior years we have invested approximately $52 million in energy conservation efforts. The overall amortization period for those projects has been less than five years. This fiscal year 1981 program is approximately $8.4 million. Three discrete items you see here for $5.2 million and minor construction projects, about $3.2 million.

Dr. FROSCH. Since 1973, we have made a 37 percent reduction in utilities consumption in the Agency. That is not a reduction in costs because the prices have risen very rapidly.

Mr. TRAXLER. Do you recall last year when we talked about the modifications made to single phase electric motors?

Dr. FROSCH. Yes.

Mr. TRAXLER. That was a discovery in your laboratory. It was a question of its application in commercial fields and there was some hope. I think you had 8 or 12 industries that were interested. Have you anything further to report on that?

Dr. FROSCH. There are at least two and I think four or five companies that have gone into commercial production. At least one is available on the retail market and I have seen it advertised in a number of journals, and it is being sold. So the devices are available on the market and being sold.

I think there are several other companies that are going into license production this year.

Mr. TRAXLER. It is your hope with mass production the price of the item would be reasonable. Do you recall what the advertised price was?

Dr. FROSCH. Yes. The advertised price for the one I saw which would run sort of ordinary things like refrigerators, small machine tools, was of the order of $20 to $25.

Dr. LOVELACE. I purchased one so they are available. They are delivering them.

Mr. TRAXLER. Did you put it on your refrigerator?

Dr. LOVELACE. Yes.

MODIFICATIONS TO THE AVIONICS INTEGRATION RESEARCH LABORATORY

Mr. TRAXLER. I would be interested in that myself. I haven't seen it.

On page CF-4-2, you are requesting $5,756,000 for modifications for an Avionics Integration Research Laboratory at the Langley Research Center. On page CF-4-3, you indicate that alternate approaches were examined and discarded.

Would you provide for the record a list of all Air Force and Navy facilities currently available—showing their scheduled use in calendar years 1977, 1978 and 1979.

[The information follows:]

Two facilities, one Air Force and one Navy, have similar but only partial functional capability as that proposed for AIRLAB. These DOD facilities are dedicated to pre-flight testing of current-day avionics and weapons delivery systems. In addition they support mission requirements that relate directly to weapons delivery systems and other military preculiar requirements.

The Air Force Laboratory, Avionic Systems Analysis and Integration Laboratory (AVSAIL) at Wright-Patterson AFB, Ohio, provides an array of simulations of take-off, navigation, target acquisition, weapons delivery, and landing systems for tactical aircraft missions. The laboratory includes the Digital Avionic Information System (DAIS) which provides for the development of controls and displays technology by supplying real-time sensor signal simulations. In addition it provides for hybrid hardware and software simulation to support performance analysis of tactical communications and data links.

The following schedule shows the uses of the Laboratory:

	Calendar Year 1977	1978	1979
Digital Avionics Information System	X	X	X
F-16 Fire Control Software Verification and Validation		X	X
Missile Launch Envelope Algorithm Assessment (MISSVAL)		X	X
Weapons Delivery Coupled to Flight Controls Assemment (FIREFLY)		X	
F-16 Dynamic System Simulator Operations		X	X
F-16 Interim Pilot Trainer			X
Avionics Event Trace Monitor Development		X	X
Support of Numerous Agency-Wide Software Development and Test Activities	X	X	X

During 1977, 1978, and 1979, AVSAIL was operated eight hours per day. The Air Force projects that operations will increase to 12 hours per day in October 1980 and to 16 hours per day in October 1982.

The Navy facility, Basic Avionics Subsystem Integration Concept (BASIC), at the U.S. Naval Air Development Center in Warmister, Pennsylvania, is used for evaluating current technology and determining its applicability to future military aircraft. This is not a research oriented facility. Emphasis is on performance optimization. This facility assesses the current technology and its impact on military aircraft avionics systems.

The following schedules shows the uses of the facility:

	Calendar Year 1977	1978	1979
Military Aircraft Support:			
F-14	X	X	X
VSTOL-A		X	X
VT XTS - Advanced Navy Trainer			X
CH-B3			X
S3-A			X
Technology Project Support Test and Evaluation:			
Tri-Service Multiplex		X	
Wideband Fiber Optic		X	
Ring Laser Gyro Navigation		X	X
Light Airborne Multipurpose System (LAMPS)		X	X
Distributed Architecture Plan Development			X
Multisensor Correlation			X
Digital Voice Multiplexer			X
Bus Controller Software AYK-14			X
Magnetic Anomally Detection (MADTACS) Program			X

This facility started operation in 1977 and has been operated eight hours per day.

Mr. TRAXLER. Was this project requested of OMB prior to the fiscal year 1981?

Dr. FROSCH. Not to my knowledge, sir. I think this is the first year that we have gone forward with this request.

Mr. TRAXLER. When was this project initiated under the facility planning and design subactivity of this appropriation?

General MCGARVEY. We did use fiscal year 1979 funds for the preparation of the preliminary engineering report for this fiscal year 1981 project. It does have a completed preliminary engineering report and it is now under design.

MODIFICATIONS TO THE AIRCRAFT LANDING DYNAMICS FACIALITY

Mr. TRAXLER. On page CF-4-9, you are requesting $15 million for modifications to the Aircraft Landing Dynamics Facility. As the justifications indicate, you are proposing to proceed with this project to increase the facility capability from 110 to 220 knots to test landing gear systems of existing aircraft as well as the development technology for future aircraft and space vehicles.

How is that coming along?

Dr. LOVELACE. Let me respond to that. I think part of the problem is that we have not done a very good job in terms of testing at the higher speeds. That has been manifested in some problems we have both in commercial and military aircraft. The only test techniques available to us have been dynanometer test, a sort of rotating wheel on which you can put an aircraft tire down but does not really give a very good test of the whole landing gear structure, that is to say the strut that holds the wheel and the tire.

Mr. TRAXLER. How did you test the Shuttle?

Dr. LOVELACE. The same way. We used a dynanometer test. If I remember correctly, we had to invest a little money in terms of upgrading the dynanometers at the Air Force Test Facility at Wright-Patterson to test the tires and wheels.

As you may also recall, we had some difficulty in certain commercial airliners in terms of taxi tests and landings, in terms of damage to tires and wheels and testing of operation.

This facility is one that will put the country, both military and civil testing, on a much firmer footing.

Mr. TRAXLER. I take it that the Air Force does not have a facility that will handle landings more than 110 knots?

Dr. LOVELACE. It does not have a comparable test facility either inbeing or in planning. We have jointly planned this with them.

DECOMMISSIONING OF PLUM BROOK REACTOR FACILITY

Mr. TRAXLER. At the Lewis Research Center you are requesting $3 million on page CF-5-2 to begin the first of five phases of work estimated to cost $15 million for decommissioning of the Plum Brook Station Reactor Facility.

Dr. LOVELACE. It goes back before my time but it was part of the nuclear propulsion rocket program.

Dr. FROSCH. I know it was an active program to develop a nuclear gas ejector rocket, and the reactor was part of the system for doing that, and then the whole nuclear propulsion system was simply phased out and dropped about 1973.

Mr. LILLY. It was the SNAP program and was cancelled some years ago.

Dr. FROSCH. We have had this inactive reactor with us since 1973 and we want to decommission the reactor and dispose of it because there is an interest in disposing of some of the property which we don't require. It is simply blocked for future use with the reactor.

Mr. TRAXLER. Is it your best judgement this facility will never again be used or needed?

Dr. FROSCH. We looked at that question and even if we were to go back into some form of nuclear rocket propulsion we don't think this reactor would be useful.

Mr. TRAXLER. Does anyone have a recollection as to what the facility originally cost?

Dr. FROSCH. We have that data.

Mr. TRAXLER. The justifications indicate around $19 million. Does that sound correct?

Mr. LILLY. Yes.

Mr. TRAXLER. Is there any possibility this could be converted to generate power for the Lewis Research Center?

Dr. FROSCH. No, it is the wrong size and the wrong kind. It would cost more than the original cost of decommissioning.

MODIFICATION OF SPACE SHUTTLE FACILITIES

Mr. TRAXLER. We will turn to the Space Shuttle facilities where you are requesting $10,100,000 in 1981. The major request is displayed on page CF-8-5 in the amount of $5,400,000 for the modification of manufacturing and final assembly facilities for external tanks.

On page CF-8-6, you indicate that a third ablator spray cell is required by early calendar year 1982 in order to support a production rate in excess of 16 tanks per year—which is the current limitation of the two cells.

Also, on page CF-8-7, you indicate that "failure to provide them at this time would prevent attainment of needed capability to manufacture ET's to support flight rates in 1983."

I assume this budget was put together before the most recent schedule slip—is that correct?

Dr. FROSCH. Yes, but I think the rates still hold.

Mr. TRAXLER. The current flight rate projected for 1983 does not require the third cell. Is that correct?

Dr. FROSCH. I think it splits across the years. The 1983 model projection is 14 flights and the 1984 rate is 19 flights, so the split that goes above 16 comes between fiscal years 1983 and 1984.

Mr. TRAXLER. You can appreciate the problem the Members of this Subcommittee have trying to reorient ourselves to the new flight schedules.

General MCGARVEY. Mr. Chairman, there are three cells involved. We had one cell authorized in fiscal year 1981 which was the first ablator spray cell and last year in fiscal year 1980 the second cell was a cleaning and priming cell. That second cell is scheduled to go under construction in June of this year. If everything goes according to schedule the second cell won't come online until late November, 1981. Then when you look at the cell we are requesting now, it will not come on line until a year later or about

October of 1982. Then you have to allow for a learning curve buildup. That is where the problem comes. If everything goes according to schedule, we should be able to get up to 16 tanks per year but if it does not, if the learning curve isn't as good as projected, we will not reach that 16 rate and we will be somewhere below it. That, coupled with the fact that with the current escalation rates in construction, particularly in the New Orleans area, it makes a lot of sense to go ahead and construct the third cell.

Mr. TRAXLER. Now let's look at the $2,700,000 requested for modifications to the solid rocket Motor Manufacturing Assembly Facility in Utah.

Again, you are requesting this modification to increase the capability of supporting Shuttle flights.

Under the current manifest, when will we first need the capability of 24 flight sets per year?

Dr. LOVELACE. Sometime between 1984 and 1985.

Mr. TRAXLER. How many flight sets per year can you handle under the current faciities? Probably more than 10 but less than 24.

General MCGARVEY. Fourteen is the present capability when the 1979 construction is completed.

Mr. TRAXLER. The estimate for Shuttle facilities in 1971 dollars was roughly $295 million. What is the current estimate of the Shuttle facilities in 1971 dollars? That was $295 million in 1971. Can you give us the current estimate?

General MCGARVEY. In 1971 dollars?

Mr. TRAXLER. Yes.

General MCGARVEY. $295.8 million.

REHABILITATION, REPAIR, AND MINOR CONSTRUCTION OF VARIOUS FACILITIES

Mr. TRAXLER. That is good news.

On page CF-10, you are requesting $15 million for the repair of various facilities. On page CF-11, you are requesting $20 million for rehabilitation and modification of various facilities, and on page CF-12 you are requesting $4 million for minor construction at selected facilities.

For all three of those requests we would like to have you prioritize the projects beginning with the first and highest ranked project down through the last ranked project. You can do that for the record.

[The information follows:]

In responding to your request for priority listings for each of NASA's minor programs (Repairs, Rehabilitation and Modification, and Minor Construction) it is necessary to first indicate the purpose and then explain the prioritization categories that are used. These centrally managed programs have been established to protect and enhance the NASA physical plant which has a book value of approximately $6.4 billion. Through this program, NASA preserves the usefulness of its facilities, modifies them to meet changing research and develop needs, and provides minor adjustments or expansions to accommodate new equipment and procedures. In all three programs large backlogs of work exist. Thus, in preparing the CoF Budget Estimates, relative priorities are thoroughly scrutinized, and only the highest priority candidates have survived for requested funding. The projects and budget totals included in the FY 1981 CoF Budget Estimates are at a level that will enable NASA to not fall further behind in this essential work. The impact on NASA of deleting or deferring these projects will be reduced mission capability, increased energy/maintenance costs, increasing frequency of "unscheduled" breakdowns, and increasingly costly "band aid" patch and repairs.

The categories below are used by NASA in developing priorities. They reflect a consensus of relative urgencies. Within these categories it is extremely difficult to assign more refined priorities.

The categories for justification include:

1. Life Critical. Work required to correct conditions that are dangerous to the life and health of personnel with the potential of fatal injuries if they are not corrected.

2. Safety. Work required to correct a safety hazard or to provide adequate fire protection for personnel or high value equipment, materials, or records that would be difficult or impossible to replace that are needed in the performance of mission or other essential tasks.

3. Program Critical. Work that is urgently needed to support a specific R&D program or mission and the effort must be completed by a stated date for the successful accomplishment of that program or mission.

4. Environmental. Work required to correct an existing condition that may pollute the environment. It includes the correction of conditions to only meet currently approved environmental standards.

5. Energy. Energy conservation work is one which meets any one of the following criteria:

a. Provides for the conversion to alternate conventional fuels in response to situations involving shortages and/or curtailments of supply, or provides for increased storage or handling capacities for present or new conventional fuel resources.

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b. Provides for improved utilization of all types of energy resources, through conservation and/or increased efficiency, resulting in a simple payback of preferably less than 5 but not more than 10 years.

6. Institutional Critical. Work urgently required to correct an existing condition involving institutional facilities, such as accelerating deterioration that requires prompt correction. It includes the improvement of utility systems that support major areas of the installation. The emphasis is on work of the most pressing nature that is not directly program related.

7. Program Related. Work required to correct deficiencies in facilities that support R&D programs or missions. It includes deterioration that limits support to tests or operations and must be corrected in the budget year. It also includes direct program projects that do not qualify as program critical projects.

8. Cost Effective. Work that is not program critical or institutional critical, but that if accomplished, would result in demonstrable cost savings or other benefits over a reasonable period of time.

9. Occupational Safety and Health Related. Work required to meet current standards of the Occupational Safety and Health Act of 1970. Such work is necessary to improve the working environment for employees but is less urgent than work performed under the category of "Safety". This category is intended to accomplish work that is clearly needed for full compliance with the law but can be deferred without serious risk.

10. Institutional Routine. Work that is clearly necessary at this time. Deferral may cause deficiency to become critical in future years. A prudent businesslike approach to the backlog of needed facilities work includes this category of work in the current budget.

REPAIRS

Safety

NSTL	- Repair of High Pressure Gas System Components	$470,000
LaRC	- Repair of Potable Water Lines, West Area	$365,000
LeRC	- Repair of Flight Research Building Apron, Bldg. 4	$470,000
JSC	- Repair of Various Facilities, White Sands Test Fac.	$315,000
MAF	- Repairs to Fire Water Piping	$410,000

Program Critical

WFC	- Repair of Airfield Pavement	$425,000

Institutional Critical

ARC	- Repair of Roofs, Bldgs. N-204, N-210, N-223, & N-235	$310,000
JPL	- Repair Below Grade Waterproofing at Physical Lab 183	$420,000
KSC	- Repair Roofs, Various Buildings	$475,000
LeRC	- Repair of Domestic Water Systems, Bldgs. 5 & 6	$270,000
MSFC	- Repairs to Chillers	$ 95,000
ARC	- Repair Boilers	$140,000

Institutional Critical (Continued)

NSTL	- Repair of High Temperature Hot Water Circulating Pumps	$160,000
JPL	- Repair Roofs of Various Bldgs. (156, 161, 186, & 248)	$485,000
GSFC	- Repair Parkway Bridge	$160,000
NSTL	- Repair of Absorption Water Chillers	$240,000
LeRC	- Repair of Roofs, Various Buildings	$265,000
ARC	- Repair Cooling Towers	$145,000

Program Related

JPL	- Repair UPS Battery Station in Space Flight Operations Facility 230	$215,000
MAF	- Repair to Plant Air Distribution	$120,000
MAF	- Repairs to Electrical Feeders #14 & 15	$200,000
LeRC	- Repair of Steam Condensate System, Various Buildings	$160,000
MAF	- Repair Sewer Line in Roof Truss, Manufacturing Building 103	$440,000
MAF	- Repairs to Michoud Slip Channel	$180,000
LeRC	- Repair of Service Air System	$175,000
JSC	- Repair of Various Facilities, NASA Industrial Plant, Downey	$445,000

Institutional Routine

GSFC	- Repair Roofs of Payload Testing Facility, Building 7 and Environmental Test Lab., Building 10	$280,000
KSC	- Repair of Hot Water Heating Systems, Various Buildings	$445,000
LaRC	- Repair of Electrical Power Distribution System, Building 642	$465,000
MSFC	- Repair Overhead Piping, Various Buildings	$200,000
WFC	- Repair Roofs, Various Buildings	$350,000
WFC	- Repair Paved Surfaces	$190,000
MSFC	- Repair Heating, Ventilating and Air-Conditioning Components	$300,000
LaRC	- Repair of Roof, Building 643	$360,000
KSC	- Repair of Banana River Bridge	$240,000
JSC	- Repair of Roofs, Various Buildings	$315,000
GSFC	- Repair Paved Surfaces	$380,000
GSFC	- Repair Building Exterior Surfaces	$165,000
JSC	- Repair of Heating, Ventilating, and Air-Conditioning, Various Buildings	$475,000
KSC	- Repair of the Indian River Bridge	$480,000
MSFC	- Repairs to Roofs, Various Buildings	$460,000
NSTL	- Repair Sewerage Station Lift Pumps	$120,000
WFC	- Repair Heating, Ventilating, and Air-Conditioning	$145,000
MSFC	- Repair of High Pressure Gas Distribution System	$450,000
JSC	- Repair Steam and Chilled Water Systems, Building 24 Complex	$180,000
MAF	- Repair Roads and Parking Lots	$240,000
LeRC	- Repair of Roads	$305,000
MSFC	- Repairs to Exteriors of Various Buildings	$450,000
MSFC	- Repairs to Test Facilities	$450,000

REHABILITATION AND MODIFICATION

Safety

NSTL - Modification of Fire Alarm System	$300,000
WFC - Modification of Water & Fire Protection Systems in the M and A-41 Areas	$455,000
LaRC - Modification for Fire Protection, Buildings 1268 and 1268A	$300,000
DFRC - Modification of Fire Protection System	$180,000
KSC - Modification for Sprinkler Protection	$135,000
WFC - Modification of Water & Fire Protection Systems, Mainland and Island Areas	$300,000
JPL - Modification to Fire Protection System (E-22 and E-32), ETS	$165,000
KSC - Modify Fire Suppression System, Goddard Unified S-Band Operations Building	$415,000
NSTL - Mods to Cooling Towers	$250,000
WFC - Modifications for Fire Protection in Various Buildings	$140,000

Program Critical

VL - Rehabilitation of Gear Box Support on Three 64-Meter Antennas	$335,000
GSFC - Modification of Meterological Systems Development Laboratory, Building 21	$480,000
ARC - Modification of the Central Computer Facility, N-233	$465,000
VL - Modifications to Deep Space Network Power Plants, Goldstone, CA	$390,000
MAF - Modification of Substations 20 and 44	$135,000
ARC - Modification of Computer Communication System	$485,000
GSFC - Modification of Data Interpretation Laboratory, Building 23 for IPF	$335,000
LeRC - Modification of Propulsion Systems Laboratory, Building 125	$260,000
LaRC - Modification to .3 Meter Transonic Cryogenic Tunnel, Building 1242	$475,000
GSFC - Modifications of Spacecraft Operations Facility for MSOCC, Building 14	$220,000

Environmental

LaRC - Modifications to the Transonic Dynamics Tunnel, Building 648	$400,000

Energy

MSFC - Modification to Provide Automation of Building Systems Management	$400,000
JSC - Rehabilitation of Utility Control System	$490,000
NSTL - Modification of Various Facilities	$475,000
JSC - Modifications to Various Buildings	$485,000
MAF - Modifications for Automation of Building Systems Management	$205,000
DFRC - Modifications to Various Buildings for Energy Conservation	$310,000

Energy (Continued)

MSFC	- Modifications to Various Buildings for Energy Conservation	$250,000
GSFC	- Modifications to HVAC Systems Three Buildings	$265,000
LeRC	- Modification of Lighting Systems, Various Buildings	$220,000
WFC	- Modification of HVAC Systems, Various Buildings	$390,000
JSC	- Modifications for Utilities Metering, Various Buildings	$165,000

Institutional Critical

KSC	- Rehabilitation of the Fender System, Haulover Canal Bridge	$405,000
JPL	- Rehabilitation of Bridge Crane	$140,000
DRFC	- Rehabilitation of Laboratory Building 4800	$260,000
MAF	- Rehavilitation of Steam Boiler, Building 207	$335,000
NSTL	- Modification of 13.8 KV Electrical Distribution System	$210,000
JSC	- Modifications for Air-Conditioning System, Photographic Technology Laboratory Building 8	$475,000
WFC	- Rehabilitation of Building F-4	$435,000
LaRC	- Rehabilitation of Electrical Power Distribution	$475,000
JSC	- Modification of Air-Conditioning System, Electronic Systems Compatibility Facility, Building 44	$165,000
WFC	- Rehabilitiation of Buildings F-1 and F-2	$485,000
LeRC	- Modifications of Electrical Substation B,Building 13	$450,000
JPL	- Rehabilitation of Compressed Air System	$120,000
GSFC	- Modifications of Various Buildings	$450,000
WFC	- Modifications to Building F-5	$115,000
GSFC	- Rehabilitation of Elevator, Central Flight Control and Range Operations Laboratory, Building 3	$160,000
GSFC	- Modification of Space Tracking and Data Facilities	$130,000

Program Related

LeRC	- Modification of Extrusion Press, Material Processing Laboratory (105)	$350,000
JPL	- Modifications in 25-Foot Space Simulator Building 150	$310,000
LeRC	- Modification of Drive Speed Control for 8-Foot x 6-Foot Supersonic Wind Tunnel, Building 53	$460,000
JPL	- Modification to a 10-Foot Solar Simulator for Cryogenic Pumping, Building 248	$350,000
GSFC	- Modification of Central Flight Control and Range Operations Laboratory, Building 3	$320,000
JPL	- Rehabilitation of Central Section Utility Tunnel, ETS	$485,000

Cost Effective

JSC	- Modifications to Central Cafeteria, Building 3	$485,000
JSC	- Rehabilitation of Air Compressors, Central Heating and Cooling Plant, Building 24	$380,000

OSHA

ARC	- Modifications for the Handicapped	$145,000

Institutional Routine

MSFC - Rehabilitation of Building 4487, "C" Wing East	$450,000
DRFC - R&M of Preflight Launch Pad and Power Supply	$ 80,000
MSFC - Rehabilitation and Modification of Cable Distribution System, Communications Facility, Building 4207	$475,000
NSTL - Rehabilitation of Warning and Paging Systems	$160,000
LaRC - Rehabilitation of Instrument Research Laboratory, West Wing, Building 1230	$465,000

MINOR CONSTRUCTION

Safety

GSFC - Construction of Access Roads	$240,000

Program Critical

VL - Construction of Addition to Operations Building DSS-43	$195,000

Institutional Critical

DFRC - Construction of Support Shop	$245,000
WFC - Construction of Aircraft Support Building	$125,000
JPL - Construction of Addition to Space Science Facility 186	$230,000
GSFC - Construction of Addition to Spacecraft Operations Facility, Building 14	$130,000
JPL - Construction of Addition to Technical Services Facility E-83, ETS	$240,000
GSFC - Construction of Ductbank	$240,000

Program Related

LaRC - Construction of Pointing Control Laboratory, Building 1232	$235,000
LaRC - Construction of Addition to Building 1205	$170,000

Cost Effective

NSTL - Construction of Addition to Central Heating Plant, Building 3204	$200,000

Institutional Routine

JSC - Construction of Addition to Life Systems Laboratory, Building 7	$ 80,000
ARC - Construction of Wind Tunnel Blade Sanding Shop	$240,000
WFC - Construction of Addition to Equipment Storage Building (N-222)	$ 80,000
NSTL - Construction of Addition to Data Engineering Building 1110	$235,000
LARC - Construction of Addition to Building 1209	$235,000
ARC - Construction of Shop and 2nd Floor Offices in Building N-211	$160,000
JPL - Construction of Warehouse, ETS	$240,000
GSFC - Construction of Addition to Visitor Center, Building 88	$240,000
JPL - Construction of Addition to General Office Facility 111	$240,000

Mr. TRAXLER. Is it correct to assume that as the bids come in for these various construction projects in the COfF budget some bids are within the estimate provided in the appropriation?

General MCGARVEY. Yes, sir. The vast majority are within those figures.

Mr. TRAXLER. We hope you have accumulated some savings and the savings are transferred to other projects. This has happened in the past. I am sure there have been some delightful surprises and you have had some bids that come in under your estimates.

General MCGARVEY. We have had bids that have been over and it is pretty close to balancing itself.

Mr. TRAXLER. What I want to know is what did you do with the savings?

Dr. FROSCH. We balanced the losses.

Mr. TRAXLER. That is the simple answer. If you would provide the Committee with a list of all the project savings that have been generated through bids received at less than the funds appropriated and the disposition of those savings for the fiscal years 1975, 1976, 1977, 1978 and 1979.

[The information follows:]

A summary of major projects by program Fiscal Year 1975 through Fiscal Year 1979 follows. Authorization/Appropriation as compared with Cost Estimates are reflected by project. The disposition of any savings and the solution of any shortages are also reflected.

CONSTRUCTION OF FACILITIES
($000)

FY 1975 PROGRAM

Proj. No.	Project Title	Appropriated Program	Current Cost Estimate
2158	Addition to Flight and Guidance Simulation Laboratory, ARC	3,660	3,660
5156	Rehabilitation and Modification of Science and Applications Labs, GSFC	890	890
5146	Modifications for Fire Protection and Safety, GSFC. $100 to Various Locations (9340); $134 to LeRC (2266).	1,220	986
5502	Acquisition of Land, JPL. $20 to JPL (5560); $8 to KSC (7721).	150	122
5548	Addition to Systems Development Laboratory (SDL), JPL	4,880	4,880
5560	Addition for Integrated Systems Testing Facility, JPL. Increased by $379 (Section 2).	3,790	4,169
7275	Modification of Water Supply System, JSC. $50 to JPL (5560); $15K to KSC (7721);$150 to LeRC (2275).	935	720
2399	Modification of 6,000 Pounds Per Square Inch Air Storage System, LeRC.$70 to Var.Locs.(9340); $20 to LeRC (2266).	515	425
2395	Rehabilitation of 16-Foot Transonic Wind Tunnel, LaRC. $25 to LeRC (2275); $150 to KSC (7721).	2,990	2,815
2266	Modification of Propulsion Systems Laboratory, LeRC. Increased by $210 (Section 2).	2,580	2,790

Proj. No.	Project Title	Appropriated Program	Current Cost Estimate
2253	Modification of Rocket Engine Test Facility, LeRC. $30 to LeRC (2266).	660	630
2275	Emergency Repair to No. 2 Secondary Drive Motor for the 10x10-Foot Supersonic Wind Tunnel, Bldg. 87, LeRC. Sec. 309B, Air & Space Act.	---	292
6705	Construction of X-ray Telescope Facility, MSFC. $92 to LeRC (2275); $70 to Var. Locs. (9340); $90 to JPL (5560).	4,060	3,808
5327	Modification of Beach Protection System, WFC. $219 to JPL (5560); $86 to Var. Locs. (9340); $1 to LeRC (2266).	1,370	1,064
9340	Construction of Infrared Telescope Facility, Mauna Kea, Hawaii, VAR. Increased $604 (Section 2).	6,040	6,644
9361	Modifications for Fire Protection and Safety at Various Tracking and Data Stations, VAR. $50 to LeRC (2275); $278 to Var. Loc. (9340).	1,430	1,102
Space Shuttle Facilities - Various Locations			
7716	Construction of Orbiter Landing Facilities, KSC. $3,900 to KSC (7720) $1,786 to KSC (7721); $130 from Var. Loc. (9357).	15,880	10,324
7720	Construction of Orbiter Processing Facility, KSC. Increased $3,900 (Sec. 3); $1,770 to KSC (7721).	13,380	15,510
7721	Modifications to Launch Complex 39, KSC. Authorization of $37,690 increased $1,794 (Sec. 2).	35,355	39,484
9354	Modifications for Dynamic Test Facilities, MSFC & NASA Industrial Plant, Downey, CA, VAR	3,920	3,920
9357	Construction of Orbiter Approach and Landing Test Facilities, VAR. Increased $1,000 (Sec. 3); $130 to KSC (7716).	1,940	2,810

Proj. No.	Project Title	Appropriated Program	Current Cost Estimate
7278	Modifications for Crew Training Facilities, JSC	420	420
7254	Modification of the Vibration and Acoustic Test Facility, JSC.	410	410
9332	Construction of Materials Test Facility, White Sands Test Facility, VAR	790	790
6710	Modifications for Solid Rocket Booster Structural Test Facilities, MSFC. $400 to KSC (7721).	2,190	2,190
9359	Construction of Shuttle/Carrier Aircraft Mating Facilities, VAR. Added by Section 3 Reprogramming.	---	1,500
Rehabilitation and Modification Various Locations	$55 lapsed 9/30/77.	14,900	14,845
Minor Construction - Various Locations	$27 lapsed 9/30/77.	4,500	4,473
Facility Planning and Design	$38 lapsed 9/30/77.	10,900	10,862
	FY 1976 PROGRAM		
2159	Modification of 11 x 11-Foot Transonic Wind Tunnel, ARC. $50K to WFC (5337).	2,695	2,645
2397	Addition for Composite Model and Metal Finishing Shops, LaRC. $310K to FP&D.	1,940	1,630
5337	Emergency Repair to Seawall, WFC. Added by Sec. 309(b), Air & Space Act.	---	950
Space Shuttle Facilities at Various Locations			
7720	Construction of Orbiter Processing Facility, KSC. $294K to JSC (7278).	8,160	7,866
7721	Modifications to Launch Complex 39, KSC. Increased $1,311K (Sec. 2) and $2,500K (Sec. 3).	13,110	16,921

Proj. No.	Project Title	Appropriated Program	Current Cost Estimate
7724	Modifications for Solid Rocket Booster Processing Facilities, KSC. $5K to JSC (7278); $50K to KSC (7725).	5,240	5,185
7725	Modifications for Hypergolic Checkout and Refurbishment Facs., KSC $1,700K to KSC (7721); $50K from KSC (7724).	6,940	5,290
7726	Modifications for Launch Equipment Test Facilities, KSC. $73 to JSC (7278).	1,960	1,887
7741	Construction of Emergency Power Facilities, KSC. Added by Sec. 3.	---	2,200
9357	Construction of Orbiter Approach and Landing Test Facilities, DFRC & AF Plant #42, Palmdale, CA., VAR. $458K to MAF (6332).	1,680	1,222
9359	Construction of Shuttle/Carrier Aircraft Mating Facilities, DFRC & AF Plant #42, Palmdale, CA., VAR. $2,230 to Var. Loc. (9372).	3,890	1,660
7278	Modifications for Crew Training Facilities, JSC. Increased by two Section 3 actions.	830	2,030
7254	Modification of the Vibration and Acoustic Test Facility, JSC. $1,311 to KSC (7721): $621 to JSC (7278); $116 to MAF (6332).	2,410	362
9369	Modifications for Solid Rocket Booster Component Manufacturing and Assembly Facilities, VAR. Project cancelled. $2,500 to KSC (7721); $500 to KSC (7741).	3,000	---
9372	Construction and Modification for Overland Transport of Space Shuttle Orbiter, VAR. Added by Sec. 3 (2,230). $503 to FP&D; $326 to MAF (6332); $207 to JSC (7278).	---	1,194
6332	Emergency Repair of Building 207, Chiller No. 1, MAF. Added by Sec. 309(b), Air and Space Act.	---	900

Proj. No.	Project Title	Appropriated Program	Current Cost Estimate
	Rehabilitation and Modification-Various Locations $44K lapsed 9/30/78.	16,000	15,956
	Minor Construction - Various Locations	5,000	5,000
	Facility Planning and Design $310 from LaRC (2397); $503 from Var. Locs. (9372); $7 lasped 9/30/78.	9,275	10,081
	FY TQ PROGRAM		
	Rehabilitation and Modification Various Locations	7,000	7,000
	Minor Construction -Various Locations	1,250	1,250
	Facility Planning and Design	2,500	2,500
	FY 1977 PROGRAM		
2128	Modification of Flight Simulator for Advanced Aircraft, ARC	1,730	1,730
2164	Modification for High Enthalpy Entry Facility, ARC	1,220	1,220
2167	Construction of Supply Support Facility, ARC	1,540	1,540
2418	Construction of Addition to Flight Control Facility, DFRC	750	750
7285	Construction of Addition to Lunar Sample Curatorial Facility, JSC	2,200	2,200
7713	Modifications for Utility Control System, KSC	2,445	2,445
7729	Construction of Airlock to Spin Test Facility, KSC. $4K to LaRC (2915).	360	356
2902	Construction of Addition for Aeroelastic Model Laboratory, LaRC. $60K to LaRC (2915).	730	670
2903	Construction of Data Reduction Center Annex, LaRC. $396K to LaRC (2915); to GSFC (5162).	2,970	2,500

Proj. No.	Project Title	Appropriated Program	Current Cost Estimate
2906	Construction of Refuse-Fired Steam Generating Facility, LaRC	2,485	2,485
2915	Emergency Repairs to Roofing System of Building 1244 (Hangar), LaRC Added by Sec. 309(b), Air and Space Act.	---	460
2268	Modification of Refrigeration System Electric Propulsion Laboratory, LeRC	680	694
2273	Rehabilitation of Combustion Air Drying System Engine Research Building, LeRC. $14K to LeRC (2268).	1,490	1,476
2281	Modification of Buildings 63 and 98 for Helicopter Transmission Testing, LeRC. Added by Section 3.	---	680
	Large Aeronautical Facilities		
2157	Modification of 40x80-Foot Subsonic Wind Tunnel, ARC	(6,000)	6,000
2905	Construction of National Transonic Facility, LaRC	25,000	25,000
	Space Shuttle Facilities at Various Locations		
6328	Modification of Manufacturing and Final Assembly Facilities for External Tanks, MAF	1,930	1,930
7720	Construction of Orbiter Processing Facility, KSC	3,750	3,750
7721	Modification of Launch Complex 39, KSC	12,855	12,855
7724	Modification for Solid Rocket Booster Processing Facilities, KSC	8,700	8,700
9359	Construction of Shuttle/Carrier Aircraft Mating Facility, VAR	1,700	1,700
9370	Rehabilitation and Modification of Shuttle Facilities, VAR	1,760	1,760
	Space Shuttle Payload Facilities at Various Locations		
5162	Modifications and Addition for Shuttle Payload Development, GSFC. Increased by Sec. 2. $74.	770	844

Proj. No.	Project Title	Appropriated Program	Current Cost Estimate
7734	Modifications to Operations and Checkout Building for Spacelab, KSC	3,570	3,570
	Rehabilitation and Modification - Various Locations	17,875	17,875
	Minor Construction - Various Locations	2,925	2,925
	Facility Planning and Design	12,655	12,655
	FY 1978 PROGRAM		
2421	Construction of Central Hydraulic System, ARC. Increased $21 by Section 2.	420	441
5166	Construction of Additional Technical Processing Facilities, GSFC	3,100	3,100
5167	Construction of an Addition to Building 14 for a Network Operations Control Center, GSFC. $1,400 added by Sec. 3; increased $36 by Sec. 2.	---	1,436
5567	Modifications to Various Buildings for Seismic Protection, JPL. Increased $283 by Section 3.	2,830	3,113
7284	Modification of Chillers in Central Heating and Cooling Plant, JSC. $35 to LaRC (2900); $21 to DFRC (2421).	2,540	2,484
7713	Modifications for Utility Control System, KSC	2,130	2,130
2900	Rehabilitation of Main Heating Plant, LaRC. $140 to JPL (5567); $35 from JSC (7284).	790	685
2396	Rehabilitation of Unitary Plan Wind Tunnel, LaRC. $16 to GSFC (5167).	980	964
2272	Modification of Central Chilled Water System, LeRC. $20 to GSFC (5167); $43 to JPL (5567).	860	797
6434	Modifications for Utility Control System, NSTL	620	620

Proj. No.	Project Title	Appropriated Program	Current Cost Estimate
	Large Aernautical Facilities		
2905	Construction of National Transonic Facility, LaRC	23,500	23,500
2457	Modification of 40x80-Foot Subsonic Wind Tunnel, ARC	13,500	13,500
9383	Rehabilitation and Modification of 64-Meter Antenna Components, VAR. $100 to JPL (5567).	1,750	1,650
	Space Shuttle Facilities At Various Locations		
7721	Modifications to Launch Complex 39, KSC	40,700	40,700
7724	Modifications for Solid Rocket Booster Processing Facilities, KSC	1,730	1,730
7737	Rehabilitation of Barge Channels, KSC	2,090	2,090
6328	Modification of Manufacturing and Final Assembly Facilities for External Tanks, MAF	18,610	18,610
9370	Rehabilitation and Modification of Shuttle Facilities, VAR	1,750	1,750
7739	Modifications and Addition for Shuttle Payload Vertical Processing, KSC	6,410	6,410
	Rehabilitation and Modification - Various Locations	18,900	18,900
	Minor Construction - Various Locations	5,950	5,950
	Facility Planning and Design	11,780	11,780
	FY 1979 PROGRAM		
2163	Modification OF 12-Foot Pressure Wind Tunnel, ARC	2,510	2,510
2168	Modification of Unitary Plan Wind Tunnel, ARC. $500 to R&M.	5,390	4,890
2169	Modification of 3.5-Foot Wind Tunnel, ARC	1,870	1,870

Proj. No.	Project Title	Appropriated Program	Current Cost Estimate
5170	Modifications and Additions for Logistic and Supply Functions, GSFC	5,640	5,640
5567	Modifications to Various Buildings For Seismic Protection, JPL	1,570	1,570
5568	Modifications and Additions to the Space Flight Operations Facility, JPL	3,060	3,060
2396	Rehabilitation of Unitary Plan Wind Tunnel, LaRC	4,520	4,520
2904	Modifications for Utility Control System, LaRC. $660 to R&M.	1,980	1,320
2271	Construction of Research Analysis Center, LeRC. $140 to R&M.	6,140	6,000
	Large Aeronautical Facilities		
2157	Modification of 40x80-Foot Subsonic Wind Tunnel, ARC	31,600	31,600
2905	Construction of National Transonic Facility, LaRC	24,500	24,500
	Space Shuttle Facilities at Various Locations		
6328	Modification of Manufacturing and Final Assembly Facilities for External Tanks, MAF	13,980	13,980
7721	Modifications to Launch Complex 39, KSC	13,570	13,570
9370	Minor Shuttle-Unique Projects, VAR $490 to Var. Loc. (9399).	1,600	1,110
9391	Modifications to Solid Rocket Motor Manufacturing and Assembly Facilities, Thiokol Plant, Wasatch, Utah, VAR	1,920	1,920
9399	Construction of Backup Landing Facilities at White Sands Missile Range, VAR. Added by Sec. 3.	---	490

Proj. No.	Project Title	Appropriated Program	Current Cost Estimate
	Rehabilitation and Modification - Various Locations $500 from ARC (2168); $660) from LaRC (2904), $140 from LeRC (2271).	12,800	14,100
	Minor Construction of New Facilities and Additions to Existing Facilities - Various Locations	4,200	4,200
	Facility Planning and Design	10,650	10,650

Mr. LILLY. There are projects such as the one you questioned on the external tank which is a complete facility and requires full funding to pick up to that capability but we may come back with a project called the same thing to increase that capability above 24 a year as the flight rate goes up. I didn't want that to be misunderstood.

Mr. TRAXLER. We appreciate that. Thank you.

Mr. Coughlin?

Mr. COUGHLIN. Thank you, Mr. Chairman.

SPACE SHUTTLE—A COST JUSTIFIABLE PROGRAM

I don't have any questions on this particular section but I would like to just briefly say as a follow-on what I said this morning. I do think it would be helpful in taking this supplemental and this proposal to the floor to have some updated cost benefit analysis of the Shuttle program.

A lot of people are going to say maybe we should scrap the whole thing and put the money in our cities or some other thing. What we have is pretty old.

Dr. FROSCH. I think what we can provide is a reexamination of the previous studies and an indication as to the extent to which they still hold.

Mr. COUGHLIN. The updated costs involved in the Shuttle. I think that may have slipped a lot of people's minds at this point in the game. In the current attitude, it would be important to refresh people's recollection that this is a cost justifiable program.

Dr. FROSCH. There is a tendency for inflationary effects to work out because they apply to Shuttle and ELU costs; but there have been other costs worth assessing and we will do that.

[The information follows:]

Although the economic benefits were not the primary justification in the decision to propose development of the Space Shuttle, NASA did make several comprehensive economic analyses to test the cost effectiveness of the Shuttle as the basis for a new national Space Transportation System. In these analyses, the Shuttle was compared to expendable launch systems in performing a representative set of future space missions over a 12-year investment horizon. The final baseline analyses prepared in 1973 showed a $14 billion savings ($72) in favor of the Shuttle over the expendable system for a 724 flight program including projected space flights for NASA, DOD, and other U.S. government agencies, commercial and foreign users. Sensitivity analyses at that time indicated that the cost effectiveness of the Shuttle would be sustained over a wide range of flight rates, e.g. at substantially reduced payload quantities down to an unequivalent 572 flights the Shuttle savings were greater than $12 billion; at rates as low as 25 flights per year (300 missions over the 12-year period) the Shuttle was still a good investment with a 10% return.

NASA has not made a recent, detailed economic comparison of performing the currently projected 487 flight model with expendables in place of the Shuttle. We have reviewed the baseline data from the 1973 analysis and derived summary level estimates, using scaling factors from that study for payload costs, and updating the investment costs (including European Spacelab development, DOD IUS, Vandenberg facilities and operations capability costs, etc.) and operations cost to the most recent estimates used for the FY 1981 budget. An appropriate adjustment was made for the sunk costs, i.e., already expended funds that are no longer relevant to a current economic comparison.

The results displayed in the table below show that STS retains a significant economic advantage over the expendables with a savings of $18 billion in fiscal year 1981 budget dollars.

1980 MISSION MODEL SUMMARY COST COMPARISON

[Billions of 1981 dollars]

	Payloads	Transportation	Non-nonrecurring investment	Total
Expendable case	$51.9	$25.2	$7.2	$84.2
Shuttle case	38.0	21.5	6.8	66.3
Benefits	13.9	3.7	.4	18.0

Mr. TRAXLER. Mrs. Boggs?

NEED FOR EXTERNAL TANKS SCHEDULED FOR CONSTRUCTION

Mrs. BOGGS. Thank you, Mr. Chairman. I apologize. I have two Subcommittees going on at the same time and had I tried to be here by the time you discussed the external tank situation and the third cell need.

Mr. Chairman, I hope it wouldn't be too impolite to ask if you could repeat for me or tell me about the need for the actual number of flights that you have requested and the need for the number of tanks already scheduled for construction and delivery in the next 24 months with a bearing on why the cell is needed.

Dr. FROSCH. In fiscal year 1983, the mission model shows a total of 14 flights. In fiscal year 1984, 19 flights. Therefore, the transition from less than 16 to a requirement for more than 16 production rate for external tanks comes between fiscal years 1983 and 1984. If I can make the conversion, fiscal year 1984 will start in October of 1983. So that would be about when the transition would occur.

There is more involved than just the production area. There is a question of having the facility in time to get it on-line and to use it and to get the flow of operations in the whole plant up to the full rate. We tend to add anywhere from six to nine months for getting it in full operation after the time it is completed and effectively ready to be used.

General MCGARVEY. I am sure you recognize this is the third cell in that facility.

Mrs. BOGGS. Right.

General MCGARVEY. According to current projected flight rates in order to get to above 16 per year the third cell it is required in that time frame.

Mrs. BOGGS. The facility is such that I would assume a long lead is necessary in order to put it on-line in time sufficient to meet your launch schedule. Is that correct?

General MCGARVEY. That is correct. It takes almost a year's time of activation and buildup in the learning period to increase production to those desired rates. After a facility has been completed almost a year's activation and learning period is involved.

Mrs. BOGGS. Having visited the facility at Michoud and seen some of the ramifications of planning and the execution of the final product, it certainly does provide an understanding of the difficulties involved in meeting the time frame needed in order to meet your schedule.

Thank you, Mr. Chairman.

Mr. BOLAND Thank you.

Any other questions on Construction Facilities. Thank you very much, General.

This morning I made reference to a local study and there were a few questions I wanted to get into the record before we turned to Research and Program Management.

At last year's hearing the Subcommittee made an effort to determine the Shuttle delays. On page 130 of the 1980 hearings, John Yardley indicated that, "We have, it is fair to say, been running the program as tightly as we can in funding, but this has not turned out to be a delaying factor in the engines up to this point."

Then, Dr. Frosch, you indicated on page 131 that, "I think the situation has been that we have been paced more by technological problems than by money problems."

And, again, Dr. Frosch, on page 137, you indicated that, "If additional funds had been provided earlier, they would have done useful work and, in parts of the Shuttle program, would have saved us from some later funding problems of larger size. But they would not have kept the total Shuttle flight program on schedule because that has been paced by the technological problems in the engine."

Those responses are interesting because they seem to directly contradict the findings of the Lovelace study which clearly indicated that the lack of funding did impact on the schedule—in fact, the schedule itself was used as a reserve to compensate for the lack of funding.

For example, the Lovelace study included a conclusion that, "The program was underfunded at the start and, viewed with investigative hindsight, has been underfunded since."

So, let me ask you the same question I did last year, hasn't the Lovelace study confirmed for you now that we needed to put more money into this program two, three, maybe four years ago, and then we wouldn't be faced with these schedule delays and perhaps with these large cost overruns?

Dr. FROSCH. I think last year in answer to that question I was focusing on the recent period, the last couple of years where I think it was the situation in the engine, that the engine test rate was limited by the given facilities and that no amount of money in those couple of years would have changed things.

If we go back four or six years ago to the point at which the program was building up, then I think it is clear from the recent history on the engine that had we funded, for example, more test facilities for the engine and built more engines earlier, then we could have gotten a greater rate of engine testing. That probably would have led to faster progress even given the same technological problems.

But starting in, say, 1977 or even 1976, probably the restriction in the rate of work with the engines was principally in the engine test facilities.

We only have the three single engine rigs and the one MPT rig and that is what controls the test rate. That would have continued to control it because if we had the money we couldn't build another rig fast enough.

An earlier period is what Lovelace's group was concentrating on. The program could have built up more facilities and heavier flow of engines and done a faster program. It depends on at where in the program you are looking.

Dr. LOVELACE. I think that is a fair assessment. The group that looked into this for me had the benefit, of course, of the current understanding of the status of the development and they looked all the way back to the genesis of the program back in the 1971–1972 time period.

It is clear that knowing what we know now we could have made investments at that time in additional test facilities to accelerate the engine test program.

I think that is the findings of the group that reported to me and the statements of last year are really compatible.

It is always the case when knowing the nature of our programs today if we had known those much earlier and had the foresight early in the program, we might have carried some parallel activities which would have cost additional money in those years.

Mr. BOLAND. But no one could have had that foresight.

Dr. LOVELACE. We did not and I rather doubt that anyone would have.

Dr. FROSCH. There are other areas where I would give a good deal for earlier foresight. It would be nice to have had more foresight about the problems we are having with the mechanical properties of the thermal protection system. That could certainly have been attacked earlier. Nobody had that foresight.

FISCAL YEAR 1981 RESEARCH AND PROGRAM MANAGEMENT BUDGET REQUEST

Mr. BOLAND. We will turn to Volume 3, Research and Program Management. You are requesting $1,047,154,000 in 1981 for the research and program management account. That compares with the current estimate for 1980 of $1,006,186,000. The $1,006,186,000 assumes enactment of the $46,286,000 supplemental appropriations to cover the pay cost increase of last October.

On page SUM-4, you indicate that you are absorbing $5,200,000 of the total pay cost increase for 1980. Specifically, from what areas are you absorbing the $5.2 million?

Mr. KILGORE. We were about 200 under ceiling at the end of fiscal year 1979. This gave us the flexibility to absorb the $5.2 million by training a lower than planned average employment during the year. That also gave us the costs in fiscal year 1980 of 50 positions which we were given by OMB this year to supplement the Shuttle program management staff.

Mr. BOLAND. If the Committee reduced your 1981 request by $15 million, for example, from which specific areas would you take the reduction?

Dr. FROSCH. I think a principal area would be to control the rate at which we replace people who leave, which means we will take it by attrition. We estimate that we might save as much as $9 million. In effect what we would be doing is controlling by the same mechanism that the current freeze controls, that is we would not

fills jobs that become vacant as a result of attrition as rapidly as we have done in the past.

This would affect programs in some way because we have in the fiscal year 1981 budget requested additional position from OMB. We received 100 additional positions for both the Inspector General's office but mostly for Shuttle requirements that arose from the management analysis of the Shuttle program.

Our estimate is that we might get $9 million of the $15 million cut; and then we would try to take the rest of it by reduction and deferral of some things like maintenance for a single time and hope we can get through until we can get back to the maintenance.

Do you want to add anything, Ed?

Mr. KILGORE. No, sir. I think that is it.

Mr. BOLAND. What if the Committee reduced your request by $25 million?

Dr. FROSCH. I think we would have to use some RIFs and at a level like that we would probably have to decrease 400 or so people by the end of fiscal year 1981.

SAVINGS IN PERSONNEL-RELATED COSTS IN FISCAL YEAR 1979

Mr. BOLAND. On the same page, SUM-3, looking at the actual personnel related costs for 1979—the number in the justifications is $709,055,000. The current estimate transmitted with the 1980 budget of last year, indicated that you would spend about $720,924,000 for personnel and related costs in 1979. How did you manage to save $12 million in this activity?

Mr. KILGORE. As I mentioned, we were under ceiling at the end of the year because we had an inordinately large number of retirements, particularly early outs late in fiscal year 1979. This enabled us to reduce the expenditures for personnel and related costs to the level shown. Of the difference, $5 million was due to the Congressional reduction in the supplemental. We really only saved about $6.8 million. That $6.8 million was used to offset some of our Shuttle related problems at JSC, KSC, and MSFC.

Mr. BOLAND. Detail for the record precisely how you arrived at the $721 million estimate carried last year and how you arrived at the $709 million actually spent.

[The information follows:]

The Personnel and Related Costs Estimates, for the fiscal year 1979 column of fiscal year 1980 Budget ($721 million) were derived in the November-December 1978 time frame and were based on past NASA experience of turnover, known budget ceilings and reasonable temporary programs which allowed for expansion of several feeder programs in accordance with agency policy. The operating year began with the knowledge of a $5 million budget cut and potential Shuttle-related institutional funding problems at JSC, KSC, and MSFC. In order to absorb these costs within the Agency R&PM appropriation, management action was taken to cut back the other than full-time permanent programs (94 work years from plan) to delay the filling of vacancies (from 4 weeks to 8 weeks lapse) and to constrain training and overtime requirements. In addition to these management actions, the Agency experienced over 400 unexpected retirements. The increase in attrition rate from the estimated 5.7 percent to 7.8 percent resulted in greater than anticipated lapse and considerable turnover savings. The following table illustrates the Personnel and Related Cost absorption during the fiscal year 1979 operating year:

	Thousands
Fiscal year 1980 budget estimates	$720,924
Permanent compensation	−8,421
(Increased lapse)	(2,673)
(Savings due to increased attrition)	(5,748)
Other than full-time permanent programs	−1,209
Benefits	−1,614
Miscellaneous: supporting costs and other compensation	−625
Total net	709,055

Mr. BOLAND. As I indicated, we reduced the supplemental pay costs by $5 million in 1979—and you were able to save $12 million. I wonder whether or not we cut it enough. Detail that information for the record.

[The information follows:]

The current fiscal year 1980 estimates include a revised attrition projection based on fiscal year 1979 experience which enabled NASA to absorb $5.2 million of the supplemental request through anticipated turnover savings. At this point in time, we do not consider it advisable to jeopardize the agency recruitment drive necessary to insure an influx of college freshouts by extending turnover lapse or to halt the planned build up or our feeder programs.

EIGHT PERCENT REDUCTION OF TRAVEL FUNDS

Mr. BOLAND. Again, on SUM-3, the justifications show that you have reduced travel from the budget estimate in 1980 of $19,797,000 to the current estimate of $19,000,000. The continuing resolution carried a proviso last year reducing travel throughout the Government by $500 million. Each agency was expected to take approximately an 8 percent reduction. It appears as though NASA has reduced travel by only $790,000 in 1980—while an 8 percent reduction would be about $1,580,000.

Why didn't you take the full 8 percent reduction required by most agencies?

Mr. KILGORE. Mr. Chairman, we took the total 8 percent cut in transportation of things as well as in the travel of persons. Travel of persons was cut $792,000, and transportation of things was cut another $779,000.

ACTUAL EMPLOYMENT AND PAY COSTS

Mr. BOLAND. On page SUM-4, you are requesting $46,286,000 for pay costs pursuant to last October's 7 percent pay increase. You are also planning to absorb an additional $5.2 million of pay costs in 1980.

Okay, now let's talk for a minute about how that request relates to your actual employment. On page SUM-11 it indicates that the actual employment in permanent positions was 22,831 at the end of 1979. The original budget ceiling for 1980 was 22,563. However, you were given a 50 position increase in 1980 which is described on SUM-4, and another 100 positions in 1981, bringing your end-of-year 1981 permanent position ceiling to 22,713.

Now, as you know the President has instituted a freeze which permits you to fill only one of every two vacancies occurring. What is the current number of full-time permanent positions filled through February?

Mr. LILLY. 22,215 were on board as of the end of February.

Mr. BOLAND. Are the 50 positions that you received above your original budget request new positions, or are you simply going to not bring employment down as far as you originally intended—from 22,831 in 1979 to 22,563 in 1980?

Mr. KILGORE. These are new positions requiring new skills, which either we do not have or do not have enough of. They will be used in the management of the Shuttle program, both in the resources area and in the key technical areas. There will be new people coming on board.

Mr. BOLAND. How will you fill these 50 positions in 1980 when you can only fill one out of every two vacancies?

Mr. KILGORE. Mr. Chairman, we have made a number of firm commitments to people prior to the hiring freeze in February. These can be honored without regard to the one for two rule. Also, we had about 300 retirements on March 1, and we can fill half of them as soon as possible. That means we could fill 150 positions right away, out of which, we intend to give priority to filling the Shuttle positions.

Mr. BOLAND. What is NASA's current turnover rate by the month? It would appear from last year that it is about 100 per month.

Mr. LILLY. Historically the turnover has been about five to six percent a year. With retirement benefits increasing at a faster rate than the civil service pay raises, we have started getting more retirements. That has upped the retirement rate about seven or eight percent. How long that will go, I don't know, but that was our experience last year and so far in fiscal year 1980.

Dr. FROSCH. I don't know what that means on an annual basis because retirements seem to be seasonal, nor can we predict with any confidence next year's turnover. Past experience has shown that when there is a freeze it does not affect retirements so much, but it does affect all other causes for people leaving, particularly interagency career moves, so that usually the average attrition rate drops during a freeze.

Mr. BOLAND. Whatever the rate—you are undoubtedly going to be lower than 22,613 by the end of the fiscal year if you can only fill one out of very two vacancies.

So the bottom line is, what additional savings do you anticipate will occur in 1980 because you are filling only one out of every two positions?

Dr. FROSCH. It will depend on how long the freeze lasts, and exactly how many of our commitments actually come on board? If the freeze lasts throughout the fiscal year until October, the estimate is we would be a couple hundred under ceiling and the resultant savings would be something between one and two million dollars. If it ended sooner, for example, in June, it would be about half that.

Mr. BOLAND. If the ceiling is 22,613 and you now have 22,215 aboard.

Dr. FROSCH. Yes, but we have a number of firm commitments that were made before the freeze, and which, according to the terms of the freeze, can be filled without regard to the one for two rule. We normally make a large number of commitments early in

the calendar year because we are trying to hire technicians and college recruits who are becoming available in the spring. We do this as a means of competing for the new graduates.

Mr. BOLAND. With respect to 1981, what do you estimate you will save in this account as a result of the one for two?

Dr. FROSCH. Again, it depends on how long it lasts. If until September 30, 1980, the fiscal year 1981 savings from our current plan could be as much as three or four million dollars depending on what skills actually leave and those we have to hire to manage in the interim. Many of the hires will be for Shuttle and will command salaries well above the average, therefore the connection between numbers of positions and dollars may be different from the average case, we used in pricing the budget.

FISCAL YEAR 1981 FUNDS ATTRIBUTABLE TO THE ADDITIONAL PERSONNEL

Mr. BOLAND. On page SUM-5, you indicate in the first paragraph that the increase in funding of $11,529,000 from the current 1980 plan to the 1981 request results from the cost of the additional permanent full-time personnel, the full-year effective 1980 pay increases, and the net of within-grade and career advances, and turnover savings.

How much of that $11.5 million is attributable to the additional 100 personnel?

Mr. KILGORE. About $3 million.

Mr. BOLAND. What lapse rate are you assuming for those 100 positions in 1981?

Mr. KILGORE. We are predicting a lapse rate for these positions of about 10 percent.

Mr. BOLAND. How much of the $11.5 million is attributable to within-grade increases in 1980 and 1981? You may supply that for the record.

[The information follows:]

The full-year effect of within grade and career advances granted in fiscal year 1980 and the partial year effect of those granted in fiscal year 1981 accounts for increased compensation costs of $13.3 million and an additional $1.3 million in benefits.

SES AND EE POSITIONS AND ASSOCIATED BONUSES

Mr. BOLAND. Does NASA have any Excepted Executive (EE) positions?

Dr. FROSCH. Yes, we do. We have a small residual number of excepted positions, most of the excepted employees transferred into the SES but we do have a small residual number.

Mr. KILGORE. There are about 20, to accommodate people who didn't specially qualify for SES because of the criteria for those types of positions.

Mr. BOLAND. So all of those have not been converted into the Senior Executive Service?

Mr. KILGORE. That is right.

Mr. BOLAND. How much do you have included in the 1981 budget for Senior Executive Service bonuses?

Mr. KILGORE. $1.75 million SES performance awards, plus the ranks.

Mr. BOLAND. Plus the what?

Mr. KILGORE. For rank awards which are presidential awards.

Mr. BOLAND. How much was spent in fiscal year 1979 for bonuses for all employees? You may supply that for the record.

[The information follows:]

In fiscal year 1979, NASA awarded a total of $2,173 thousand for the special achievements of all its employees.

Mr. BOLAND. What was the highest bonus paid under the previous law regulating bonuses? You may supply that for the record also.

[The information follows:]

The highest award paid under previous law was $5,000. This was the maximum authority delegated to NASA.

Mr. BOLAND. Do you have any plans yet for what level of bonuses you plan to pay in 1981?

Mr. KILGORE. We expect that we will do much the same in 1981 as planned for in 1980. By the law we are allowed to give up to 50 percent to the Senior Executive Service some kind of bonus. Based on our current plans, we would expect that the average bonus would be about $5,000.

FISCAL YEAR 1980 BUDGET INCREASE DUE TO INCREASE OF SUPPORT CONTRACTOR

Mr. BOLAND. Turn to page RPM–1–20, we have been over this for the past two years and again I note that in the 1980 budget year you are running $400,000 above the budget estimate. Your explanation indicates that the increase is partially due to an increase of four workyears of support contractor effort for increased security requirements during the Space Shuttle missions.

You are not saying that those four workyears cost $400,000?

Mr. KILGORE. No, sir; additional funding is for the the four additonal workyears plus the increase in contractor wage rates in fiscal years 1980 and 1981.

Dr. FROSCH. It is the escalation of wage rates for all of the years plus the cost of the additional four manyears of effort.

Mr. BOLAND. Can you indicate how many people are involved in these four workyears?

Mr. KILGORE. You mean the number of people involved in this whole area?

Mr. BOLAND. Yes.

Mr. KILGORE. We have about 4,000 support service contractor manyears funded from the R&PM appropriations.

Mr. BOLAND. No, just for the four workyears you mentioned here. The wage rates paid for the janitors would be four dollars.

Dr. FROSCH. Four manyears is the equivalent of four people for 1 year.

Mr. BOLAND. On page RPM–2–2, under management and operations, I notice that the budget estimate and the current estimate for 1980 are both below the 1979 actual for management and

operations. Why can't the 1981 budget maintain that excellent record?

Mr. KILGORE. That is primarily due to the change in the Shuttle schedule. We did not become operational as fast as anticipated in terms of being operational a year ago. This budget provides for us to become operational at Kennedy.

FUNDING FOR AND NEED FOR WALLOPS

Mr. BOLAND. On page RPM-6-2, the funding is outlined for the Wallops Center. This is one of NASA's smallest centers and the total request for 1981 is only $18,977,000. About 395 permanent personnel are stationed at Wallops.

We have talked some about this in the past, but I want to touch again on what appears to be a problem with NASA—in that now the RP&M account is over a billion dollars and you continue to spread that over the same number of centers. It seems inconceivable that some of these centers—possibly one or two of them—could not be closed and the functions performed elsewhere.

Dr. FROSCH. We looked at this extensively some years ago. Wallops has a unique location both from the point of view of sounding rocket launchers and from having a unique airfield and airspace over the ocean. We see no way we could perform those functions as effectively and economically elsewhere. If you put that together with the investment in facilities at Wallops and what it would cost to either build new facilities or to move existing ones, you have a very large expenditure in front of you to amortize with potential savings. It is not necessarily the case, however, that if we were setting up a set of centers starting from scratch today to do NASA's business that we would do it in the way we have. In summary, we could not close a center unless we simply went out of that part of our business being performed at that center.

Mr. BOLAND. I suppose if I listen to that reasoning, you will never be able to close any of your centers.

Dr. FROSCH. One can close a center when either a function goes away or goes down to a point where that can be moved elsewhere, and can be done so economically.

Mr. BOLAND. Is Wallops the only center that can support sounding rocket launches, aeronautical flight test support and the balloon program?

Dr. FROSCH. The only other center that could conceivably do some of that is Dryden. It would have some problems with the sounding rockets because it would not be launching them over the ocean.

Mr. BOLAND. What about Kennedy?

Dr. FROSCH. We could not carry the flight operations at Kennedy. We do not have that kind of airfield at Kennedy. We do not have the reserved airspace at Kennedy that we have at Wallops. Performing the sounding rocket mission at KSC would be much more costly because of the number of sounding rocket launches and the need for much more formal procedures required at KSC. Therefore, we could presumably do the sounding rocket business at Kennedy, but not the aviation business.

Mr. BOLAND. The justifications usually carry the value of the center. What is the value of the center at Wallops?

General MCGARVEY. $141.9 million as of September 30, 1979.

Dr. FROSCH. That is the book cost, and I would like to be able to replace Wallops for that now.

Mr. BOLAND. I have been sitting here for several years and I do not recall that there has ever been a closing of any NASA center. Is that correct?

Dr. FROSCH. The Electronic Research Center in Massachusetts was transferred from NASA in 1971.

REDUCTION OF FUNCTIONS AT MICHOUD AND CLOSURE OF PLUMBROOK

Mrs. BOGGS. Michoud Assembly Facility in New Orleans was at one time a huge operation with different types of activity. It has now been reduced to one activity. The government has made clever use of the space there in various ways in conjunction with local businesses, schools, and colleges.

As a matter of fact, right now we have one of the census scanning centers within the facility.

Mr. KILGORE. In 1973, we also mothballed the Plumbrook Station near Cleveland, Ohio that had about 600 civil servants assigned to it.

Mr. BOLAND. Plumbrook was not very large.

INCREASE IN FISCAL YEAR 1981 FUNDING DUE TO SERVICE CONTRACTS

Mr. BOLAND. On page RPM-8-13 under the Dryden Research Center, we find again a substantial increase in the budget year for facility services. Apparently your only explanation is that the increase is due to negotiated support contract or increases?

Mr. KILGORE. Mr. Chairman, that was one of the large reasons for the increase. We have, by the way, taken a serious look at Dryden over the past year in terms of the wage rate their contractors are paying for guards and janitorial services.

Mr. BOLAND. What has been the percentage of increase in contractor support services?

Mr. KILGORE. About 7 percent on an overall basis, but some places the rate is larger than that.

Mr. BOLAND. But the increase is not 7 percent. The budget estimate is $2,661,000 and the current estimate is approximately $3 million.

Dr. FROSCH. The overall rate in NASA service contracts was 7 percent in 1980 and 8 percent in fiscal year 1981. But there are a couple of places where the rate increases have been very high because of the peculiarities of the administration of the Service Contract Act.

Mr. BOLAND. What would you think if we included a limitation in the appropriation bill which would limit all conract increases for personnel support to the President's guideline of 9½ percent?

Dr. FROSCH. If you would also put something in the appropriations act which would make it override the Service Contract Act,

something might be accomplished. But if you simply put a limitation in an appropriation, that would introduce a conflict between two laws. Under the Service Contract Act, the Department of Labor tells us what the minimum wage rates of compensation are to be for the employees of service contractors.

Mr. KILGORE. Mr. Chairman, we, have been attempting to control the rates paid through the use of variance hearings under the Section 4C procedure of the Act as implemented by the Department of Labor. Where contractor wage rates in a collective bargaining agreement are considerably higher than those prevailing in the surrounding areas, we will request a variance hearing. We did that at Dryden last year, and were able to effect a substantial decrease in the wage rate. For example, the janitorial rates went from about $8 an hour to about $5 an hour.

Mr. BOLAND. Who was paid $8 an hour for what?

Mr. KILGORE. That is what janitors were being paid by the contractor at Dryden.

Dr. FROSCH. The problem is at two sites, particularly, Kennedy and at Dryden. The Department of Labor has chosen the area of survey for wage rates to be identical with the area of Government employment, not including the surrounding area. Under the Service Contract Act, each contract recompetition includes a wage rate which cannot be less than the prevailing wage rate in the area or the wage rate of a union agreement, if one exists. Since the data used in both cases relates only to the enclave itself, a recompetition results in the wage rate being raised.

When we looked at certain wage rates at Kennedy, those being paid at the center for particular skills were, in some cases, twice the wage rates in the surrounding county. We have been discussing this matter with the Department of Labor in hopes that we can get a better survey that does not distort the local labor situation so drastically.

Because we knew that the custodial rates at Dryden were so badly distorted, we went to a hearing with the Department of Labor asking for rates based on a survey of the surrounding area. We were fortunate to get a ruling that the lower rate was applicable. The next contract will be paid at a rate considerably below the current rate of $8 an hour.

REPLACEMENT OF ADMINISTRATIVE AIRCRAFT IN FISCAL YEAR 1981

Mr. BOLAND. How many administrative aircraft are you proposing to replace in 1981?

Dr. FROSCH. One.

Mr. BOLAND. What type of aircraft will be replaced?

Dr. FROSCH. A Queen Air. We do not know what the specific replacement will be because it will go out on bid.

Dr. LOVELACE. There is $1 million provided in the budget.

Mr. BOLAND. Was this particular budget account zero-based?

Dr. LOVELACE. Yes, sir, it was.

Mr. BOLAND. Do you ZBB it on the basis of centers—and do you rank centers by order of priority—or do you rank their missions by order of priority?

Dr. LOVELACE. The actual presentation to OMB combines all the centers into the minimum budget. The minimum budget for the centers combined together is that level needed to support the R&D program. Amounts above that are to support requirements above the minimum levels. Each of the centers presents their budget request in the same way, a minimum level to support the programs assigned, and as many levels above the minimum required.

Mr. BOLAND. What is the overall level of the R&PM?

Dr. LOVELACE. The fiscal year 1981 budget presented to you represents the minimum level, and I believe there are two or three cases where they approved a level above the minimum. The replacement of that aircraft is one of them, I believe. Mr. Kilgore, can you expand on that?

Mr. KILGORE. We requested replacement of three aircraft and OMB deferred two of them.

Dr. LOVELACE. But in terms of the items above the minimum level?

Mr. KILGORE. In addition, there was an administrative computer at Goddard.

Mr. BOLAND. I suppose slide-ruling the R&PM account, on the basis of just, as you described it, probably could never get you to the point of closing a center unless you ended a program.

Dr. LOVELACE. That is correct, unless you propose to make significant changes from what you are currently doing. No, it would not.

Mr. BOLAND. Mr. Sabo?

PENDING BILL FOR ENERGY RESEARCH INVOLVING NASA

Mr. SABO. Thank you, Mr. Chairman.

I have a question that relates to an activity you are not involved in. There is a bill currently before the Science and Technology Committee which would authorize some activity for NASA in automotive research. It is my understanding that this proposal will be included in your authorization bill. There is some rumor that NASA has some interest in maybe an even larger role.

I am curious as to your reaction. Obviously it is not authorized yet so you do not have money requested.

Dr. FROSCH. I have two reactions, one is that we clearly have some technological capabilities that can be applied to that and there are people in NASA interested in doing. However, it is not central to our task and there are clearly other agencies with responsibility in that area, Department of Transportation and Department of Energy, for instance. It is not clear that it is appropriate that NASA be given a central responsibility. We have also from time to time been authorized additional missions, but generally we have not had appropriations to go along with them. We have a number of tasks we have been authorized and in effect asked to do for which we have not had the appropriations.

The Space Act authorizes a certain number of tasks we are not doing because we have never had the funding.

The other comment is that even the authorization and appropriation alone is not sufficient without some kind of manpower slot authorization. We have now, for example, arrived at the point,

with regard to energy research, at Lewis Research Center, where we are doing all the energy research for the Department of Energy that we will allow Lewis to do because we cannot allocate them any more manpower slots. If they were to do more energy research, they would have to take people away from their aeronautical and space research, which is after all the central job of the agency, so we have simply told DOE we can accept no more.

Auto research, some would logically come to Lewis, and I would feel we could not accept that work under the existing manpower. There are several difficulties in doing this. It is not to say it would be impossible if the Congress wanted us to do it, the Congress could presumably overcome those difficulties.

Mr. SABO. Thank you.

Mr. BOLAND. Thank you very much Dr. Frosch, Dr. Lovelace, General McGarvey, and Mr. Kilgore.

We will adjourn subject to the call of the Chair.

FRIDAY, APRIL 18, 1980.

Mr. BOLAND. The Committee will come to order. We are delighted to have the National Aeronautics and Space Administration back with us again today.

We have received the detailed budget revisions agreed on between NASA and the OMB. In summary, NASA has been required to take a reduction of $219 million in budget authority in 1981, which, in conjunction with actions taken in connection with the 1980 construction budget, will result in outlay saving of $224 million in 1981.

The 1981 cuts have been spread throughout various programs of the Agency—primarily in the science, applications and aeronautics areas. The planetary missions and the space telescope have been relatively untouched.

What is deeply disturbing about how you have proposed these reductions—is that you have not come to grips with the central issue of actually eliminating a specific project.

The fact is NASA is proposing to simply delay many programs—with the result that instead of realizing some savings—the delays will cost almost as much or more than you propose to save in 1981.

I don't think anyone can argue with that. The figures are there and this is precisely the conclusion anyone would have to come to who has been looking at this budget.

One of the classic examples of that policy is the Solar Polar Mission. You are proposing to slip it two years—to 1985. That will save $43 million in 1981—but—delaying the mission for two years will add $100–150 million dollars to the total cost of the mission.

In short, your plan is inefficient. It simply delays projects which result in greater costs in the future. With that statement, Mr. Administrator, we will be glad to hear any response you may have at this time.

Dr. FROSCH. Thank you, Mr. Chairman.

I would propose, in the interest of time, to read a shortened statement, offering my complete statement to the Committee for the record.

GENERAL STATEMENT

Dr. FROSCH. Thank you for the opportunity to continue our presentation of the fiscal year 1981 appropriations request for the National Aeronautics and Space Administration.

As you know, at the time of our earlier appearance, the President had under consideration a wide-ranging budget amendment as part of his anti-inflation program and we were not able to discuss non-Shuttle related program activities. Since that time a budget amendment for NASA has been submitted reducing fiscal year 1981 budget authority by $219 million and outlays by $224 million. The resultant amended budget request for fiscal year 1981 totals $5.518 billion in budget authority and $5.216 billion in outlays. A summary of the request is attached to this statement.

The Space Shuttle development and production schedule is not affected by the budget amendment. The fiscal year 1980 Shuttle supplemental request of $300 million continues to be an urgent priority to meet critical civilian and defense needs. I urge the Subcommittee to act promptly on this request.

Mr. Chairman, in your opening comments at our last appearance, you noted that the pending budget reductions were much larger than any cuts made by the Congress in the last decade. The reductions embodied in the budget amendment for NASA are indeed significant and will force deferrals of several very important elements of our programs, with resultant loss of near-term benefits, increased cost and schedule risks. Our budget request has been trimmed back as far as is prudent if we are to maintain balanced and productive programs in aeronautics and space research and development. The most significant effects of these reductions are:

The International Solar Polar Mission will be delayed two years.

Future physics and astronomy, life sciences, and environmental observation experiments planned for flight on Spacelab missions will be delayed one to two years.

Funding for procurement of long-lead hardware and ground system improvements for a follow-on land observing system is deleted.

The Earth Radiation Budget Experiment, which is important to climate research, will be delayed about one year.

Systems Technology activity in the areas of aircraft energy efficiency, including the energy efficient engine and laminar flow control programs, will be curtailed with some risk to schedules in achieving technology goals.

Reductions will be made in basic and applied research and analysis activities, with potential impact on future capabilities, and in mission operations and tracking and data support, with some increased risk of loss of data return from current missions.

Space Transportation Systems Operations and Operations Capability Development are reduced to reflect the implications of these actions on the phasing of transportation requirements.

As you can see, the impact of these reductions is significant. However, I want to emphasize that the amended request does recognize the need to develop new programs so that the benefits of our activities in space and aeronautics can continue to be realized in the years ahead. As you know, NASA had no new flight starts in

the fiscal year 1980 budget and I testified a year ago that we would have serious difficulty in maintaining proper balance and momentum in our programs if this situation continued for an additional year. The recent budget reductions were carefully selected in this context and we have been able to preserve the basic new starts and initiatives which were originally presented in January. Specifically, this request will allow a balanced national space and aeronautics program to continue by providing:

Full funding for the development of the Space Shuttle and for the production of follow-on orbiters to maintain the most cost-effective schedule and to meet the needs of critical civilian and military missions;

Enhancements in aeronautical research including new thrusts in technology for advanced rotorcraft, emphasis on variable cycle engine technology, increased effort on technology to prolong the life of aircraft turbine engines and enabling technology for advanced turboprops;

Funding for the Landsat-D program at the level necessary to meet recent problems in the development of the Thematic Mapper and the space and ground systems;

Continuation of our support to the Department of Agriculture in the AgRISTARS effort to improve early warning and crop inventory forecasting;

Development of the National Oceanic Satellite System, a tri-agency program that will demonstrate operational global sea surface observation capabilities from space;

Expanded communications satellite research and development studies and advanced technology for experimental wideband satellite communications;

Continued development effort on the Space Telescope, and on the restructured Galileo mission for a 1984 launch; and

A new mission, the Gamma Ray Observatory, that will provide, for the first time, a survey of the full range of celestial gamma ray phenomena visible in the extensive gamma ray spectrum.

With regard to the Construction of Facilities request, as part of our overall effort to reduce outlays in fiscal year 1981, we are delaying contract award dates for selected fiscal year 1980 projects to reduce fiscal year 1981 outlays by approximately $7 million. I would like to point out that the $120.0 million requested for these activities represents a decrease of $36.1 million from the fiscal year 1980 level, a reduction of more than 23 percent. The projects requested represent the very minimum level necessary to support our ongoing programs. Any further cutbacks will either adversely affect our planned programs or reappear in later years at higher costs due to inflation and further deterioration. I urge your full support for this austere request.

In the Research and Program Management Appropriation, we will accommodate a $14 million reduction from the amount originally submitted by delaying filling Civil Service vacancies as they occur until near the end of the year and also by reducing installation support activities, such as deferring purchases of some types of supplies, materials, equipment and maintenance on a one-time basis. The combination of these actions will have some impact on our research and development activities which we would prefer to

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avoid. However, we believe we can satisfy our R&D objectives on a longer term basis if further reductions are not imposed. We have employed those techniques available to us to minimize the impact in accommodating the $14 million reduction. Further cuts would necessitate a reduction in force of our Civil Service staff and the severe curtailment of purchases of supplies, materials and equipment which are essential for the support activities at our installations. We believe it is imperative for the success of our programs to attain our fiscal year 1981 year-end employment level of 22,713 and to avoid any additional institutional support reductions.

In summary, our total appropriations request for fiscal year 1981, as recently amended represents an austere, minimum budget in support of our space and aeronautics programs. While the reductions which have been made do create risks to schedules, costs, and to the potential for loss of valuable scientific data, I believe they reflect the best possible set of near-term spending cuts in support of the President's anti-inflation program. I urge your full support for the amended budget.

I will be happy to attempt to answer any questions the Subcommittee may have.

[The statement follows:]

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effects of these reductions are:

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curtailment of purchases of supplies, materials and equipment which are essential for the support activities at our installations. We believe it is imperative for the success of our programs to attain our FY 1981 year-end employment level of 22,713 and to avoid any additional institutional support reductions.

I would now like to discuss briefly each of the program areas except for those which were covered in my prior testimony: the Space Shuttle, Construction of Facilities, and Research and Program Management.

SPACE TRANSPORTATION SYSTEMS

We are requesting a total of $767.5 million for Space Flight Operations. Of this amount, $346.5 million is for Space Transportation System Operations, $79 million for Space Transportation System Operations Capability Development, $183.5 million for Development, Test and Mission Support, $8.8 million for Advanced Programs, and $149.7 million for Spacelab.

Of our total request for STS Operations in FY 1981 of $346.5 million, the major portion, or $296 million is for Shuttle Operations. These funds are for long lead materials and fabrication and assembly of flight hardware such as external tanks and solid rocket boosters for operational flights through FY 1983. In addition to these major procurements, Shuttle Operations funding in FY 1981 augments and supports major facilities at the Johnson Space Center (JSC). Included are the maintenance and operation of the Mission Control Center and Shuttle Mission Simulator and other facilities being readied for the early operational flights. FY 1981 funding also supports the preparation of orbiter flight software for the operational flights. Buildup of the Rockwell and JSC teams continue into FY 1981 as we are currently in the learning stage of the necessary engineering analysis and design attendent to integrating payloads on each of the Shuttle flights on the manifest. The balance of our request in FY 1981 is required for Spacelab Operations ($1.6 million), Upper Stages ($30.9 million), and Payload Support ($18.0 million).

In STS Operations Capability Development, the budget as amended will reduce planned funding for the Inertial Upper Stage (IUS) from $39 million to $29 million. This reduction is consistent with the deferral of the International Solar Polar Mission launch from 1983 to 1985. The first mission requiring a three-stage IUS will now be the Galileo Mission in 1984. The amended budget will support a revised development schedule consistent with the Galileo launch date. The revised schedule, however will delay much of the NASA unique development activity until after the two-stage IUS development by the Department of Defense is completed, resulting in some loss of efficiency in the overall development effort.

Of the $149.7 million requested for Spacelab, $120.5 million will be applied to procurement of the second set of Spacelab hardware from the European Space Agency. No reduction has been made in the budget authority requested in this area and manufacture of hardware will proceed as planned, although FY 1981 outlays will be reduced $30 million through a revised schedule of payments. The amount for development and integration activities in the United States has been reduced by the budget amendment, from $31.2 million to $29.2 million. This reduction will result in a delay of delivery of the Spacelab simulator with a resultant delay in crew training. There will also be some delay in processing of Spacelab hardware once it arrives from Europe.

SPACE SCIENCE

For FY 1981, we are requesting $561 million for Space Science, about $40 million less than the $600.8 million approved for the FY 1980 program. Our FY 1981 request includes funds for the start of the Gamma Ray Observatory (GRO). It also provides support to continue with the development of the Space Telescope and the Galileo mission to Jupiter. Galileo is now planned as a dual-launch mission in 1984. The budget request, as amended, reflects a delay in the launch of the International Solar Polar mission for two years, delays the development of follow-on Spacelab missions and deletes some research and analysis efforts. The request provides for accomplishment of the initial Spacelab missions and continues the three explorers now in development. It will also continue mission operations and data analysis on current missions, such as the High Energy Astronomy Observatories, the International Sun-Earth Explorer, the International Utraviolet Explorer, the Solar Maximum Mission, Pioneers 6-11, Pioneer Venus, and Voyager, although the data analysis activities for Pioneers 6-11 will be deferred.

As the Subcommittee knows, new starts are necessary to maintain the health and viability of the Space Science Program. Our request of $19.1 million to initiate development of the Gamma Ray Observatory (GRO) mission is therefore a cornerstone of our FY 1981 budget. The GRO is a well planned, relatively low cost mission which will study the important but little understood gamma ray region of the electromagnetic energy spectrum, a region which could be key in understanding the origin of the universe. Gamma rays are produced by the explosive, high energy processes that power the universe. They are the most energetic form of electromagnetic radiation. The creation of the elements, the acceleration of electrons and protons in enoromous magnetic fields, the collision of cosmic rays with photons and dust particles, and the annihilation of matter and antimatter are all processes that

reveal their presence by emitting gamma rays. The sites and times of gamma ray production range from the chaos of the "Big Bang" beginning of our universe to the flares on our own Sun. They are produced by exploding galaxies, quasars (the most distant known objects in the universe), supernovas, exploding stars in our own and in other galaxies; pulsars, black holes and the as yet unknown sources responsible for mysterious gamma ray bursts. The Gamma Ray Observatory's five instruments will give us tools to use in understanding these high energy processes and sources through the first full-sky survey of gamma ray sources.

In visible light astronomy, the keystone of the next decade will be the Space Telescope for which we are requesting a total of $119.3 in FY 81 million for continued development. This amount will enable us to stay on plan for a 1983 Shuttle launch. Hardware fabrication, mission operations design, scientific instrument assembly and the beginning of qualification testing will occur in FY 1981. Also in that year we are planning to establish the Space Telescope Science Institute to provide scientific management of this long duration permanent observatory in space to plan its operations and to act as a focus for scientific research using this facility. This institute will be a national facility for the receipt and evaluation of data from the Space Telescope.

In FY 1981, $33.0 million is requested to continue development activities on our Explorer missions including the Solar Mesosphere Explorer (SME), the Dynamics Explorer (DE), the Infrared Astronomical Satellite (IRAS), and to initiate development of the Active Magnetospheric Particle Tracer Explorer (AMPTE). There are no major problems on the SME or the DE, and both are progressing well on a schedule leading to launches in 1981. The IRAS has had to overcome a number of difficult technical problems related to the operation of the telescope system and its associated electronics at temperatures near absolute zero. Since IRAS, a mission with great scientific potential, continues to be a challenging project, we will maintain extremely close monitoring of its progress as we enter the system integration and test phase.

The launch date of the Joint NASA/European Space Agency International Solar Polar mission has been slipped from 1983 to 1985 to accommodate a lower funding level in FY 1981. In FY 1981, $39.6 million is required to continue development on the revised schedule. ISPM is an exploratory mission for which the scientific return is exceedingly high. The original planned launch in 1983 was guided by two considerations, both of which can be met by the 1985 mission. The first was that each of the ISPM spacecraft spend on the order of two solar rotations (about 60-70 days) above 70° solar latitude during each of their two polar passages.

The second consideration was that the spacecraft undergo their "polar passages" when coronal holes are present at the Sun's polar caps. The optimum time for the presence of polar coronal holes is near solar minimum, 1986-1987, for which

the original 1983 ISPM launch would have been ideal. However, the polar holes continue to exist, albeit with ever decreasing areas, up to shortly before solar maximum, which should occur in 1991-1992. A 1985 launch will lead to polar passages in 1989, safely before the maximum.

The FY 1981 Physics and Astronomy Spacelab request of $29.1 million will allow completion of development activities on Spacelab 1 and 2 and support mission management for Spacelab 3 and other planned applications missions. This budget request, down from a level of $40.9 million in FY 1980, will delay preparations for follow-on physics and astronomy missions.

With flight crews and payload specialists soon to be in space, the Life Sciences Program, for which we are requesting $39.1 million in FY 1981, will resume manned inflight investigations and will focus on biomedical research and operational medicine studies. Of that figure, $12.7 million is for the Life Science Spacelab experiments program, which is down from $16.6 million in FY 1980 level. This funding level will provide a slower development of investigations for dedicated life science missions which will start a year later than the 1981 budget originally planned. The first launch is planned for May 1984 and subsequent flights are expected to occur about every 18 months thereafter.

Since our FY 1980 budget hearing before this Subcommittee, the Galileo mission to Jupiter has been restructured. Instead of a single Shuttle launch in 1982, we will use the Shuttle Inertial Upper Stage for separate launches of the orbiter and probe in 1984. Concern over early Shuttle capability necessitated this change. This mission, the only planetary mission currently in development, is a particularly important one for exploring our solar system. In FY 1980, the design activities, including the revisions needed for the mission changes, will be completed, and development and fabrication of hardware will commence. The FY 1981 request of $63.1. million will continue the development of the science instruments, the probe, the probe carrier and the orbiter spacecraft.

The aims of scientific studies of the Jovian atmosphere dynamics, satellites, and magnetosphere are unchanged from the original Galileo mission plan. The orbiter should achieve eleven encounters with the Galilean satellites, mapping their surfaces in far greater detail than was possible with Voyager. In addition, during its twenty-month orbital tour, the orbiter spacecraft will map the magnetosphere of Jupiter and acquire data on its dynamics and on the dynamics of the Jovian atmosphere.

The two Voyager spacecraft, which returned extraordinary images of Jupiter and the Galilean satellites in the spring and summer of 1979, are in good health as they travel on toward Saturn for November 1980 and August 1981 encounters with that planet.

The Pioneer Venus spacecraft, which has been in orbit around Venus for fifteen months, continues to return large quantities of excellent data on the atmosphere and ionosphere of that planet and coarse resolution maps of its surface.

Also operating beyond their design lifetimes are a Viking lander and an orbiter. These spacecraft continue to send useful information from Mars, providing considerable insight into the seasonal changes and climate of that planet. A small team of scientists and engineers control the spacecraft, making the cost associated with this scientifically productive mission very modest.

SPACE AND TERRESTRIAL APPLICATIONS

A total of $368.8 million is requested in FY 1981 for Space and Terrestrial Applications programs. The increases over the FY 1980 budget level reflect provisions for continued development of Landsat D; maintaining important new thrusts in communications technology and materials processing research; continuation of Technology Transfer and Technology Utilization programs; and, a new initiative, the National Oceanic Satellite System.

Of the total request, $170.3 million will be applied to Resource Observations programs, with emphasis on agricultural research and Landsat D. This figure represents reductions of $22 million from our original budget proposal for FY 1981 and impacts Applied Research and Data Analysis and initial support of the land oriented operational remote sensing system. This request does provide, however, an additional $30 million for continued development of Landsat-D for a net increase of $8 million in Resources Observations.

Last November, in a key policy decision resulting from an Administration review of civilian space policy begun in 1978, the President announced the designation of the Commerce Department's National Oceanic and Atmospheric Administration (NOAA) to manage all operational civilian remote sensing activities from space.

Initially, operational remote sensing efforts will be based on experience gained over the years from the Landsat program begun by NASA in 1972. NOAA will make the final determination of the characteristics of the fully operational system. An Interim Policy Group is currently addressing steps which may be necessary to provide interim operation capability using the Landsat D until a fully operational system is available.

Our budget request in January included $16 million to initiate enhancement of the Landsat ground data handling system to meet operational needs and to initiate procurement of long-lead time parts for an operational space system. In the budget

amendment this funding has been deleted, but funding for Landsat-D development has been increased by $30 million in FY 1981. The increase in Landsat-D funding is necessary because of recent development and integration problems in both the space and ground segments. As a result of these problems, we are reviewing the baseline program and options to modify program content and schedule to provide the most effective flow of earth resources data in the period leading to initiation of an operational system. The options under consideration include launching the initial spacecraft with a multispectral scanner, but without a thematic mapper. This approach, which would allow the earliest feasible launch of the next Landsat spacecraft, has considerable appeal in view of the sensor problems being experienced in the currently operating Landsat 3. We are reviewing the total estimated impact of these options as well as the baseline program and expect to arrive at a position in the near future.

The Agricultural and Resource Inventory Survey Through Aerospace Remote Sensing (AgRISTARS) initiative, now in its second year, is progressing well. This joint effort, with participation by the Departments of Agriculture, Commerce and Interior, and NASA, utilizes remote sensing data, together with other data sources, to improve the timeliness and objectivity of information on world crop conditions and anticipated production. AgRISTARS will also provide a research base allowing for integration of improved remote sensing technology into existing or future information systems. FY 1981 NASA funding for AgRISTARS will be directed primarily toward R&D necessary for commodity production forecasting and supporting research, as well as addressing high priority information requirements of the Department of Agriculture intitiatives.

During FY 1981, Resource Observations funding also will provide for the continuation of geodynamics activities, including the second year of crustal dynamics measurements of regional deformation in Western North America and extension of measurements to areas of the Caribbean. Cooperative agreements with the U.S. Geological Survey, National Science Foundation, and the National Geodetic Survey, are nearing confirmation. These agreements will allow joint efforts in monitoring motion and internal stability of several major tectonic plates, determination of crustal deformation in seismically active areas, and improved modeling techniques.

In the area of Environmental Observations, a total of $109.6 million is requested -- a reduction of $28 million from our original proposed FY 1981 budget request. While this reduction will necessitate a delay of one year in some programs, we will be able to maintain FY 1980 level in atmospheric Applied Research and Data Analysis and continue our Upper Atmosphere Research Program. The revised FY 1981 budget request will also permit a slight increase in ocean research.

The time is right and the need is certain for initiation of the National Oceanic Satellite System -- NOSS. Findings form the analyses of SEASAT data have confirmed the operational potential of ocean remote sensing. It proved to be a remarkable new tool for making ocean observations from space -- for the first time we were able to "see" through the clouds both day and night to monitor ocean surface conditions.

NOSS will be jointly funded with NOAA and DOD to provide an operational demonstration of global sea surface observation through a two-satellite system which can be launched and retrieved by Shuttle. The NOSS demonstration will be driven by the criticality of the ground segment, so that data may be provided from space to users in near real time and under varying weather conditions. Parameters measured will include surface wind and direction, ocean surface temperature, wave characteristics, ice dynamics and speed and direction of surface currents. This data will be processed through a single ground distribution center, and will provide forecast and ocean state information to both civilian and military users. While NASA will be responsible for overall development of the NOSS system, NOAA and DOD will be responsible for operations, and have included funding in their respective FY 1981 budgets for spacecraft development and ground systems operations.

Consistent with the President's space policy articulated in October 1978, and last year's initial re-entry into selected areas of communications research and development, our FY 1981 request includes $10 million for advanced technology development and definition studies addressing long-term, high-risk initiatives in multi-beam antennas, onboard switching systems, and components. Such definition studies may lead to an experimental wideband communications satellite to operate at the 30/20 GHz spectrum. These advanced state-of-the-art efforts are vital if the U.S. is to maintain, during the 1990's, the technology leadership we enjoy today in world space communications research and development.

In Materials Processing, our FY 1981 request will provide for continued Shuttle/Spacelab payload development, research and technology development activities, definition studies, and efforts toward commercialization. As you are aware from previous testimony before this Committee, NASA has instituted a new program effort to stimulate commercialization of materials processing in space through joint endeavors with private industry. We have concluded our first agreement for a joint endeavor--with the McDonnell Douglas Company. This is a significant step in pioneering new techniques for utilization of government and industry resources which allow commercial processes or products that might not otherwise be introduced to the marketplace. In this joint endeavor, McDonnell Douglas will develop electrophoretic separation systems to process biological materials in space, while NASA will furnish flight time and related services on Shuttle missions. We are currently negotiating a second joint endeavor.

For our Technology Transfer and Technology Utilization programs we are requesting $19.6 million. This figure represents a $6 million reduction in funds we had anticipated. We will continue most of our programs -- but at a reduced pace.

The Applications Systems Verification and Transfer (ASVT) program involving five current projects will be continued but with no new ASVT's to be initiated in FY 1981. Similarly, the Regional Remote Sensing Applications Program will concentrate on completing current joint projects with state governments but the extension of these to local governments will be deferred. Efforts will be maintained to evaluate private user needs through joint transfer projects, placing emphasis on the increased use of private industry service suppliers as NASA's technical arm for future transfer projects with both private and public users. Additionally, these areas are among those under consideration by the Interim Policy Group as activities which might be made a part of the operational civilian remote sensing program to be managed by NOAA.

The Technology Utilization Program request of $12.1 million is unchanged from the FY 80 budget level. We plan to continue the Biomedical Applications Teams and on-going projects to develop prosthetic devices to aid the handicapped will be supported. Transportation, Public Safety and Manufacturing Teams will also be continued to identify problems and assist in development and evaluation of on-going projects. The IAC and STAC programs will be supported at a slightly enhanced level as we look to improve services to small businesses and in non-industrialized areas.

AERONAUTICS AND SPACE TECHNOLOGY

The proposed fy 1981 Aeronautics Research and Technology budget of $275.3 million supports research and development activities in the various scientific and technical disciplines which form the basis for all aeronautical systems development. The Research and Technology Base portion of this funding is increased by 9 percent. The FY 1981 program also allows the Aircraft Energy Efficiency (ACEE) program to proceed toward its goal of reduced transport aircraft fuel consumption.

The reduction in the Aeronautics R&T budget from the FY 1980 figure of $308.3 million is due to both the planned fall off of several program requirements, primarily in the ACEE program, and to selected budget adjustments taken as part of the President's recent reductions. Cuts totalling $15.0 million have been taken in four areas. Laminar Flow Control (LFC) funding within the ACEE program has been reduced by $7.0 million. The impact will be a two-year delay in flight demonstrations and ground evaluations in the long-term effort to establish LFC technical feasibility. The long-term elements of the Energy Efficient Engine project, also part of the ACEE

program, will be impacted somewhat by the $5.5 million reduction; however, no significant impact is expected on our short term planned accomplishments. A one-time reduction of $1.0 million in system studies will result in a lowered effort in this area. The fourth reduction is $1.5 million in the Advanced Low Emission Combustion program. The impact will be to delay a portion of the fundamental and applied efforts in Combustion and Emission Reduction research.

Two important enhancements requested in FY 1981 are in advanced rotorcraft and variable cycle engine technologies, both of which were augmented by the Congress in FY 1980. The rotorcraft enhancement is needed to meet the threat of increased foreign competition and to take early advantage of the vast potential of rotorcraft. It is the initial step in a coordinated R&T plan designed to enable rotorcraft to achieve a major air transportation role with all the requisite characteristics of cost effectiveness, operational flexibility and passenger acceptance. The variable-cycle engine (VCE) enhancement strengthens our effort on the key technology area in achieving supersonic cruise capability with favorable economics and environmental compatibility. It is a necessary step in maintaining, for the United States, a viable supersonic cruise option for future civil or military applications.

Enhancements are also proposed in advanced turboprops and turbine engine hot section technology. The turboprop effort is part of the ACEE program in pursuit of a large energy saving potential. The hot section technology (HOST) activity has a productivity potential through reduction of maintenance costs due to more effective scheduling of maintenance.

The ACEE program remains our largest aeronautical activity although, after four years, its funding has peaked. More significantly, however, early results are already being reflected in new aircraft and engines now in development.

Other aeronautics activities will continue to advance technologies in both fundamental and vehicle-specific areas. Emphasis will be placed on improved safety in both transport and general aviation programs. The highly successful research aircraft flight programs will yield valuable data for correlation with analysis and wind-tunnel measurements in support of future aircraft design and certification. V/STOL and high-performance aircraft investigations will provide the military with technological options for future system developments.

Our Space Research and Technology budget request is $110.2 million, down about 5% from the FY 1980 figure. The R&T Base accounts for 91% of the total funding. This discipline-oriented activity seeks to maintain and advance the technology for future missions, improving the capability and effectiveness of planned missions and enabling programs that might otherwise not be possible. Areas of emphasis in FY 1981 include advanced propulsion,

automation, solar cells, and aerothermodynamics. Efforts will also continue toward improvements in sensor and data handling systems, large structure concepts, and the use of Shuttle-borne experiments for flight research.

Budget adjustments in the Space R&T program totalled $5.0 million. The R&T Base has been reduced by $3.1 million and this reduction has been accommodated by reductions in selected areas. We will continue to support OSTA's experimental communication satellite initiative in our Satellite Communications Technology area where we reduced certain planned efforts by $0.9 million. In the Long Duration Exposure Facility (LDEF) project, $1.0 million is being deferred for one year. The effect will be a one-year delay in the current scheduled LDEF launch date.

This year, NASA is requesting $4.0 million, an increase of $1 million over FY 1980, to support exploratory energy work at NASA Centers that will allow us to gain an initial understanding of how NASA expertise can be applied to specific energy problems. In FY 1981, the emphasis in NASA-funded solar energy activities will be on evaluating Small Dispersed Solar System Applications and Bioenergy. Work also will be undertaken on Ocean Thermal Energy Conversion (OTEC), Solar-Augmented Desalination Systems and Solar Rankine Applications, and in the areas of fossil energy, energy conservation and utiltiy systems.

In FY 1981, we anticipate receiving approximately $290 million of reimbursable funds from other agencies, up from the $211 million transferred to us in FY 1979. This work in energy research, development and demonstration encompasses a wide range of activities that capitalize on unique NASA capabilities developed for our aeronautics and space programs.

Although we have not received any official notification from DOE on cuts that may be made in programs that NASA is managing for DOE, informal discussions indicate that NASA manpower probably will not be affected. Program reductions presently being contemplated would result in reductions in work being managed under contract to NASA and probably be accommodated by stretch-outs in achieving program and project objectives.

SPACE TRACKING AND DATA SYSTEMS

For the FY 1981 Space Tracking and Data Systems budget we are requesting $349 million. This will continue tracking and data acquisition support for Earth-orbital spacecraft, planetary missions, sounding rockets, and research aircraft. An average of about 40 Earth-orbital applications and scientific spacecraft will be supported during this period. The Deep Space Network efforts will be highlighted during the encounters of Voyager 1 and 2 with Saturn, both occurring in FY 1981.

Contractor development of the Tracking and Data Relay Satellite System (TDRSS) continues on a schedule consistent with launch of the first satellite on-board the first operational flight of the Shuttle.

Late last year we announced plans to consolidate our tracking networks once TDRSS is operational in 1982. Consistent with prior planning and the expanded coverage available through TDRSS, we will close stations in Hawaii; Guam; Quito, Ecuador; Santiago, Chile; and on Ascension Island.

In addition as specific operational requirements are no longer needed we will phase out some of the remote sites prior to the launch of TDRSS. For example, the Rosman, North Carolina, facility which had been supporting the Applications Technology Satellite-6, will be closed in January, 1981. Operations at the Winkfield, England, station will be terminated during the current year.

Since the Spaceflight Tracking and Data Network capabilities needed at Goldstone, Australia, and Spain are similar to those required for the Deep Space Network stations at the same locations, the capabilites at each station will be combined to save operations costs and to achieve more efficient use of the facilities which will be consolidated into a single network under the management of NASA's Jet Propulsion Laboratory.

The third General World Administrative Radio Conference (GWARC) took place last fall. The long range impact of decisions made at the GWARC is significant to the space program, and several years of preparation were involved in the effort to develop U.S. position papers, negotiation strategies, and proposals. From the standpoint of major NASA interests--space research, Earth exploration, and applications frequencies--the conference was highly successful.

The President's adjustments to FY 1981 spending resulted in a $10 million reduction in the Office of Space Tracking and Data Systems budget. Since the OSTDS budget is keyed to the support of ongoing programs, the reduction must be applied to that small portion of the budget which can be deferred but it increases the risk of providing reliable support to the projects. Among the proposed deferrals are maintenance activity and temporary reductions in logistics and related support in operations. Other deferrals include a one year delay in purchasing computer replacement systems at the Goddard Space Flight Center (GSFC) and Wallops Flight Center (WFC). Among the system purchases being deferred are an impact prediction system at Wallops and a data processing and command memory management computer at GSFC. The deferrals will result in increased risk to project support due to expected further deterioration in hardware reliability as the system increases in age.

INTERNATIONAL ACTIVITIES

As you know, there is significant international involvement in a number of the major projects I have mentioned. The European Space Agency (ESA) is an active partner in or contributor to the Space Transportation System with Spacelab, Space Telescope, the International Ultraviolet Explorer and the International Solar-Polar Mission (ISPM). The proposed delay of the ISPM launch until 1985 will not degrade the science, although delaying the launch could mean some increased costs to ESA. We are in close touch with ESA on these developments. The German Federal Republic is providing an important element of the Galileo orbiter and is collaborating in the AMPTE (Active Magnetospheric Particle Tracer Experiment) project planned for initiation in 1981. The Netherlands and the UK are contributing the spacecraft and ground-support system, respectively, for the Infrared Astronomical Satellite (IRAS). International interest in the proposed Gamma Ray Observatory is high and I would expect that prospects for fruitful cooperation will emerge in that program as well. Prior to undertaking cooperative activities we review each proposed project to assure that it contributes positively to NASA's program objecties or to broaden US interests. As the past has shown, carefully structured international cooperation pays off in numerous ways--expanded scientific opportunities, access to foreign scientific data, reduction of NASA costs and positive contributions to our balance of payments.

NASA is also involved with many countries in satellite remote sensing activities. Since the launching of Landsat-1 in 1972, nine foreign-funded ground receiving and processing stations have been established in eight countries. A number of other countries are currently planning their own Landsat stations including the Peoples Republic of China which is to begin procurement of a Landsat ground station from U.S. industry in the near future. In addition, users in more than 100 countries have purchased and used Landsat data for research and assistance in development planning.

On the space segment side, France is building a land remote sensing satellite scheduled to fly in 1984 and Japan, ESA and India are in various stages of planning for the development of land and ocean remote sensing satellites. The U.S. is currently undertaking bilateral discussions with these countries in an attempt to determine the possibilities for establishing compatibility and complementarity among nationally operated satellite systems.

Overall we are continuing to monitor the steady growth in foreign government investment in space activies. In some instances this will result in increased competition as well as in further cooperative opportunities. For example, last

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December ESA successfully tested the Ariane vehicle (Atlas-Centaur class), Japan is developing advanced versions of the N vehicle (Delta class) and India last summer fired with partial success its initial SLV-3 (Scout class). I believe such competitive challenges to U.S. leadership are predictable and natural outcomes of the growing experience and interest with space around the world. They are a reminder that to stay ahead we need to maintain a vigorous program.

SUMMARY

In summary, our total appropriations request for FY 1981 as recently amended represents an austere, minimum budget in support of our space and aeronautics programs. While the reductions which have been made do create risks to schedules, costs, and to the potential for loss of valuable scientific data, I believe they reflect the best possible set of near-term spending cuts in support of the President's anti-inflation program. I urge your full support for the amended budget.

I would be happy to attempt to answer any questions the Subcommittee may have.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

BUDGET AMENDMENT
(Thousands of Dollars)

BUDGET PLAN	FY 1979	FY 1980	FY 1981 Request Pending	FY 1981 Proposed Amendments	FY 1981 Revised Request
Research and development.....	3,477,200	4,107,500[a/]	4,569,500	-205,000	4,364,500
Construction of facilities.....	147,500	156,100	120,000	--	120,000
Research and program management.....	933,808	1,006,186[b/]	1,047,154	-14,000	1,033,154
TOTAL BUDGET PLAN.....	4,558,508	5,269,786	5,736,654	-219,000	5,517,654
OUTLAYS.....	4,196,472	5,002,600	5,439,700	-224,800	5,215,700

a/Includes proposed supplemental of $300,000,000 for the Space Shuttle.

b/Includes proposed supplemental of $46,286,000 to cover revised salary rates implemented in October 1979.

Attachment 1

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND DEVELOPMENT PROGRAMS

BUDGET PLAN
(Thousands of Dollars)

Cognizant Office and Program	FY 1979	FY 1980	FY 1981 Pending Request	FY 1981 Budget Amendment	FY 1981 Revised Request
SPACE TRANSPORTATION SYSTEMS	2,011,600	2,403,300	2,738,200	-42,000	2,696,200
Space Shuttle	1,638,300	1,886,000[a/]	1,873,000	---	1,873,000
Space flight operations	299,700	446,600	809,500	-42,000	767,500
Expendable launch vehicles	73,600	70,700	55,700	---	55,700
SPACE SCIENCE	505,400	600,800	668,000	-107,000	561,000
Physics and astronomy	282,900	337,100	438,700	-92,100	346,600
Planetary exploration	182,400	219,900	179,600	-4,300	175,300
Life sciences	40,100	43,800	49,700	-10,600	39,100
SPACE AND TERRESTRIAL APPLICATIONS	283,900	343,900	394,800	-26,000	368,800
Space applications	274,800	331,800	381,700	-25,000	356,700
Technology utilization	9,100	12,100	13,100	-1,000	12,100
AERONAUTICS AND SPACE TECHNOLOGY	376,400	427,100	409,500	-20,000	389,500
Aeronautical research and technology	264,100	308,300	290,300	-15,000	275,300
Space research and technology	107,300	115,800	115,200	-5,000	110,200
Energy technology	5,000	3,000	4,000	---	4,000
SPACE TRACKING AND DATA SYSTEMS	299,900	332,400	359,000	-10,000	349,000
TOTAL	3,477,200	4,107,500	4,569,500	-205,000	4,364,500

a/ Includes proposed supplemental of $300,000,000 for the Space Shuttle.

Attachment 2

IMPACT OF BUDGET REDUCTION ON INTERNATIONAL SOLAR POLAR MISSION

Mr. BOLAND. Thank you, Mr. Administrator.

Let's begin by turning to pages RD-4-12, 13 and 14 where we find the International Solar Polar Mission detailed. This legend is found on page 17 of the budget amendment. The original 1981 budget request for this mission was $82,600,000. That is being reduced by $43 million under the new budget amendment—making the revised request $39,600,000. The primary impact of this reduction is a slip of 26 months in the launch of the Solar Polar Mission. It occurs to me that by making this proposal, you are doing precisely what you told us last December, during the Galileo Reprogramming hearing, precisely what you told us was not a good idea to do—from the standpoint of efficiency, from the standpoint of risk, and from the standpoint of our relationship with the European space community. You cited all of these problems to us last December when we made the suggestion that the Centaur be developed instead of the IUS which would have caused a two year delay in the Solar Polar Mission.

Isn't the credibility of NASA being stretched a wee bit here?

Dr. FROSCH. No. I still think it would be much better not to delay the mission for two years.

Mr. BOLAND. Why is it better to delay than cancel the mission?

Dr. FROSCH. When compared to cancelling it, the two year delay is preferable.

Mr. BOLAND. What will we loose if it is delayed?

Dr. FROSCH. Some of the science return will be somewhat smaller but still large enough.

Mr. BOLAND. I think you would recognize that what you are doing is giving everyone a smaller piece of the pie. Your original budget estimate is over $5 billion. With a budget this size, it is a huge budget, not easy to defend when there are tremendous cutbacks in other areas affecting programs that are targeted to those who need it the most.

It would seem to me in a budget that is this large where the outlays are about $224 million, that you are not sharing the burden of meeting some of the problems the President suggests in trying to come up with a budget that does call for some restraint.

This is not a lecture. I am just giving you my own perspective on the reductions.

Dr. FROSCH. We discussed with the OMB the consequences of larger cuts on the ongoing programs and our suggestion and the total conclusion was that cuts beyond what we finally agreed upon would do sufficient damage to the ongoing program and to the benefits coming from the program and it was unwise within this budget adjustment.

Mr. BOLAND. Who will bear the burden in the future years of the so-called savings on a program like this? Isn't it true that the delay is going to increase the cost of this mission by at least $100 million?

Dr. FROSCH. That is correct.

Mr. BOLAND. And possibly closer to $150 million. Is that correct?

Dr. FROSCH. Yes, when STS costs are included.

Mr. BOLAND. Isn't that a consideration that should have been looked at more closely?

Dr. FROSCH. It was a consideration that was looked at but the fact is that it does not change the value of the data both scientifically and in terms of understanding the relationship of Sun and Earth and climate. We still need that scientific understanding so it does not appear sensible to drop the mission.

EFFECT OF SOLAR POLAR DELAY ON EUROPEANS

Mr. BOLAND. Last November when we discused Solar Polar Mr. Traxler asked a question, "How do the Europeans feel about the possibility of delaying the solar program until 1985? What would be their response to that?"

Your response was, "It is not clear that they would stay part of the program largely because of the cost to them of the lengthening of the development period." You also indicated that was your opinion too.

Dr. FROSCH. Yes.

Mr. BOLAND. What happened to that concern?

Dr. FROSCH. We were not sure when we delayed the launch that the Europeans would stay in the program.

Mr. BOLAND. That would be a simple question to ask them.

Dr. FROSCH. As soon as we were free to do so we did ask them. I asked them last month when Roy Gibson was in the U.S. for another purpose and he was not certain at that time what the European reaction would be. He thought that they would be likely to go along with it. I have subsequently seen him and the Europeans have agreed to go along with it and have sent me a telegram to that effect. Perhaps it would be useful to enter it into the record, Mr. Chairman.

Mr. BOLAND. Isn't it very likely that you are going to require a dual launch—one for the United States spacecraft and one for the European spacecraft? Isn't that correct?

Dr. FROSCH. Yes.

Mr. BOLAND. Doesn't the strong possibility of a dual launch increase the cost—you have to buy an additional IUS and you have to have an additional Shuttle launch—correct?

Dr. FROSCH. Yes.

Mr. BOLAND. Have the Europeans agreed to this slip? You testified last November that you felt they would pull out of the project if we did slip it two years.

Dr. FROSCH. They have assured me they will not pull out of the project. Perhaps I ought to read the telegram.

Mr. BOLAND. Fine.

Dr. FROSCH. This is to me from Roy Gibson.

"ISPM 1985 launch. The two-year delay will, of course, mean increased expenditure for ESA and since we have a fixed annual budget for our scientific programme this inevitably means delaying a new start somewhere downstream. Nevertheless, the scientific interest in ISPM is so high that we are prepared to accept the delay and the additional cost which may be as high as 20 million U.S. dollars.

"We look forward to close collaboration with you and your colleagues in order to achieve an optimum schedule for the delayed spacecraft development. The delivery dates for certain U.S. subsystems and experiments are crucial for ESA, because we can probably minimize cost by completing development on a slightly extended time scale and then mothballing.

"A final point: A further launch delay beyond 1985 would be catastrophic for ESA—and probably equally so for NASA. It would also have a serious impact on any further envisaged collaboration between NASA and ESA.

"Regards."

Mr. BOLAND. It gets a little confusing when you indicate that the Europeans will pull out if we slip the schedule but now when you suggest a delay they are willing to go along with it.

Dr. FROSCH. We weren't sure what they would do and they had expressed a good deal of concern. We were unwilling to answer the question until we had talked to them.

FUNDING OBLIGATION FOR ISPM

Mr. BOLAND. As I understand it, you had obligated $12,500,000 for this program in its initial year funding of 1979. Is that correct?

Mr. LILLY. That would be about right.

Mr. BOLAND. Your current estimate for 1980 is $47,900,000. We understand you have obligated about $4 million per month for the past four to five months—bringing the total obligations to date to roughly $30 million.

Mr. LILLY. Through March they are about $22 million.

NOTE.—Actual obligations were $35.2 million through March. Accrued costs were $22.3 million; cumulative obligation including fiscal year 1979 was $47.7 million.

Mr. BOLAND. If you cancel this project today, even after you pay the termination costs you might have some funds left from fiscal year 1980. Is that correct?

Mr. LILLY. That is correct.

Mr. BOLAND. And you would have $40 million in 1981 that you could use to offset cuts in other areas and which by being delayed will also cost more money in the out years. Is that a fair statement?

Dr. FROSCH. I think it depends on what termination costs we would have.

Mr. LILLY. I would estimate those costs to be somewhere around $12 million.

Mr. BOLAND. Why can't you make the tough decision of simply stopping this program?

Dr. FROSCH. I would be very reluctant to do that because the requirement for the data and the interest in the data with regard to scientific questions and eventual application remain. I think we would simply come back to it again. It doesn't change the priorities.

Mr. BOLAND. If you cut your losses now, isn't it true that you will spend only $30 million—against the possibility of spending a total of $350 million for this project?

Dr. FROSCH. My comment, Mr. Chairman, is that even if we cancelled today, our investment would be on the order of $35–40 million and our spending is continuing at a rate of $3–4 million per

month. I believe if it were cancelled the requirement would still exist. We would come back and start this program again at a later date. I think it is clear that at that later date we would not have any European collaboration because we would have handed them a bill of at least $25 million plus their termination costs, and since the requirement exists we would pick it up at a higher cost at a later date.

Mr. BOLAND. As I understand the telegram, it is a terribly important program to them, and whether you stop it or not they would want to be in it.

Dr. FROSCH. I would hope they would but I wouldn't know what the nature of the collaboration would be if this were done.

BUDGET REDUCTION IN SPACE FLIGHT OPERATIONS

Mr. BOLAND. Now let's look at a related reduction which occurs on page RD-2-23, under Space Flight Operations. Here you are requesting $374,500,000 in 1981. That request has been revised to $346,500,000—a cut of $28 million as part of the budget exercise. The $28 million reduction is consistent with the delay of the International Solar Polar Mission and other planned flight schedule adjustments. What do you mean by other planned flight schedule adjustments?

Dr. FROSCH. There were also changes in the Spacelab flight schedule after Spacelab 3 so those costs were adjusted. There are some other flight adjustments but all of those put together change certain operating requirements by delaying certain flights.

Mr. BOLAND. How does the $28 million break down by the categories displayed on RD-2-23?

Mr. LILLY. Upper stages were reduced from $32,900,000 to $30,900,000, a reduction of $2 million. Payload support operations were reduced by $1.5 million. The Shuttle operations costs were reduced $24.5 million.

Mr. BOLAND. A $24.5 million reduction?

Mr. LILLY. Yes.

Mr. BOLAND. This reduction is reflected on page 13 of the new budget amendment. This revised budget amendment came up to us fairly late, so the questions were developed using the original budget submission.

With respect to this operation, would the $28 million grow any larger if the Solar Polar Mission were eliminated?

Dr. FROSCH. Not in the fiscal year 1980 or 1981, because it just moves it out of the year.

Mr. BOLAND. If the Solar Polar Mission were cancelled, how would you distribute the $40 million that you would gain in 1981 and whatever carryover from the $47 million currently planned for 1980 that became available in 1981?

Dr. FROSCH. Since we hadn't contemplated the question, I don't really know. We would have to supply it for the record.

Mr. BOLAND. Fine.

[The information follows:]

Cancellation of the ISPM is not likely to result in "savings" of a substantial sum in fiscal year 1980. For example, we estimate that a final cancellation decision in late June would result in unobligated fiscal year 1980 balances of less than $5 million. If fiscal year 1981 funding were made available, but the mission cancelled,

we would need to assess at that time the most pressing needs in other program and project areas before deciding how best to apply those funds. If there were no urgent unanticipated needs, we would use these funds to restore the budget amendment reductions in the Research and Analysis and technology activities in Space Science, Space and Terrestrial Applications, Space Technology and Aeronautics.

IMPACT OF BUDGET REDUCTION IN SPACE FLIGHT OPERATIONS ON ISPM

Mr. BOLAND. Let's look at another decrease that is associated with the Solar Polar Mission delay. On page RD-2-3—the comparable page is 12 in the budget amendment estimate—under Space Flight Operations, the Space Transportation System Upper Stages is reduced by $10 million from $39 million. The revised budget legend indicates that that reduction is consistent with the deferral of the International Solar Polar Mission—and it indicates that "the revised schedule, however, will delay much of the NASA unique development activity until after the two stage IUS development by the Department of Defense is completed, resulting in some loss of efficiency in the overall development effort." What does that mean?

Dr. FROSCH. That means that instead of having to meet the 1983 ISPM launch date with the three stage IUS since that has moved to 1985, we would now have to meet the 1984 date for Galileo. This means we can delay part of that development and take the money out of fiscal year 1981 but that will again increase overall costs. The ground rule that we were given for this budget amendment was to attempt to decrease outlays in fiscal year 1981, recognizing the potential for increased outlays in later years. But, we tried to do it in such a way that we felt that we could live within the overall projected envelope of budgeting for those out years without an overall increase. We have tried to do that.

Mr. BOLAND. You just indicated it would reduce the overall costs. How much would it have reduced the overall costs?

Dr. FROSCH. It is going to increase the overall costs.

Mr. BOLAND. What is the cost of the impact?

Dr. FROSCH. We don't know, but we know it will go up.

Mr. BOLAND. How much of this line item, Space Transportation System Upper Stages—which has now been revised to $29 million as detailed on page RD-1-5—how much is included in the $29 million for Galileo?

Dr. FROSCH. This is the development of the IUS.

Mr. BOLAND. Is there anything included in the $29 million in here for Galileo?

Dr. FROSCH. This is the development of the three-stage IUS and the cost does not identify specific programs for which the IUS will eventually be used. The delay of the ISPM mission enables us to delay the completion of the development of the IUS. The budget line which would be related directly with Galileo or with ISPM would be the line in which we purchase the three-stage IUS's which is STS Operations.

Mr. BOLAND. Also concerning Galileo, on page RD-2-9 under Payload and Operations Support, how much is included in the $11,200,000 for Galileo?

Mr. LILLY. I don't have that right now.

Mr. BOLAND. You may supply that for the record.

[The information follows:]

There are no funds within the sub-line item, "Payload and Operations Support" (page RD2-9) for Galileo. This activity consists of effort for the Payload Operations Control Center (POCC), Operations Management Support and Orbital Flight Test (OFT) Payload Integration. Fiscal year 1981 funding for Galileo support is, however, included in the sub-line items under STS Operations on page RD2-23 and is detailed in response to the request concerning Galileo support costs in the STS Operations Budget.

ORBITER TRANSFER VEHICLE

Mr. BOLAND. On page RD-2-19, the advanced programs line item is detailed. The original request $10,800,000 has been reduced by $2 million. How much was included in the original request for the Orbital Transfer Vehicle?

Dr. FROSCH. There was $900,000 in the original budget for Orbital Transfer Vehicle studies.

Mr. BOLAND. Are there any other funds in this budget for the OTV?

Dr. FROSCH. I don't believe so.

Mr. BOLAND. When the suggestion was made that the Centaur be developed for the use in the Shuttle—one of the arguments in favor of that proposal was that it could be used as an Orbital Transfer Vehicle in the late 1980's and 1990's. Is that is correct?

Dr. FROSCH. A modified version could be used in that way.

Mr. BOLAND. It appears, however, that you rejected that suggestion and so decided to scrub any future use of the Centaur or any follow-up of the Centaur.

Dr. FROSCH. No, I do not think that is not a correct interpretation.

Mr. BOLAND. And instead you are heading down the road of developing a totally new Orbital Transfer Vehicle with a totally new engine.

Dr. FROSCH. That is certainly a possibility. But I would not say we are necessarily heading down the road.

Dr. LOVELACE. It is only in the study period, Mr. Chairman. We are looking at a number of options.

Dr. FROSCH. If we could figure out how to get the advantages of Centaur into the program in a timely way and accomplish what has to be done with it, then we would propose to do that.

Mr. BOLAND. So I take it that you have not finally and firmly rejected Centaur for the Shuttle?

Dr. FROSCH. We have looked at it again in terms of putting it in now, and we continue to think it would not be wise at this time. There are difficulties with putting it in later—we are on the horns of a dilemma. If we try to put it in now, then we feel we are tampering with the Shuttle schedule and engineering. We don't want to do that.

If we come back to it in several years, the problem is that the Centaur production capability will meanwhile have been shut down. The question will then be: "Is it really economical to bring it back in?" We are just in a very difficult position with timing. That is the problem.

Mr. BOLAND. So you would have to split Solar Polar if Centaur were available?

Dr. FROSCH. If Centaur were available, we would not have to split the International Solar Polar Mission. I think that is right.

Dr. MUTCH. Yes, that is correct.

Mr. BOLAND. In our previous discussions the Subcommittee was advised that the most economical solution of the planetary program was to supply ISPM in 1983 with a Shuttle IUS possibility split mission and a dual spacecraft Galileo in 1984. Because of the recent budget cuts, NASA has been forced to delay the International Solar Polar Mission from 1983 to 1985. It is also understood that the Shuttle IUS performance with the Galileo mission in 1984 is still a problem. Is that correct?

Dr. FROSCH. It is.

Mr. BOLAND. In lieu of these changes, would it appear that the most economical solution would now be based on a Shuttle Centaur flying single spacecraft with Galileo and ISPM in 1984 and 1985 respectively?

Dr. FROSCH. If we could do it.

Mr. BOLAND. You can't do it.

Dr. FROSCH. We don't believe we can do it in a safe and reliable way. We have looked at what is required and I am not now willing to have the necessary Shuttle modifications started at this point. I think it is unwise to add that to the program. There is also some question as to whether, in fact, we could really rely on it in time. If it were possible to do, we believe it would be the best thing to do.

Mr. BOLAND. Has there been any projection on the total costs of the Orbital Transfer Vehicle?

Dr. LOVELACE. The vehicles that are under study?

Mr. BOLAND. Yes.

Dr. LOVELACE. None.

IMPACT OF BUDGET REDUCTION ON SPACELAB

Mr. BOLAND. On page RD-2-21—that is on page 13 of the revised budget—the Spacelab program is detailed. The original budget estimate was $151,700,000 and that has been reduced by $2 million to $149,700,000. On page RD-2-22, the justifications indicate that the major part of your request in 1981 is for the purchase of the second set of Spacelab elements and initial spares to support the early flights. My understanding is that amount is $120,500,000 of the $149,700,000. Is that correct?

Dr. FROSCH. That is correct; $120.5 million in budget authority will be applied to procurement of the second set of Spacelab hardware. But we do not plan to make any outlay against that authority in fiscal year 1981.

Mr. BOLAND. Can we assume that none of the reduction of the $2 million has been taken out of the payment to the Europeans for a second Spacelab?

Dr. FROSCH. Yes, that is correct.

Mr. BOLAND. What about the authorization committees? Did they reduce this item?

Dr. FROSCH. The House Authorization Committee reduced the budget authority by $15 million for Spacelab in its mark-up.

Mr. BOLAND. Are you in agreement with that reduction?

Dr. FROSCH. We would prefer to keep the full budget authority as a contractual assurance to the Europeans but it does not affect the outlays.

Mr. BOLAND. On page RD-2-23, under the four line items that are displayed for Space Transportation System Operations—how much is included in 1981 for Galileo?

Dr. FROSCH. We will have to supply that for the record.

[The information follows:]

Three of the four sub-line items in our present submission for Space Transportation System Operations (page RD2-23) contain funding in fical year 1981 for the two Galileo launches. Space Shuttle Operations contains $6.2 million for long-lead procurement and manufacturing of flight hardware which include the external tanks and solid rocket boosters supporting the flights on which the Galileo missions are scheduled; Upper Stages Operations contains $3.2 million for procurement of two Inertial Upper Stages for Galileo; and Payload Support Operations includes $1.0 million for payload integration analysis for a total of $10.4 million support to the Galileo mission.

Mr. BOLAND. With respect to the participation of the Europeans in the Spacelab flight, how much additional cost will be incurred here because of the delay in the delivery of the simulator and the delay of processing Spacelab hardware arriving from Europe?

Dr. FROSCH. I don't think that will be significant because the Europeans are supplying the hardware. This will simply mean a delay in processing for later missions.

EXTENSION OF AVAILABILITY OF ATLAS/CENTAUR

Mr. BOLAND. Let's turn for a minute to the Expendable Launch Vehicle section and page RD-3-4, where the Centaur program is detailed. The justifications indicate that fiscal year 1981 was intended to be the last year of funding for this program and that "our current planning is based on a close-out of the program by the end of 1981."

I understand that decision is being looked at again. Is that correct?

Dr. FROSCH. Yes, it is. We had a request from INTELSAT to consider extending the availability of Atlas/Centaur launches to them for a longer period to give them added insurance in the Shuttle schedule. We have informed them that that would be possible at their cost. We have quoted them a price based on assumptions as to how many they would want and when. We have told them in order to continue the line, we have to have a firm understanding from them by the end of June 1980, which is after the next board meeting. We do not yet know what they have decided.

Mr. BOLAND. I take it that the user demand is forcing you to reopen the question of the Centaur phase-out.

Dr. FROSCH. That may be the case. INTELSAT, as far as I know is the only potential user who has asked for that. We don't know what they are going to do.

BUDGET REQUEST FOR SPACE TELESCOPE

Mr. BOLAND. On page RD-4-1, under the Physics and Astronomy Program—we have already discussed the International Solar Polar mission—and the other major project being the Space Telescope, which is detailed on RD-4-10 and on page 15 of the revised budget

amendments. The Space Telescope garners the largest part of the Physics and Astronomy budget at $119,300,000 in 1981. Why didn't you take any of the reduction in the recent budget exercise out of this program? It doesn't require any specific launch window. It is scheduled to be launched in December of 1983. If it doesn't meet that launch date, no science is lost.

Dr. FROSCH. There would be a delay in science being obtained. This essentially was a feeling that it would be unwise to try to tax everything; that would interfere with all programs. The optimum strategy was to leave alone when we looked at it and considered that it is at a point in its development, where it is moving along fastest and that it would probably be damaging to the program and, therefore, unwise to tamper with it.

Mr. BOLAND. Is there another reason, why you spent more money in this area than in other programs, that have narrow launch windows?

Dr. FROSCH. I don't understand the question, Mr. Chairman.

Mr. BOLAND. I suppose the question is why do you choose to take funds out of a program that has a very narrow launch window, that will result in the delay of two years, that will result in a much riskier mission which could result in losing most of the science instead of this program where you could easily delay?

Dr. FROSCH. Because we could take a definite action in ISPM and know exactly where we were putting it; and make an examination of what science was lost, and it was a palatable amount; and we would have a definite schedule rather than interferring with this the Space Telescope development. We felt that was the wiser choice to make.

Mr. BOLAND. Did anyone in the Physics and Astronomy Office suggest that the cut should come from in this project?

Dr. FROSCH. I don't remember whether anybody suggested it. We certainly considered it consciously.

Mr. BOLAND. I am not talking about whether you considered it yourselves. I am talking about the suggestion coming from within that office.

Dr. MUTCH. Yes, sir; we did consider it.

Mr. BOLAND. You rejected it?

Dr. MUTCH. Yes, sir. We considered cuts in this area and we adopted the point of view that Dr. Frosch has just expressed.

Mr. BOLAND. What is the current development cost of this program?

Mr. LILLY. The current development is approximately $555 million in dollars of the fiscal year 1981 budget.

Mr. BOLAND. Is this project on time and will it really meet the December 1983 launch date?

Dr. MUTCH. Yes, sir. The development of the Space Telescope is on schedule.

Mr. BOLAND. If it is on time, there are some launches you don't have any problem with.

Dr. MUTCH. This is a program which requires a large expenditure of money. It is a very challenging program and it is under continuous cost and schedule review. We had a detailed cost review this past December. On the basis of these very detailed reviews, I do believe that we can accomplish it within cost and schedule.

Mr. BOLAND. Do you have any serious concerns about the optical telescope assembly which houses the 94 inch mirror?

Dr. MUTCH. No, sir. As far as I can tell, and we examined this in detail, the program is going well. We have a critical design review on that in a few months.

Mr. BOLAND. Fine. Can the Space Telescope be launched and retrieved within the Space Shuttle—and not have any structural problems?

Dr. FROSCH. As far as we know that is all right.

Mr. BOLAND. No structural problems with reference to the Shuttle or to the Telescope itself. Is that correct?

Dr. FROSCH. Not that I am aware of.

TOTAL DEVELOPMENT COSTS FOR THE SPACE TELESCOPE

Mr. BOLAND. As you probably know, the General Accounting Office issued a report which recommends that the full cost of this project should be displayed to the Congress. We have been over some of this ground before—but it is interesting to note of the total development cost of $530 million listed in the status report last July—it appears that a full $296 million of that amount—or more than 50 percent consists of project reserves. Isn't it fairly simple to get a project completed within your estimate when you have those kinds of reserves. Was the GAO correct?

Mr. LILLY. No, they are not correct, Mr. Chairman. Their interpretation of reserves is quite at variance with what we would say. The fact is that we are not always able to define in specific detail all of the work on a contract that is going to be required. We contract later for those things at a time when we can define them in sufficient detail. This does not mean that the later work contracted for is a reserve. That is the kind of thing they were counting.

Mr. BOLAND. They shouldn't have counted it?

Mr. LILLY. That is right. They should not.

CURRENT ESTIMATED LIFE CYCLE FOR THE SPACE TELESCOPE

Mr. BOLAND. What is the current estimate for the "life-cycle" cost of this project?

Dr. MUTCH. It would depend on the definition of life-cycle.

Dr. FROSCH. I am not sure I understand life-cycle. This is rather like a facility.

Mr. BOLAND. The GAO report indicates that NASA's estimate of the "life-cycle" costs was $1.1 billion. That included $530 million development costs, expressed in 1979 dollars, and an estimated $600 million for telescope operations.

Dr. FROSCH. That is for some defined period which I presume is ten or fifteen years. I was puzzled when I read the GAO report because I haven't the faintest idea of what they mean by "life-cycle" costs with a facility. It is like asking what is the "life-cycle" cost of the U.S. Capitol as a building. I can tell you the 10 year costs that the architect of the Capitol expends, but the building, I presume, will be here and go on and be used for a very long time.

Mr. BOLAND. It is not much of an answer.

Dr. FROSCH. I can give you the following——

Mr. BOLAND. Don't give me any more. Let's hear from Mr. Lilly. I suppose a "life-cycle" is the cycle from birth to death of the project. Is that correct?

Mr. LILLY. That is correct.

Mr. BOLAND. This is another area in which apparently you have problems with the GAO. The GAO indicates that when you plug in inflation and other Civil Service salary costs, the total "life-cycle" cost of this project will be about $2.2 billion.

Mr. LILLY. The "life-cycle" cost comes to about $1.870 billion.

Dr. FROSCH. The problem is, I do not know if 15 years is the right time. If it lasts for 20 years, it will cost even more, but will be even more valuable.

Mr. COUGHLIN. It is important to know what the total overall long-term costs will be, the kind of commitment we will be making.

Dr. FROSCH. The life-cycle cost has to be defined for a time. We are buying a facility which we hope will last for a long time, and so it is not clear what the number means. If one says we want to cost out what it costs to buy it and operate it for 10 years, and then we will make a new decision, then we can arbitrarily define that as the cycle being determined and give it a number. But it is in my mind somewhat like a building. I was very puzzled by the GAO way of accounting for it. I have never heard of anybody analyzing a building in terms of a life cycle and then attempt to add in the cost of the utilities used in the life of the building and the cost of all the civil servants who will be occupying the building. It seems to be a strange way of accounting and one they invented for the purpose. I believe the Congress should know what it costs for a given period of time, but to pretend that one loads into these things lots of other things and goes on to talk about an indefinite period seems to be a strange way of accounting. That is the difficulty.

Mr. COUGHLIN. The Congress needs to know what the overall long-term cost of a building will be, whether it is a building or something else.

Dr. FROSCH. I think the Congress does not think of the total cost of a building until it collapses. It seems the appropriate thing would be what it costs to develop and achieve the facility and what it will cost to operate per year on some sensible basis, such as a 5- or 10-year basis. But then to attempt to get a number which adds all that up for a very long time does not add anything to that form of accounting.

Mr. COUGHLIN. What I am saying, is that I do not buy your analogy of a building. A building is a program, and when you estimate the cost of a program you include the cost of housing the program.

Dr. FROSCH. This is, in fact, the facility which carries out a program. The program will change over the years and will continue. There will be lots of things that are not funded directly out of the Space Telescope. These could be calculated. One could calculate the cost of U.S. astronomy including the cost of all facilities, including the cost of the Space Telescope. But to do it the other way around is an odd way of doing it.

Mrs. BOGGS. It is also difficult to equate the capital investment in improvements.

Mr. BOLAND. I guess it would be difficult to project how long the Space Telescope would be up there.

What about the life-cycle cost of the Viking mission to Mars?

Dr. FROSCH. We can tell you what the costs are today.

Mr. BOLAND. Supply that for the record.

[The information follows:]

The direct cost of the Viking basic mission was $931 million, which included project development, missions operations and data analysis. Other identifiable related costs included $80 million for launch vehicles, $20 million for tracking and data acquisition, $25 million for planetary flight support, $14 million for facilities, and $50 million for the extended mission.

SHUTTLE/SPACELAB SCIENCE PAYLOAD MANAGEMENT

Mr. BOLAND. Let us turn to page RD-4-16 and the Shuttle/Spacelab Science Payload Emission Management area. We see that you were requesting $72,100,000 for this activity in 1981. That has taken, on a percentage basis, the largest reduction in the recent budget exercise. The new estimate is only $29,100,000—or a reduction of $43 million. Is that correct?

Dr. FROSCH. Yes.

Mr. BOLAND. Let me ask whether or not the justifications lack any detail on the $72.1 million. How much is in here for Spacelab 1 and 2?

Mr. LILLY. There is $4.1 million in the fiscal year 1981 amended budget for experiment development.

Mr. BOLAND. Is the $43 million reduction associated only with Spacelabs 4, 5, and 6?

Dr. MUTCH. The reduction does not affect Spacelabs 1, 2, and 3.

Mr. BOLAND. Under the current manifest, when were those Spacelabs scheduled for flight?

Mr. LILLY. May I correct something: There is $10.3 million in fiscal year 1981 for Spacelabs 1 and 2 which is made up of $4.1 million for experiment development and $6.2 million for mission management.

Mr. BOLAND. For the record, provide a breakdown of the $43 million.

[The information follows:]

The launch dates assigned to Spacelabs 4, 5, and 6 by the STS manifest dated February 15, 1980, are:

Spacelab 4—November 3, 1983.

Spacelab 5—April 10, 1984.

Spacelab 6—July 6, 1984.

However, the mission flight assignments cannot be finalized for Spacelab missions until the Shuttle becomes operational.

The reduction of $43 million is broken down as follows:

[Thousands of dollars]

	Fiscal year 1981 Pres. budget	Fiscal year 1981 budget amended reduction	Fiscal year 1981 amended budget
Science experiment development:			
OFT/Spacelab 1, 2, and 3	4,300	.....	4,300
Physics and astronomy payload development for future missions	20,900	−20,900	.....

[Thousands of dollars]

	Fiscal year 1981 Pres. budget	Fiscal year 1981 budget amended reduction	Fiscal year 1981 amended budget
Subtotal	25,200	−20,900	4,300
Mission management:			
OFT/Spacelab 1, 2, and 3	6,600		6,600
Follow-on Missions—Physics and Astronomy, Applications and Technology	40,300	−22,100	18,200
Subtotal	46,900	−22,100	24,800
Total	72,100	−43,000	29,100

Mr. BOLAND. Associated with the reduction of $43 million from the Shuttle/Spacelab development, is a reduction of $6,100,000 occurring on page RD–4–24, under research and analysis. That is reflected on page 19 of the revised budget. Is the entire reduction of $6,100,000 coming out of this Spacelab science payload definition line?

Dr. MUTCH. No, sir.

Mr. BOLAND. What is it coming from?

Dr. MUTCH. It is in several things.

Mr. BOLAND. We have a new table which adds up to a reduction totaling $6.1 million.

Dr. MUTCH. That is correct.

Mr. BOLAND. Are these reductions being taken on programs that we are cooperating with the Europeans on—and is there any concern on the part of Europeans with these cuts?

Dr. MUTCH. Mr. Chairman, you are referring to the Spacelab program, I believe.

Mr. BOLAND. Yes.

Dr. MUTCH. The Research and Analysis efforts are not cooperative efforts and the Europeans have no reason to be concerned with these reductions.

Mr. BOLAND. They are not concerned with the cut being made in this area?

Dr. MUTCH. No, sir.

GAMMA RAY OBSERVATORY—NEW START

Mr. BOLAND. An area that was not targeted for any reduction occurs on page RD–4–14—the new start which is known as the Gamma Ray Observatory. The initial request is for $19,100,000, and as the justifications detail on page RD–4–15, the current total estimate is $225 million plus $45 million in scientific data analysis, plus $40 million for a Shuttle launch for a total of approximately $310 million—is that correct?

Mr. LILLY. Yes.

Mr. BOLAND. Why can you not delay this program for a year—instead of taking it out of the ongoing program area of Spacelab flights? It just does not seem to make sense.

Dr. FROSCH. We started the budget amendment process by looking at this and concluded there was not enough outlays in fiscal

year 1981, to stop initiation of a new start. The initial guideline was to reduce the fiscal year 1981 outlays. The only way we could get enough outlay to meet any of the targets was to touch major ongoing programs. Having done that, it added very little to what we were doing to touch the new starts. If we did that, then we would have to affect both the ongoing programs and new starts and end up with no program.

Mr. COUGHLIN. Mr. Chairman, can I jump in here for just one moment? It seems as though NASA just has not gotten the message. If all we are trying to do is balance the budget in 1981 at the expense of increased costs in out years and more unbalanced budgets, then that is an awfully political statement. That is not for what this Member is looking.

We are looking for ongoing reductions so we can continue to have a balanced budget.

Dr. FROSCH. We assume the budgets will continue to be constrained and pushing these things out will have an impact on later new starts. But within the total set of constraints, this is what seemed to be the most sensible way in which to constrain fiscal year 1981 costs and leave out-year costs reasonably constrained.

Mr. COUGHLIN. There is no launch window for the gamma ray program, is there?

Dr. FROSCH. No.

Mr. COUGHLIN. It could be put off until some future time without a significant loss to the world.

Dr. FROSCH. Since the bulge of the funding will come in future years, all we would be doing is piling up the bulges in future years.

Mr. COUGHLIN. You could delete this new start and continue ongoing programs so they would not increase the costs in the out year.

Dr. FROSCH. That is exactly the point. We looked at the question of removing the new starts, and there is not enough money in the new starts to enable us to not have an effect on the ongoing programs.

Mr. COUGHLIN. There is some money?

Dr. FROSCH. We cannot put enough money into ISPM, for example, in order to hold it for a later year. We would still have to delay ISPM and destroy the new starts. That would leave us with a situation in 1981, that we would not have a NASA program.

NASA'S OUT YEARS BUDGET

Mr. BOLAND. You cannot get rid of the bulge in the out years unless you stop these particular new programs from starting.

Dr. FROSCH. You cannot get rid of the total amount of money required in the out years, but you can hope to phase it in such a way that it is not increasing the total program.

Mr. BOLAND. The President looks for a balanced budget in 1981 and you talk about out years. He is looking for a balanced budget in 1981 and is making a heroic effort to do so.

As Mr. Coughlin points out, if we could eliminate a $24 million item, that helps towards balancing the 1981 budget. Then you do not have to take money from human needs programs, other programs addressed to so many constituencies that depend upon gov-

ernment programs for their vital needs. I think that is the problem we face here. Where it is possible to cut particular new programs that are just starting this year. No one is going to get hurt if you start them down the road sometime. You may start them later, you may not, but no one is going to get hurt if you do not start them this year.

As I said when you were up here in March, it seems to me the scientific community is an area that does not want to bleed even a little in times that require it, in times that require sacrifice by everybody. You do not agree with that, do you?

Dr. FROSCH. No, I do not.

Mr. BOLAND. I would think looking at this budget, one would have to come to that conclusion.

Mr. LILLY. More than half of our total cut is coming from science projects. It was the heaviest-hit area in our program.

Mr. COUGHLIN. Mr. Chairman, I guess the other point I have is, it is not just meeting other human needs, and that is important in itself, nor is it important to just look for a 1 year balanced budget then a whole string of nonbalanced ones. We have to consider the out years, too.

Dr. FROSCH. I assume the NASA budget, the out year budgets are going to end up with fewer projects in them as a consequence of this, simply because we will have to accommodate the increased costs.

Mr. COUGHLIN. This is one area where we can do something this year where it will have an effect on out years, too.

Dr. FROSCH. Again, it is an area where I think it will simply mean we will be back at a later date with the new starts and at a higher cost.

Dr. MUTCH. May I just interject something here relative to the science of the Gamma Ray Observatory. This is one new start among many that we considered and the only one we did propose. It is in the area of high-energy astrophysics that we are making great discoveries at the present time. It is a mission that has been planned for some years.

Although it may be more subtle than in some other areas of human activity, it is just as real a need that you develop and maintain a critical mass and momentum in a scientific program. When you do that, you can exploit it. Conversely, fundamental difficulties will arise in this particular case relative to the high-energy astrophysical program and community if the mission were further delayed, can be very great.

So, in a very real sense, if you delay a program such as this, which is carefully chosen to be consonant with the development of science, you do suffer inefficiencies—financial, scientific and related inefficiencies.

Dr. FROSCH. The problem we were given was to reduce outlays in fiscal year 1981 without necessarily implying major increases in the total NASA budget in the out years. We were asked not to make a fundamental change in the Agency's mission nor to change the policy of balance between science, applications, technology, aeronautics, and so on in the NASA budget. We have tried to do that in such a way that we do not destroy the program. It would be easy to get a much smaller budget by doing hardly anything. We

could easily end up being an Agency which I described at one point in the discussions as a "trucking company." You operate the Shuttle and do not do anything else.

Mr. BOLAND. How do you destroy the program by eliminating a $20 million project—a new start? How do you destroy that kind of program if it is something that has never been started before? Why can't it be started down the road? Why did you not start it 5 or 10 years before now?

Dr. FROSCH. We did not know how.

Dr. MUTCH. It was not possible.

Mr. BOLAND. Well, it is possible to start it next year or further down the road, is it not?

Dr. MUTCH. Yes, sir; it is technically possible.

Mr. BOLAND. Why wasn't any of the reduction taken out of the Explorer Development Program on page RD-4-19 which has been going along for years at about the same level or out of the suborbital program line item which appears on page RD-4-29? Why did they not share in any of the reduction?

Dr. FROSCH. Because we feel they were already at minimum levels and we simply could not carry on anything in those areas if we began to cut that. Again, the quantity one could cut by taking out elements simply did not help the problem very much.

REDUCTION IN MISSION OPERATIONS AND DATA ANALYSIS FOR PLANETARY EXPLORATION

Mr. BOLAND. Let us turn to the Planetary Exploration Program which is detailed on page RD-5-1. The only reduction occurring from the recent budget exercise in planetary exploration affects the mission operations and data analysis line item which is being reduced from $64,800,000 to $60,500,000—a reduction of $4,300,000. Otherwise this area of NASA's budget is relatively untouched.

On page RD-5-5, the Galileo project is detailed. Of the total amount committed through February of 1980, roughly how much has been spent on the probe?

Mr. LILLY. On the probe itself, the contract has not been let yet—excuse me, I was thinking of the probe carrier, Mr. Chairman.

Mr. BOLAND. Provide for the record what the total amount planned to be spent on the probe is through 1980.

[The information follows:]

The probe costs through February 1980 are $42.5 million. We expect to cost a total of approximately $52 million on this probe through fiscal year 1980.

SOLAR ELECTRIC PROPULSION SYSTEM

Mr. BOLAND. In the planetary area, Dr. Mutch, you originally had some hope of including in the 1981 budget a new start for the Solar Electric Propulsion System (SEPS). That funding was scrubbed in the original request and appears to look even dimmer under the current budget conditions.

Is it correct that without the SEPS you cannot do a Halley's Comet rendezvous—only a flyby?

Dr. MUTCH. We had originally planned a mission which would have flown by Halley's Comet and rendezvoused with a second

comet, Temple 2. Without the SEPS, we cannot rendezvous with Temple 2.

Mr. BOLAND. Are you going to do a flyby?

Dr. MUTCH. We are considering it as a possible fiscal year 1982 new start, a flyby of Halley's Comet.

Dr. FROSCH. Which would not require SEPS.

Mr. BOLAND. How much is in the budget for 1981?

Dr. MUTCH. It would be a candidate new start for fiscal year 1982.

Dr. FROSCH. There are funds in one of the study lines which are being used to study that possibility.

Mr. BOLAND. In your judgment, is the cost of doing a Halley's flyby worth the science that can be obtained?

Dr. FROSCH. That is the question we are addressing.

GALILEO MISSION STATUS

Mr. BOLAND. I think we went over the Galileo Mission in considerable detail in past years and spent a little time on it last December. Is there anything you would like to tell us about the program that has changed since your testimony last December?

Dr. FROSCH. Not that I know of. We continue to be concerned about the IUS and that is the major thing, but that is not new. Have you any comment, Bill?

Mr. LILLY. The only other thing, Mr. Chairman, I would say is in terms of the estimate I believe we gave here. We gave you a range of $595 to $650 million. In the meantime, we have completed our study of that and have revised the range to $620 to $670 million.

Mr. BOLAND. As you know, we put a specific dollar ceiling on all Galileo and Galileo related work in the appropriations bill last year. Also, in January we asked you for the projected cost of the revised Galileo program which is slipping in 1984. We may put a ceiling on for 1981—and also possibly a total program ceiling. Would you object to a ceiling in 1981 and possibly a total program ceiling?

Dr. FROSCH. It is always difficult to operate with a ceiling. I presume the appropriation for a given year is the ceiling.

Mr. BOLAND. Considering that this program is going to run an additional $250 million—the overrun here was $250 million? You can understand our concerns with trying to keep a ceiling on its costs.

Dr. FROSCH. I do not know the exact amount. There is a considerable increase because of the delay of the mission.

FISCAL YEAR 1982 NEW START FOR VENUS ORBITING IMAGING RADAR

Mr. BOLAND. Let me ask, do you foresee any new start in the 1982 budget on a Comet mission or on a Venus Orbiting Imaging Radar?

Dr. FROSCH. We are certainly considering those two as possible new starts to put forward to OMB.

Mr. BOLAND. Which of the two has the higher priority?

Dr. FROSCH. At this point, I would guess that the Venus Orbiting Imaging Radar would be, but that is partly because we have not looked at the cometary possibility very hard. I would hesitate to prioritize them until we have looked at them together.

Dr. MUTCH. I would agree with Dr. Frosch's comment. It is a little bit like comparing apples and oranges. The Venus Orbiting Imaging Radar is a major free flyer, but it is possible that we may be able to react to the Halley Comet arrival with a number of relatively low-cost options that we are investigating. In that sense, they may not be competitive.

REDUCTION IN LIFE SCIENCES PROGRAM

Mr. BOLAND. On page RD-6-1, the life sciences program is detailed. The original request for 1981 was for $49,700,000. The recent budget exercise reduced that by $10,600,000 to a new request of $39,100,000. One of the impacts of that reduction is a delay of one year in the first dedicated life sciences Spacelab flight from May 1983 to May 1984. Is that correct?

Dr. FROSCH. Yes.

Mr. BOLAND. So the impact is a reduction of a delay of one year. What would be the cost of that delay?

Mr. LILLY. The cost of the one year delay that I can identify now is whatever the inflation would be on that amount.

Mr. BOLAND. Do we have any questions in this area before turning to the Space Applications Program?

Mrs. BOGGS. Mr. Chairman, with regard to the $2.7 million that would be saved by not upgrading the present Pioneer mission computer system which is causing difficulties; what kind of impact will that have if the computers fail? Will there be a loss of scientific data?

Dr. MUTCH. We believe there is no significant risk, but there is some increased risk. We would have some loss of data. In brief, we do not look forward to that possibility, and we think we have guarded against it, but inevitably to meet these budget constraints, we have to take a little more risk. We do not think it is a responsible thing to do.

Mrs. BOGGS. I notice in the space tracking and data systems you also have $5 million scheduled for the replacement of old computer systems at Goddard and Wallops to be updated.

Dr. MUTCH. In general, this is a continuing problem in the sense that it is desirable from the point of view both of efficiency and reliability to continually examine and update your computer systems.

Dr. FROSCH. I believe the item you are referring to is only partly connected with Pioneer Venus but is the general item in tracking and data computers. There it is really a matter of deferring modernization and assume we will manage to continue as we are without a major problem until we get them modernized.

Mrs. BOGGS. So much is cut from the life sciences program. Will this result in the elimination of ongoing research which would be beneficial to continue?

Dr. MUTCH. The cut is large and clearly we have been obliged to defer certain activities. But we have looked very carefully at those

activities, for example, which were critical for supporting long-duration manned flight and so forth. We believe the program, if we build back up in latter years, is consonant with the requirements of the man-in-space program.

Dr. FROSCH. One additional comment, please, that was an area in which the budget was growing significantly and it should be. But the effect of the decrease is essentially to hold fiscal year 1981 at the fiscal year 1980 level, approximately. That means that is a lower level of effort due to inflation, and is somewhat of a decrease in the program, but still it is holding it to approximately the previous level. There is work loss, no question about it.

Mrs. BOGGS. Thank you, Mr. Chairman.

REDUCTION IN SPACE APPLICATIONS PROGRAMS

Mr. BOLAND. We will turn to Space Applications which is detailed on the summary sheet appearing on page RD-7-1. The original budget request for this area was $381,700,000 for 1981. The reduction is $25 million to $356,700,000. However, that $25 million reduction is really misleading because since the 1981 budget was put together, the Landsat-D program, which is detailed on page RD-7-12, has grown by $30 million. That means that the space applications programs have had to be cut by $55 million to absorb both the $30 million increase and the $25 million general reduction. Is that correct?

Dr. FROSCH. The way we went about the process did not take the whole of the $55 million out of Space Applications. What we did was go through the whole decrease without regard to the $30 million that had to be added in, added the $30 million back into Landsat-D amount for fiscal year 1981 and then went back into the whole decrease process to find the $30 million to make the total. So not all of the $30 million came out of Space Applications. Some came from Space Science and elsewhere. I think that is right, Bill, is it not?

Mr. LILLY. No, it all came from applications.

Dr. FROSCH. I stand corrected.

Mr. BOLAND. Where is Dr. Calio?

Dr. CALIO. Right here.

Mr. BOLAND. It is nice to see you. You are one of our favorite witnesses.

How did you make your decisions of where to take the $55 million reduction?

Dr. CALIO. We established a priority.

Mr. BOLAND. On a ZBB basis?

Dr. CALIO. We tried to establish what were the most important things for us to maintain in the program. We took a delay in ERBE of one year. We also deleted the $16 million in our budget request for the operational land remote sensing system and took additional reduction in ongoing flight activities that could be delayed. We then went down to areas more critical for us to maintain Applied Research and Data Analysis, and Technology Transfer.

Mr. BOLAND. Are the reductions taken here in conjunction with your own priorities established by the ZBB process?

Dr. CALIO. Those are my priorities, sir.

LANDSAT PROGRAM STATUS

Mr. BOLAND. Let us talk about the Landsat program, and particularly Landsat-D, which is scheduled to be launched when—in late 1981 or early 1982, or when?

Dr. CALIO. Landsat-D it was scheduled to be launched in September 1981. Our current assessment indicates that the baseline program reflected in the fiscal year 1981 budget would probably be delayed by one year. That is creating some difficulty, so we are looking at two other options right now, including the possibility of launching a multispectral scanner earlier than the thematic mapper. We have three cases under study because of the technical difficulties we are incurring in the program.

Mr. BOLAND. Are their technical difficulties embedded in the Landsat-3's tape recorder?

Dr. CALIO. Yes. On Landsat-3, one tape recorder has failed, and we are operating on the backup tape recorder, but that is working all right now.

Mr. BOLAND. I understand Landsat-2 is dead, it expired in January of this year?

Dr. CALIO. That is right, after 4½ years of service.

THEMATIC MAPPER ON LANDSAT

Mr. BOLAND. On March 10, the staff was advised by NASA that it was looking at the possibility of launching Landsat-D without a thematic mapper. What is the thematic mapper?

Dr. CALIO. A sensor which measures reflectance of light from Earth, in different regions of the spectrum.

Mr. BOLAND. Does it have a high resolution?

Dr. CALIO. Yes, it will have 30 meter resolution.

Mr. BOLAND. Are you going to launch Landsat-D without that mapper?

Dr. CALIO. That decision has not been made. We have that under study. We have three cases under study—that being one of them.

Mr. BOLAND. What would be the total overrun, including launch costs, if the thematic mapper is flown separately?

Dr. FROSCH. We would not fly it separately. The option would be to leave it off Landsat-D and probably fly it on a later Landsat or follow-on spacecraft. We would not fly it as a single mission.

Mr. BOLAND. What would be the cost overrun if you were to fly it on a later mission?

Dr. FROSCH. I do not know that it would appear in that way. It might be a replacement for something else that would have been flown on the later one. So I am not sure how to do the analysis.

Mr. BOLAND. What was the original total cost included in the launch of Landsat-D?

Mr. LILLY. The total estimated cost in the fiscal year, 1978 budget, Mr. Chairman, was initially about $235 million. The budget was amended to include Landsat-D. Changing the total estimate to approximately $290 million. That did not include launch. The launch was planned on Delta vehicles which would have been an additional cost of about another $16 million.

Mr. BOLAND. So would you consider that to be a cost overrun?

Mr. LILLY. I would consider the items that have happened since then as cost overruns; yes, sir.

Let me say they are cost increases from the original estimate. There have been several programmatic changes.

Mr. BOLAND. It is somewhat a different program than was originally proposed in 1978?

Dr. CALIO. Yes, the original program was with a thematic mapper. The multispectral scanner was added later.

Mr. BOLAND. Am I correct in saying that there was a $39 million overrun in 1980 and 1981?

Mr. LILLY. Yes.

Mr. BOLAND. Will the total come close to $100 million additional?

Mr. LILLY. In terms of the options right now and on a very preliminary basis, yes, in the range of $100 million.

Dr. CALIO. That increased estimate is for flying the same mission we had originally proposed with the multispectral scanner and the thematic mapper.

Mr. BOLAND. Are you considering scrubbing the thematic mapper for good?

Dr. CALIO. Yes.

Mr. BOLAND. What was the original estimated cost for the thematic mapper?

Dr. CALIO. The original contract value was about $39 million. The estimate now is about $110 million.

Mrs. BOGGS. Mr. Chairman, could I clarify something in my mind, please?

Mr. BOLAND. Yes.

OPTIONS CONSIDERED FOR THEMATIC MAPPER

Mrs. BOGGS. Are you saying you have the options of the multispectral scanner now and/or the MSS and adding the mapper later——

Dr. FROSCH. We had better describe the three options which are being considered:

One we would call the base line. That is, Landsat-D would have both the thematic mapper and the multispectral scanner (MSS). The old instrument that the users are used to and the new instrument now being developed.

The second option is that we would have no thematic mapper on either, and would just stick with the old instrument. In the planning for the transition with NOAA, we would make the decision on what to do with the new instruments.

Then there is a split option where Landsat-D, the first one in the series to be launched, would have only the MSS and not the mapper; but the second spacecraft, Landsat D, would have both. That would give us the earliest possible launch of a Landsat-D for continuity and give us more time to work out the problems on the thematic mapper. We are looking at all three of these and trying to decide with NOAA which is the best to do in terms of the transition to an operational system.

Mrs. BOGGS. Were there funds requested for added capabilities on the part of the contractors?

Dr. FROSCH. We are concerned about the cost estimate being developed by the contractors. There is a serious problem there which is being looked at now.

Mrs. BOGGS. Thank you.

Mr. BOLAND. What if the Committee made the decision for you and scrubbed the thematic mapper? How much would be freed up in fiscal year 1981? You may supply that for the record.

[The information follows:]

A savings of about $30 million could be realized in fiscal year 1981 by cancelling the thematic mapper and associated ground processing systems.

OPERATIONAL LAND OBSERVING SYSTEM

Mr. BOLAND. On page RD-7-14, the budget revision eliminates the entire $16 million requested for the operational land observing system.

Dr. CALIO. Yes, sir.

Mr. BOLAND. Does that not pretty well knock out any possibility of an operational Landsat?

Dr. CALIO. No, sir.

Dr. FROSCH. The prime responsibility for the operational system rests with NOAA, and they are still looking at the question of what amendments might be necessary with the fiscal year 1981 budget to begin their part. The $16 million in the NASA budget was partly to keep the transition activities going.

Mr. BOLAND. How would you like to relate this to the gamma ray observatory: How does the 1981 outlay for the operational land system, a new effort, compare with the 1981 outlay reduction for the GRO gamma ray laboratory?

Mr. LILLY. The estimate for outlays is $6 million. The estimate for outlays on the GRO is $9 million.

Mr. BOLAND. This program has had a lot of problems, has it not?

Dr. CALIO. Yes, it has. First of all, in definition it had difficulties.

Dr. FROSCH. Which program are you asking about?

Mr. BOLAND. The Landsat program.

Dr. FROSCH. The Landsat program up to date has been mostly successful; in fact, the problems have in part grown out of the success in the sense that it was intended to be very much research and development but is being used before we were able to insure continuity.

Mr. BOLAND. How about Landsat-D?

Dr. FROSCH. Landsat-D has been having a lot of problems, particularly with respect to the thematic mapper and the attempt to get to the new instrument. But the earlier portions of the program have been successful; that is why we are trying to go operational.

Mr. BOLAND. Turn to page RD-7-26, the Agriculture and Research Inventory Surveys through Aerospace Remote Sensing (AgRISTARS) program is described. Would you give us the background on why this program was so controversial in the Senate last year—what the rationale was for cutting it out?

Dr. FROSCH. I can give you an opinion.

Mr. BOLAND. Okay.

Dr. FROSCH. What we are trying to do is introduce a high-technology capability which the Secretary of Agriculture can use in his

attempts to make predictions on which he bases decisions with regard to agricultural programs. I believe there was a feeling that this was somehow in competition with the funds for direct payments in certain agricultural programs and was, therefore, something in controversy. In addition, there was an argument as to whether the original research and development program called LACIE, demonstrated whether this was likely to be successful or not. I think there is no question that it did demonstrate it would be successful and the Secretary of Agriculture is convinced it is. It is not unusual that an attempt to shift technology is attacked.

A $12 MILLION CUT IN EARTH RADIATION

Mr. BOLAND. The earth radiation budget is reflected on page 34 of the amendment. The original request was for $29 million. It was reduced by $12 million in the budget amendment to $17 million. Was that a new start in 1979?

Dr. FROSCH. Yes.

Mr. BOLAND. You requested, as I understand it, $23 million for the program in 1980, originally—but you reduced that by $8 million largely to compensate for the $8.9 million increase in the Landsat program in 1980. Is that correct?

Dr. CALIO. We reduced our original request of $23 million by $6 million for that, sir.

Mr. BOLAND. Now in 1981, you are going to cut the program another $12 million so that the $29 million request will become $17 million. Is that correct?

Dr. CALIO. That is correct.

Mr. BOLAND. What was the original total cost of this program?

Dr. CALIO. $75 to $85 million.

Mr. BOLAND. What will the slip of one year mean in additional costs on this program?

Dr. CALIO. It will add $5 to $10 million, primarily for inflation.

Mr. BOLAND. Counting the cut in 1980 and 1981, what is the total cost of the program estimated at now?

Dr. CALIO. Between $80 and $95 million.

NATIONAL OCEANIC SATELLITE SYSTEM (NOSS)

Mr. BOLAND. On page RD–7–46, the initial request of $5,800,000 for the new National Oceanic Satellite System (NOSS). This $5.8 million is the first step in what will eventually be a $700 million program involving three agencies—NASA, NOAA, and the Department of Defense. The ultimate bill will be paid on the basis of 25 percent by NASA, 25 percent by NOAA, and 50 percent by DOD.

Dr. CALIO. Yes.

Mr. BOLAND. Why was there a decision to split this project among three agencies' budgets?

Dr. FROSCH. It was an OMB decision that, since DOD, NASA and NOAA all benefit from the project, they would like to have the agencies carry the costs in their own budgets. That is the reason for the split.

Mr. BOLAND. What is the justification for this project?

Dr. FROSCH. The examination of the data from SEASAT by NOAA, the Navy, and the users convinced the agencies that by

providing that kind of data regularly, they could provide new services for both civil and military users that would produce new capability and save a good deal of money. Essentially, it is a demand or requirement on the part of the user agencies. NASA is functioning as the research, development, and technology agency.

Mr. BOLAND. Again, let me say that it is difficult to understand why you would start this new program this year when there is not enough money to do the things you would like to do.

Dr. FROSCH. There were three agencies involved. The question was whether all three, in the end, felt there was a national need. The agreement was that there was and that it should be started.

Mr. BOLAND. Why are you proceeding with a request for a project that's going to cost $7-$8 hundred million—wouldn't you rather have that in the Landsat program? Would you not be able to move along more rapidly or resolve some of the problems you have in Landsat rather than funding at the requested level?

Dr. CALIO. The funding at the requested level is sufficient for Landsat. NOSS provides a new technology and valuable capabilities to military and civil fleets at sea, and to research activities.

Mr. BOLAND. Do you have any concern, Dr. Calio, with the fact that three agencies are actually involved in the funding for this project, which means that three Appropriations Subcommittees have to look at it?

Dr. FROSCH. I have a lot of concern.

Mr. BOLAND. Would you not be better off if the funding were all appropriated in the NASA budget, but the DOD share and the NOAA share simply reimbursed to those agencies by NASA?

Dr. FROSCH. From our point of view as a manager, it would be simpler. From OMB's point of view, if we did it that way it would not be clear to them that the other agencies were holding their responsibility.

In any case, presumably if it all appeared in the NASA budget originally, and they had to reimburse, it would have to appear in their budgets, too. I am not sure what possibility you are suggesting, Mr. Chairman.

Mr. BOLAND. It would seem to me where you are responsible for 25 percent, NOAA for 25 percent, and DOD for 50 percent, the amount in this budget is only your part of the cost. If we combine all of that in NASA and you reimburse DOD and NOAA, I would think you would have better oversight on the project dollarwise.

Dr. FROSCH. But I am not sure how the appropriation would look. If they are to reimburse us, it must appear in their appropriation.

Mr. BOLAND. If all the money is in your budget—

Dr. FROSCH. We would then essentially be providing them with the service.

Mr. BOLAND. Would that not be a better and easier way and probably a more effective way of running the program?

Dr. FROSCH. From a management point of view, it would be a simpler way of doing it.

Mr. LILLY. It would obviously be simpler if the money is all in one place where the total management accountability is being held. If you share responsibilities for coming up with requirements which must be honored and yet the money is only in one agency's budget, then that also creates difficulties. To the extent DOD has

unique requirements, there might be some problem. Under the arrangements we have for the NOSS project, Mr. Chairman, NASA will be the manager of system development, under the direction of a tri-agency steering committee. The other agencies, NOAA and DOD, will provide their respective share of total funds required to NASA, the manager.

Mr. BOLAND. In looking at the technology transfer area on page RD–7–50, that request of $12,500,000 is being reduced by $5 million to $7,500,000. Detail for us where this reduction will come.

Dr. CALIO. The break is shown on page 35 in the Budget Amendment.

$29 MILLION REQUEST FOR SPACE COMMUNICATIONS.

Mr. BOLAND. On page RD–7–58, there is a request for $29 million in 1981 for space communications. This was an area the government was supposed to be getting out of—but it appears in the last two years we have been getting into it again. What about that, and why has not any of the reduction been taken in this area?

Dr. FROSCH. This is an area that NASA has been out of. We concluded a couple of years ago that if we continued to be out of it, then U.S. capability in space communications would probably end up considerably behind certain other nations instead of ahead of them, as we have been. We concluded that we should get back into the technology of the space communications business which we did starting with the fiscal year 1980 budget.

This is simply the continuation and buildup of that program. We felt this was extremely high priority in the applications program and in an area where, since we were just starting up but had begun, that it would be very crippling to take any serious decrease.

Mr. BOLAND. It was not possible to take a reduction in this area?

Dr. FROSCH. We felt any reduction in this area would have a very serious consequence on the program.

Mr. BOLAND. On page RD–9–1, the budget details a request of $290,300,000 for aeronautical research in 1981. The recent budget exercise reduced that by $15 million to $275,300,000.

REDUCTION IN AERONAUTICAL RESEARCH BUDGET

Is it fair to say that the aeronautical research effort has been getting a smaller share of the total budget? In 1977, for example, the aeronautical budget was about 6.5 percent of the total and under the revised figures that percentage has dropped to about 6.3 percent.

In view of the fact you actually allocated less to this program in 1981 than you did in 1980, why are you applying any of your reduction here?

Dr. FROSCH. The decrease came about largely because the large expenditures in the aircraft energy efficiency program had begun to taper off. We looked essentially for some cutback in that area to see if there was anything that could stand a cutback, and we found two pieces of the program where we felt that there could be some stretch-out. We simply decided that we could stand that here.

Dr. OLSTAD. I think that is essentially correct. We were able to maintain some new enhancements in the year 1981 budget. We

felt, looking at relative priorities that we could absorb some small additional cut, which is what it is, a fairly small one.

Mr. BOLAND. Last year, at the 1980 original request, you told us that under the ZBB concept, the 1980 budget was under the current services level. After the $15 million reduction, is this budget at the current services level or has it dropped to the minimum level?

Mr. LILLY. It would be below the current level. It is not below the definition used for the minimum level.

Mr. BOLAND. As I understand it, there was $5 million in the 1980 requests for the variable cycle engine work. How much is in the fiscal year 1981 request for this activity?

Dr. OLSTAD. $4.5 million.

Mr. BOLAND. How much is in this budget for supersonic cruise technology work in all areas?

Dr. OLSTAD. A total of about $10 million.

Mr. LILLY. That $10 million does not include the number you gave for the variable cycle engine.

Mr. OLSTAD. That is correct.

Mr. BOLAND. What was last year's level in the supersonic cruise technology area?

Dr. OLSTAD. It was roughly the same. It has been a continuing level of activity.

Mr. BOLAND. How much is in this budget for the energy efficient engine?

Dr. OLSTAD. It is now about $40 million.

Mr. BOLAND. What about the advanced turbo prop program? What does this budget carry for that program?

Dr. OLSTAD. About $3 million.

Mr. BOLAND. I would like to make a comment and don't be distressed. It is impossible to really ask any questions about this section of the budget because you have made wholesale changes in the structure of the justifications so that it is impossible to track it from 1980 to 1981. On page RD-9-2, there is a short sentence which says,"In addition, the aeronautics budget structure has been changed to provide for more effective and efficient program management." That does not include more effective and efficient overview by the Congress. Some comment should probably be made that no changes should be made in the budget justifications of any significance without first checking with the staff of the Committee.

Every other agency before this Committee—we have about 21 of them—does that with the exception of NASA. I think that NASA ought to follow that procedure in this appropriation.

The net result of the changes in the justifications in the aeronautics budget is less detail than last year. As we have pointed out previously, that is going in absolutely the wrong direction. We would like to have this section of the budget resubmitted to the Committee on the same basis that it was presented in 1980 and with the corresponding detail. You can provide that for the record.

[The information follows:]

A review of the work breakdown structure for the OAST programs was conducted as a part of the process of implementing the OAST reorganization in December 1978. This resulted in a change to the OAST budget structure. In the Aeronautics Research and Technology program,the Experimental Programs and System Studies

categories were eliminated. The programs previously included in these categories are now managed in the expanded Systems Technology category.

As requested, the enclosed table presents the fiscal year 1981 Aeronautics budget in the previous structure and in the revised structure. In the Systems Technology areas, we are providing a level of detail below that displayed in the Congressional Budget Book to reflect the crosswalk necessary for you to evaluate our fiscal year 1981 budget request. An alphabetical code has been developed to show the current location of specific programs in the revised work breakdown structure.

FISCAL YEAR 1981 BUDGET IN PREVIOUS AND CURRENT STRUCTURES

PREVIOUS STRUCTURE

	Millions
Aeronautics Research & Technology	$275.3
I. R&T base	131.1
II. System studies	2.6
III. Systems technology programs	90.4
Materials & Structures Systems Technology	9.6
A. Materials for Adv. Turbine Engines	2.4
A. Integrated Prog. for Aerospace Veh. Design	4.0
A. Aeroelasticity of Turbine Engines	0.7
A. Turbine Engine Hot Section Technology	2.5
Propulsion Systems Technology	12.4
B. Adv. Low-Emission Combustion	0.8
J. Variable-Cycle Engine Components	4.5
J. Advanced Turboprop Systems	3.0
B. Helicopter Transmission Technology	1.6
B. Broad Specification Fuels Technology	2.5
Avionics and Flight Control Systems Tech	1.6
E. General Aviation Adv. Avionics	0.1
C. Adv. Guidance & Control Systems	1.5
Aircraft Operating Systems Technology	10.2
H. Terminal Configured Vehicle	7.2
F. Rotorcraft Operating Systems	3.0
Aerodynamic Vehicle Systems Technology	4.6
H. Laminar Flow Control	4.6
Advanced Civil Aircraft Systems Technology	18.9
D. Aeronautical Systems Technology Studies	1.0
H. Energy Efficient Transport	15.3
F. QPLT Systems Technology	2.6
High-Performance Aircraft Systems Technology	18.5
G. Supersonic Cruise Research	10.5
F. V/STOL Systems Technology	3.3
G. Flight Experiments	4.7
Rotorcraft Systems Technology	14.6
F. Advanced Rotor Systems/RSRA Ops	7.9
F. TRRA Flight Investigations	1.7
F. Advanced Rotorcraft Technology	5.0
IV. Experimental programs	51.2
J. Energy Efficient Engine	43.2
G. Highly Maneuverable Aircraft Technology	1.6
H. Composite Primary Aircraft Structures	6.4

REVISED STRUCTURE

Aeronautics Research & Technology	$275.3
I. R&T Base	131.1

	Millions
II. Systems Technology Programs	144.2
A. Materials & Structures Systems Tech	9.6
Materials for Advanced Turbine Engines	2.4
Integrated Prog. for Aerosp. Veh. Design	4.0
Aeroelasticity of Turbine Engines	0.7
Turbine Engine Hot Section Technology	2.5
B. Propulsion Systems Technology	4.9
Advanced Low-Emission Combustion	0.8
Helicopter Transmission Technology	1.6
Broad Specification Fuels Technology	2.5
C. Avionics & Flight Control Systems Tech	1.5
Adv. Guidance & Control Sys. Tech	1.5
D. Aeronautics System Studies	3.6
E. General Aviation Systems Technology	0.1
General Aviation Advanced Avionics	0.1
F. Low-Speed Systems Technology	23.5
Rotorcraft Operating Systems	3.0
QPLT Systems Technology	2.6
Adv. Rotor Systems Tech./RSRA Operations	7.9
TRRA Flight Investigations	1.7
V/STOL Systems Technology	3.3
Advanced Rotorcraft Technology	5.0
G. High-Speed Systems Technology	16.8
Supersonic Cruise Research	10.5
Flight Experiments	4.7
Highly Maneuverable Aircraft Technology	1.6
H. Transport Aircraft Systems Technology	33.5
Laminar Flow Control	4.6
Energy Efficient Transport	15.3
Composite Primary Aircraft Structures	6.4
Terminal Configured Vehicle	7.2
J. Advanced Propulsion Systems Technology	50.7
Energy Efficient Engine	43.2
Variable-Cycle Engine Technology	4.5
Advanced Turboprop Systems	3.0

Mr. BOLAND. Dr. Olstad, we are glad to see you here today.

Dr. OLSTAD. Thank you. I would point out that the estimate I presented in the 1981 budget, 1980 estimates, shown along with them are comparable and cover the same areas.

REDUCTION IN TRACKING AND DATA ACQUISITION

Mr. BOLAND. There are no questions on space research technology, so let's turn to tracking and data acquisition on page RD-12-1—page 46 in the budget amendment—where the original budget request was $359 million and has been reduced to $349 million. That is a larger percent decrease in one year than the Congress has ever made in tracking and data applications. Will that decrease have any significant impact on your programs?

Dr. FROSCH. Essentially, it defers some replacement and maintenance, and gives us some risk of increased breakdown in the system but it is intended not to have a direct effect on programs.

COST OVERRUN OF TDRSS

Mr. BOLAND. Let me make a comment here. The Office of Space Tracking Data Systems continues to have one of the more difficult and expensive programs in NASA—and we are talking about the Tracking and Data Relay Satellite System (TDRSS). The original cost of this program was targeted at about $780 million. The current cost is $1.4 billion and almost a 100 percent overrun—so far. I understand that NASA's Inspector General, Eldon Taylor, who was formerly with the National Science Foundation, is planning a major program audit of TDRSS. Is he here today?

Dr. FROSCH. He is not here. But he is planning to do such an audit.

Mr. BOLAND. He can comment to us for the record on how he is planning conduct the audit. We would like to find out what the major problems are and what he expects to find but more importantly, what he plans to do with the information when be finds it.

[The information follows:]

One of the principal objectives of the new NASA Office of Inspector General organization has been the development of a capability to conduct operations audits of large-scale NASA programs. Heretofore, audits have tended to be limited to small, relatively routine reviews focussed primarily on topics of local interest rather than of NASA-wide or program-wide significance.

The audit of the Tracking and Data Relay Satellite System (TDRSS) is the first such large-scale operations audit to be initiated. This audit will examine NASA Headquarters oversight, project management at NASA filed installations and systems management by the several major aerospace contractors associated with the program. The TDRSS review will be an interdisciplinary effort with auditors, investigators, engineers, and an attorney assigned to the project.

As a joint Government/commercial venture with unusual financing arrangements, the TDRSS program represents a unique experiment for NASA. Audit analysis will assess how well the technical objectives of the program are being met; will review the effectiveness of the TDRSS contractual arrangements and their administration; will examine the adequacy of financial controls and management reporting; and will examine the alternatives and options for the future of the project.

The focus of the audit report will be on providing useful insights for application when considering future complex development programs such as TDRSS. In addition, the audit will comment on the upcoming ten years of TDRSS operations once the development and launches are completed.

The final report of the Office of Inspector General audit of the TDRSS program will be routinely distributed to the Administrator and to key NASA management officials. As a public document, it will also be available to the Congress, to Executive Branch agencies, and to interested private organizations and individuals upon request.

Dr. FROSCH. One comment I would make on the increase is that this program, as you know, is structured as a lease program and so included in the estimate of total costs is interest on funds which will be paid eventually as part of the lease costs. The launch of the satellites has been delayed by the initial launch delays in the Shuttle, and that produces an increase in the interest funds. It also produces an increase due to inflation. A fair chunk of that increase in cost is a combination of those two. Only part of the increase has to do with technical and contractual change.

Mr. BOLAND. This program has experienced about as many problems as any Satellite program—would you agree?

Dr. FROSCH. It has experienced some problems. I think there are some programs that have had worse problems.

Mr. BOLAND. You can detail some of those TDRSS problems for the record.

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[The information follows:]

TDRSS has experienced problems as do all spacecraft during their development. Currently, there are two spacecraft problems which have not yet been totally resolved. These are related to the solar array assembly and the Traveling Wave Tube Assembly (TWTA).

The solar array has suffered some structural cracking in thermal testing. While the cracking has not affected the electrical performance so far, the number of heating and cooling cycles the spacecraft will undergo in orbit as it enters and leaves the Earth's shadow causes some concern regarding long term operation. Due to the difficulty in correctly modeling and analyzing the stresses which occur as the array materials are cycled thermally, other proposed modifications that have been identified by TRW will require further testing before the full implementation for all spacecraft.

The TWTA has experienced a number of manufacturing problems which have prevented the production of flight qualified assemblies. While several problems in tube manufacture and conditioning have been corrected, the yield of flight quality tubes has remained low. the TWTA deliveries for flight spacecraft No. 1 are late. However, a plan for retrofit and re-test has been agreed to by the contractors and NASA. NASA anticipates delivery of qualified TWTA's for the first two spacecraft this summer.

CONTRACTUAL PROBLEMS WITH TDRSS

Mr. BOLAND. This project is funded off-budget through the Federal Financing Bank, and I think it is a classic case of why we should never agree to let the funding go that route. The enormous cost growths are totally without the review of either the Executive Branch or the Congress—particularly under the contract that was negotiated.

Hasn't this project been such a disaster for Western Union that it is now in a very tough commercial situation—actually having to request relief from NASA—but that relief was denied last year?

Dr. FROSCH. I wouldn't say they asked relief in direct terms. They asked whether we would consider restructuring the whole thing in a particular way, essentially allowing them to handle the fiscal aspects in a different way. We were unwilling to do that because it had some legal implications with regard to the government's rights.

Mr. BOLAND. As I understand it, Western Union has now been joined in this program; they have sold off 50 percent of the TDRSS program to Continental and Fairchild.

Dr. FROSCH. That is correct. We are just now in the process of being asked to agree to inovation of the contract to the new partners, and we are in the process of consulting with the other affected agencies, including Treasury.

Mr. BOLAND. Also, hasn't Western Union gone to Hughes and purchased a new Westar and to McDonnell Douglas and committed for a new Delta to launch a backup Westar because TDRSS is so late in getting underway?

Dr. FROSCH. Yes, they have done that, but I have to repeat that the delay in launch of TDRSS is essentially caused by the delay in the Shuttle launch. It is a secondary effect rather than coming directly from TDRSS problems.

Mr. BOLAND. Are there going to be some additional cost increases in this program of significant magnitude because of the Department of Defense's interest in acquiring about 35 percent of the total use time? Are they going to have some special encoding of the data incorporated into the contract which is going to drive the price up even further and if so, who is going to pay for it?

Dr. FROSCH. The Department of Defense has asked that because of their use will be security related changes made to the system. We have responded that we would expect them to pay for those changes caused by their requirements.

Mr. BOLAND. Can you tell us whether or not this project is going to end up in court soon?

Dr. FROSCH. I am not able to say at the present time. Some items are now in dispute before the Contract Board of Appeals.

Mr. BOLAND. Bill Schneider, before he retired as the Associate Administrator of the Office of Space Tracking and Data Systems, indicated that NASA was holding talks with companies to, and I quote, "assess the long-term impact of the new relationship on TDRSS." What is happening in that respect?

Mr. POZINSKY. I do not know what he was referring to.

Mr. BOLAND. That concludes the questions on the budget portion on the NASA hearings. I did want to ask additional questions concerning the recent budget exercise. How do you determine how each of the major areas of NASA applications, aeronautics, space, science, et cetera, would share in the $220 million reduction?

I would like you to provide to the Committee your original ZBB priority rankings to OMB last September—indicating where the line was that the original 1981 budget was based on—and demonstrate how these recent cuts compare with the priority rankings in September.

Dr. FROSCH. I would like to make a comment about that. In essence the process was to give ourselves and give each office a target number which was larger than we thought we would come out with and then get their responses to those target numbers, talk about them with each Associate Administrator, and then go through a cyclical process of trying to put all this together to reach the right target. We essentially did that and had each office do its prioritizing.

Then we tried to do an overall prioritizing and after discussing that with them, arrived at what seemed to be the best consensus on the results.

REPROGRAMMING LANGUAGE

Mr. BOLAND. We want to resolve the problem of reprogramming. When there are changes made we want to know what they are and we would like to have NASA comply with suggestions that this Committee makes.

This is being followed by the other 21 agencies that come to this Committee for appropriation funding. What about this provision which we are thinking about writing into the bill itself. "Funds appropriated by this Act shall be available only to the extent and in the manner set forth in the budget justifications submitted for such funds. Reprogramming of funds in excess of $250,000 or 10 percent, whichever is less, between programs or activities requires prior approval of the House and Senate Appropriation Committees." You wouldn't mind that?

Dr. FROSCH. I am not sure. I would have to look at the numbers. I think the Committee might find that an onerous burden but I am not sure in the sense of the number of actions that would have to be considered.

Mr. BOLAND. If we raised the amount? Do you have a suggestion on this?

Mr. LILLY. Mr. Chairman, the only suggestion I have is that if such a provision were made, I would hope that we would be able to structure our budget estimate detail consistent with contract structure. For example, on a five-year contract for a spacecraft development we were to break that out in the budget in two or three categories, then that would become a limitation within that contract of what the allocation of effort and cost will be in that time period for each of those categories.

That would give us considerable problems in trying to write that kind of enforcement to a contractor. I would have to limit them to exactly those amounts by category as we develop the spacecraft. In that way, it would create a problem in systems managment and holding the contractor accountable for developing and delivering the end item.

If I had an opportunity to structure in a way to accommodate it, I think obviously we could do it.

Dr. FROSCH. That kind of problem would likely lead to costs for a variety of reasons, one of them being that the level suggested would lead to a constant need for consultation with the Committees which are not always in session when contracts are let.

Might I suggest that part of the problem is that we don't completely understand the level and kind of thing that you would like us to bring to the Committee and that it would be very useful if the Committee staff and my staff discussed this so we understood somewhat better what really is being faced.

Mr. BOLAND. We are concerned with the wholesale changes in the programs.

Dr. FROSCH. I understand.

Mr. BOLAND. Oftentimes we wind up with a program that appears to us to be a brand-new program by a transfer of funds within the agency itself.

Dr. FROSCH. No, I think we understand that. But we don't always understand what the Committee perceives to be a program or an activity. We sometimes perceive things as being not clearly programs or activities but things inside programs and activities.

Mr. BOLAND. The staff will discuss it with you.

Mrs. BOGGS.

Mrs. BOGGS. Thank you, Mr. Chairman.

TECHNOLOGY TRANSFER ACTIVITIES

I was wondering about activities in conjunction with other entities of government, for instance, the technology transfer program. You concentrated on completing nine current projects and providing the follow-up technical assistance but completion of six projects scheduled for 1981 will be deferred to 1982. No new regional demonstration projects will be initiated in 1981, and activities associated with transfer of Landsat technology to State governments will continue at a reduced level of effort.

What violence does this do to their own budget considerations in those governmental entities?

Dr. FROSCH. I think the answer is at this point we don't really know because we have not yet talked to them about it. In most of these areas they are programs that are experimental for the State governments at this stage as well as being experimental for us. So I would presume it will mostly affect the rate at which new technology will be introduced into their operations rather than affecting their central budget operations.

TERMINATION OF UNIVERSITY GRANTS

Mrs. BOGGS. Also, I notice that in the university applications activity, at least five university grants will be terminated. That could be disastrous to the budget considerations of the universities. Why were they eliminated?

Dr. FROSCH. When we had decided we had to find the funding decrease there, it had to be taken somewhere and that was the only place we could find.

Dr. CALIO. There are 20 to 22 such programs underway. We normally fund those programs on what we call a three-year grant basis. What this means that is the third year will not be put back in so they will be phased down over a two-year period. It will not be precipitous. We normally carry those programs between three and four years. They are given advanced notice to respond to this action.

Mrs. BOGGS. Thank you. Could you please tell me what the impact will be on the plan to increase production of external tanks by having a $28 million reduction in the rescheduling of the International Solar Polar Mission from 1983 to 1985?

Mr. LUNNEY. We have not spread the $24.5 million over the elements of the program. Some of that would come out of the solid rocket boosters which we are building. Some of it would actually come out of the work that would be done at Michoud Assembly Facility. I don't have an exact number. I would imagine that the effect at Michoud would be about a quarter of that total. It is delaying building. It would be money that we would not spend in fiscal year 1981 that we would begin to spend it in fiscal year 1982.

Dr. FROSCH. It would not appear as a decrease but would appear as a decrease in the rate of increase—if that is clear, a decrease in the buildup.

Mrs. BOGGS. Thank you very much. We are delighted to have you.

Dr. FROSCH. May I make a final comment. I am afraid at times in the hearing it sounded a little as though we had not been cut in this budget amendment. I think it is clear to the Committee and to us that in fact we did have a significant budget cut in fiscal year 1981. We had to hold the Shuttle harmless for obvious reasons. It meant over a $100 million change in the Space Science budget, $50 million in Applications, more than 10 percent. It is not easy. We have had to take our share. I am not sure that other agencies of a similar type have taken as large a cut and certainly I think some of them not as large a cut in some comparable program areas.

I would hope we could hold things pretty much where they are in the budget.

Mr. BOLAND. Thank you very much. The National Aeronautics and Space Administration's justifications will be inserted in the record at this point. The Committee stands adjourned.

[The justification follows:]

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES

VOLUME I

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 BUDGET ESTIMATES

GENERAL STATEMENT

The National Aeronautics and Space Administration, established October 1, 1958, conducts space and aeronautics activities for peaceful purposes for the benefit of all. NASA's activities are designed to maintain United States leadership in aeronautical and space research and technology, and it's utilization. More specifically, the objectives of NASA activities are to:

-- Extend our knowledge of the Earth, its environment, the solar system, and the universe;

-- Expand the practical applications of space technology;

-- Develop, operate, and improve manned and unmanned space vehicles;

-- Improve the civil and military usefulness of aeronautical vehicles, while minimizing their environmental effects and energy consumption;

-- Disseminate pertinent findings to potential users; and

-- Promote international cooperation in peaceful activities in space.

The President's civil space policy announced in October 1978 emphasized a balanced strategy of applications, science and technology development designed to:

-- Emphasize space applications that will bring important benefits to our understanding of Earth resources, climate, weather, pollution and agriculture;

-- Emphasize space science and exploration in a manner that retains challenge and excitement and permits the Nation to retain the vitality of its space technology base;

-- Take advantage of the flexibility of the Space Shuttle to reduce the cost of operating in space;

-- Assure American scientific and technological leadership in space;

-- Increase benefits for resources expended through closer integration of the national space programs;

-- Demonstrate advanced technological capabilities in open and imaginative ways;

-- Foster space cooperation with nations by conducting joint programs;

-- Confirm our support of the continued development of a legal regime for space that will assure its safe and peaceful use for the benefit of all.

The NASA FY 1981 budget recommendation of $5,736.7 million provides for progress toward achievement of these objectives at a pace consistent with a constrained fiscal environment.

Space program elements in the recommended budget provide for progress in development of the operational capability and use of the Shuttle and related systems; in practical application of space capabilities in remote sensing of land and ocean conditions, in atmospheric studies, in materials processing and in communications; in exploration of the solar system and expansion of our knowledge of the universe; and in advancing the technology necessary for United States leadership in space. Major areas of emphasis include:

- Development, qualification and flight testing of the Space Shuttle and manufacture of the orbiter vehicles on a schedule consistent with the requirements of the Department of Defense. The Space Shuttle is progressing toward the initial flight tests, but the final preparations and ground testing required before these flight missions can be confidently undertaken are taking longer and requiring more effort than previously planned. The requirements of the Department of Defense and other Shuttle users, as well as the requirements of the NASA program, make it necessary to proceed as expeditiously as possible in achieving the capabilities of the Space Transportation System. Consistent with these requirements, it is necessary to recommend a Supplemental Appropriation of $300 million for FY 1980. The FY 1981 budget recommendation is based on the assumption that this Supplemental Appropriation will be approved;

- Continuation of the approved flight missions in Science and Applications, but with a revised plan for the Galileo mission to Jupiter to achieve the science objectives using separate launches of orbiter and probe spacecraft in 1984 rather than a combined spacecraft launch in 1982;

- Continuation of the basic and applied research activities essential to future capabilities and leadership in space;

- Carefully selected program enhancements and next step initiatives in the areas of practical applications of space capabilities and scientific exploration of space. Specifically, enhancements and initiatives in the area of practical applications, remote sensing and communications include the National Oceanic Satellite

System in response to both military and civil requirements for remote sensing of ocean data and advanced technical development effort on an experimental wideband communications satellite. In the area of Space Science, development will be initiated on the Gamma Ray Observatory to conduct a comprehensive sky survey of the highest energy region of the electromagnetic spectrum.

Aeronautical research and technology activities in the recommended budget are necessary to advance aeronautical technology to ensure safer, more economical, efficient and environmentally acceptable air transportation systems which are responsive to current and projected national needs; to maintain the strong competitive position of the United States in the international aviation marketplace; and to support the military in maintaining the superiority of the Nation's military aircraft. The FY 1981 program continues emphasis on the fundamental research and technology base in all disciplines vital to aeronautics; on specific technology efforts directed toward major improvements in transport aircraft energy efficiency for operations and on systems technology to provide a basis for improved performance and safety for future vehicles in each major aircraft category. The FY 1981 program also continues and extends focused efforts on aircraft energy efficiency technology to provide the basis for a major reduction in fuel requirements for transport aircraft; on design technology for future quiet, efficient, all weather rotorcraft; on variable flow propulsion technology; and, on other key areas of systems technology. Construction effort is proceeding on two major aeronautical facilities, the National Transonic Facility at the Langley Research Center and the Modification to the 40-by-80 foot Subsonic Wind Tunnel at the Ames Research Center. The facilities, which will considerably enhance the Nation's aeronautical research capability, are scheduled to come on line as operational facilities during FY 1982.

Resources Summary

The budget for FY 1981 has been developed on the assumption that the FY 1980 Supplemental Appropriation of $300.0 million required for the Space Shuttle program will be approved on a timely basis. The total budget authority for FY 1980, including this supplemental appropriation, and a supplemental of $46.3 million requested to cover the increased salary costs that became effective in October 1979 pursuant to Executive Order 12165, totals $5,269.8 million. The budget authority recommended for FY 1981 totals $5,736.7 million with estimated outlays of $5,439.7 million. Civil service staffing levels are planned at 22,613 for the end of FY 1980 and 22,713 at the end of FY 1981.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

BUDGET SUMMARY
(Thousands of Dollars)

	Budget Plan		
	FY 1979	FY 1980	FY 1981
RESEARCH AND DEVELOPMENT			
Space Transportation Systems	2,011,600	2,403,300	2,738,200
Space shuttle	1,638,300	1,886,000[a/]	1,873,000
Space flight operations	299,700	446,600	809,500
Expendable launch vehicles	73,600	70,700	55,700
Space Science	505,400	600,800	668,000
Physics and astronomy	282,900	337,100	438,700
Planetary exploration	182,400	219,900	179,600
Life sciences	40,100	43,800	49,700
Space and Terrestrial Applications	283,900	343,900	394,800
Space applications	274,800	331,800	381,700
Technology utilization	9,100	12,100	13,100
Aeronautics and Space Technology	376,400	427,100	409,500
Aeronautical research and technology	264,100	308,300	290,300
Space research and technology	107,300	115,800	115,200
Energy technology	5,000	3,000	4,000
Tracking and Data Acquisition	299,900	332,400	359,000
TOTAL RESEARCH AND DEVELOPMENT	3,477,200	4,107,500	4,569,500
CONSTRUCTION OF FACILITIES	147,500	156,100	120,000
RESEARCH AND PROGRAM MANAGEMENT	934,069	1,006,186[b/]	1,047,154
TOTAL	4,558,769	5,269,786	5,736,654
OUTLAYS	4,196,472	5,012,600	5,439,700

a/Includes proposed supplemental of $300,000,000 for Space Shuttle.
b/Includes proposed supplemental of $46,286,000 for October 1979 pay raise.

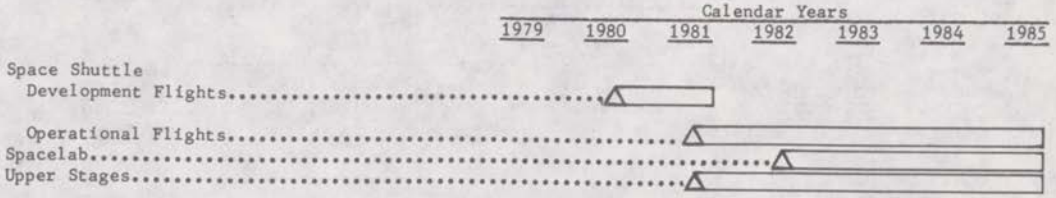
AS 4

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE TRANSPORTATION SYSTEMS

- Develop a versatile Space Transportation System to provide for:
  - -- Expanded capabilities employing the reusable Space Shuttle system
  - -- Manned orbital experiments using Shuttle and Spacelab
  - -- Deep space and geosynchronous mission capability with upper stages
  - -- Orbital placement, servicing and retrieval of automated satellites
  - -- Economy in transportation, space operations, and payload costs
- Continue production to provide a national fleet of Space Shuttle orbiters
- Establish capability for Space Transportation System operations
- Conduct Shuttle orbital flight tests
- Conduct design and verification activities for Shuttle thrust augmentation
- Provide expendable launch vehicle services as required by NASA and other users during transition to Space Transportation System

MAJOR FLIGHT ACTIVITY

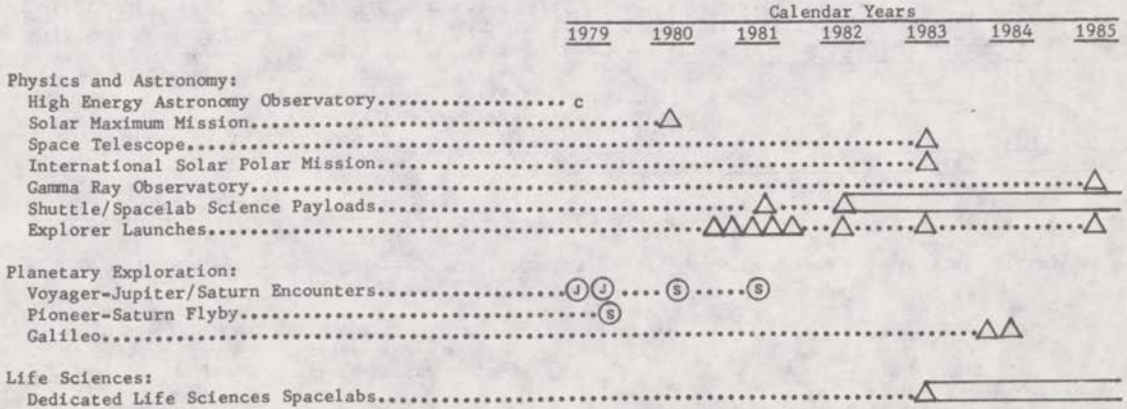


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE SCIENCE

- Increase our understanding of the evolution and nature of the Earth and its environment, the solar system and the universe through a balanced program of space exploration missions and ground-based investigations
- Exploit the knowledge gained from current and completed program efforts by thorough analysis and interpretation of the scientific data obtained
- Utilize the space environment for research in the biomedical, biological, and bioinstrumentation fields

MAJOR FLIGHT ACTIVITY

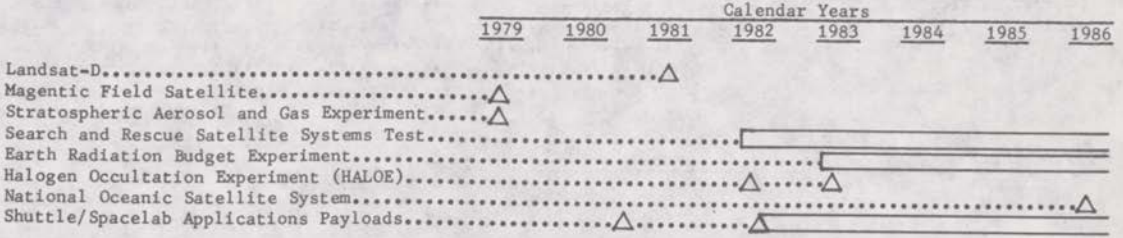


NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE AND TERRESTRIAL APPLICATIONS

- Develop and demonstrate practical uses of space and space-derived technology
  - -- Remote sensing of Earth resources
  - -- Environmental observations from space
  - -- Materials processing in space
  - -- Space communications
- Accelerate the transfer of NASA-developed research and technology advances to public and private sectors

MAJOR FLIGHT ACTIVITY



NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

AERONAUTICAL RESEARCH AND TECHNOLOGY

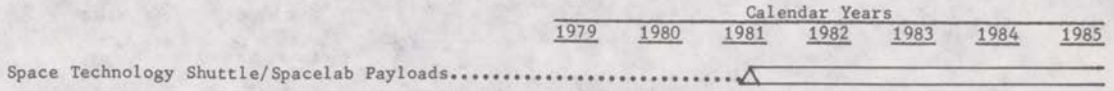
- Provide a technology base for current and future civil and military aircraft to:
  - -- Reduce energy requirements
  - -- Improve performance
  - -- Increase safety
  - -- Decrease environmental effects
  - -- Reduce costs
- Achieve these objectives, by means of ground and flight-based research and technology activities, through advances in the technology areas of:
  - -- Materials and structures
  - -- Propulsion
  - -- Avionics and flight control
  - -- Aerodynamics
  - -- Operations
  - -- Human-vehicle interactions
- Major technology focus:
  - -- Aircraft Energy Efficiency Technology

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SPACE RESEARCH AND TECHNOLOGY

- Provide a technology base to enable and enhance future space activities by:
  - -- Improving performance
  - -- Reducing cost
  - -- Increasing reliability
- Achieve these objectives, by means of ground and space-based research and technology activities, through advances in the technology areas of:
  - -- Materials and structures
  - -- Electronics
  - -- Chemical and electric propulsion
  - -- Space power systems
  - -- Component standardization

MAJOR FLIGHT ACTIVITY



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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

ENERGY TECHNOLOGY

- Energy technology activities to facilitate use of NASA-developed aerospace technologies, experience and facilities to meet the program needs of the Department of Energy and other agencies responsible for energy programs

TRACKING AND DATA ACQUISITION

- Worldwide networks of ground stations interconnected with highly reliable communications to provide support to:

  -- Shuttle Orbital Flight Tests

  -- Automated Earth Orbiting Missions - Covering an average of approximately 40 applications and scientific spacecraft, the support workload will include Nimbus 5, 6, & 7, the Landsat missions, Heat Capacity Mapping Mission, International Ultraviolet Explorer, International Sun Earth Explorer missions, the High Energy Astronomy Observatory missions, the Applications Technology Satellite missions, Magsat, and the International Solar Maximum Mission

  -- Planetary Missions - In addition to seven Pioneer spacecraft, Helios 1 & 2 and Voyager 1 & 2 will also be supported

  -- Sounding Rockets

  -- Aeronautical Flight Research Program

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES

SUMMARY OF APPROPRIATIONS
(Thousands of Dollars)

Appropriations	FY 1979	FY 1980	FY 1981
Research and Development	3,477,200	4,107,500	4,569,500
Basic appropriation	3,292,200	3,807,500	4.569,500
Supplemental for Space Shuttle	185,000	---	---
Proposed supplemental for Space Shuttle	---	300,000	---
Construction of Facilities	147,500	156,100	120,000
Basic appropriation	147,500	156,100	120,000
Research and Program Management	934,069	1,006,186	1,047,154
Basic appropriation	910,500	959,900	1,047,154
Rescission, PL 96-7	-2,400	---	---
Supplemental appropriation for civilian pay raises, PL 96-38	25,969	---	---
Proposed supplemental for civilian pay raises	---	46,286	---
Total	4,558,769	5,269,786	5,736,654

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES

SUMMARY RECONCILIATION OF APPROPRIATIONS TO BUDGET PLANS
(Thousands of Dollars)

Fiscal Year 1979	Total	Research and Development	Construction of Facilities	Research and Program Management
Appropriation, PL 95-392	4,350,200	3,292,200	147,500	910,500
Rescission, PL 96-7	-2,400	---	---	-2,400
Supplemental Appropriation, PL 96-38	210,969	185,000	---	25,969
Unobligated balance lapsing	-261	---	---	-261
Total Budget Plan	4,558,508	3,477,200	147,500	933,808
Fiscal Year 1980				
Appropriation, PL 95-392	4,923,500	3,807,500	156,100	959,900
Proposed supplemental for Space Shuttle	300,000	300,000	---	---
Proposed supplemental for civilian pay raises	46,286	---	---	46,286
Total Budget Plan	5,269,786	4,107,500	156,100	1,006,186
Fiscal Year 1981				
Appropriation request/budget plan	5,736,654	4,569,500	120,000	1,047,154

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES

SUMMARY OF BUDGET PLANS BY INSTALLATION BY APPROPRIATION
(Millions of Dollars)

	TOTAL			Research and Development			Construction of Facilities			Research and Program Management		
	1979	1980	1981	1979	1980	1981	1979	1980	1981	1979	1980	1981
Johnson Space Center	1,306.3	1,470.9	1,575.7	1,151.2	1,302.6	1,400.0	2.2	5.4	5.0	152.9	162.9	170.7
Kennedy Space Center	373.1	457.2	488.4	233.5	300.3	342.0	16.3	25.0	5.0	123.3	131.9	141.4
Marshall Space Flight Center	914.2	1,031.2	1,233.9	747.8	853.0	1,056.8	*17.4	*20.6	*17.2	149.0	157.6	160.4
National Space Technology Laboratories	21.2	23.0	22.4	15.4	16.1	14.5	1.3	2.0	2.8	4.5	4.9	5.1
Goddard Space Flight Center	656.1	699.2	774.5	519.3	560.4	631.0	8.9	3.0	4.2	127.9	135.8	139.3
Jet Propulsion Laboratory	241.2	314.0	313.2	235.1	310.4	306.1	6.1	3.6	7.1	---	---	---
Wallops Flight Center	33.2	37.4	44.5	16.6	17.0	21.9	.8	3.3	3.6	15.8	17.1	19.0
Ames Research Center	248.0	251.6	222.5	141.5	139.7	135.8	43.8	42.1	15.3	62.7	69.8	71.4
Dryden Flight Research Center	33.9	41.6	41.1	13.1	18.2	17.8	1.7	1.7	1.6	19.1	21.7	21.7
Langley Research Center	279.4	304.0	301.9	138.8	164.4	156.0	34.0	23.6	26.7	106.6	116.0	119.2
Lewis Research Center	243.7	276.0	273.9	149.2	170.2	156.8	7.0	8.0	15.7	87.5	97.8	101.4
Headquarters	202.0	345.9	428.9	115.7	255.2	331.3	1.8	---	---	84.5	90.7	97.6
Undistributed Construction of Facilities:												
Various Locations	---	3.8	3.1				---	3.8	3.1			
Space Shuttle Facilities	1.9	---	2.7				1.9	---	2.7			
Rehabilitation and Modification	1.5	---	---				1.5	---	---			
Facility Planning and Design	2.8	14.0	10.0				2.8	14.0	10.0			
Total Budget Plan	4,558.5	5,269.8	5,736.7	3,477.2	4,107.5	4,569.5	147.5	156.1	120.0	933.8	1,006.2	1,047.2

*Includes Michoud Assembly Facility ..... (14.9) (13.2) (13.2)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND PROGRAM MANAGEMENT

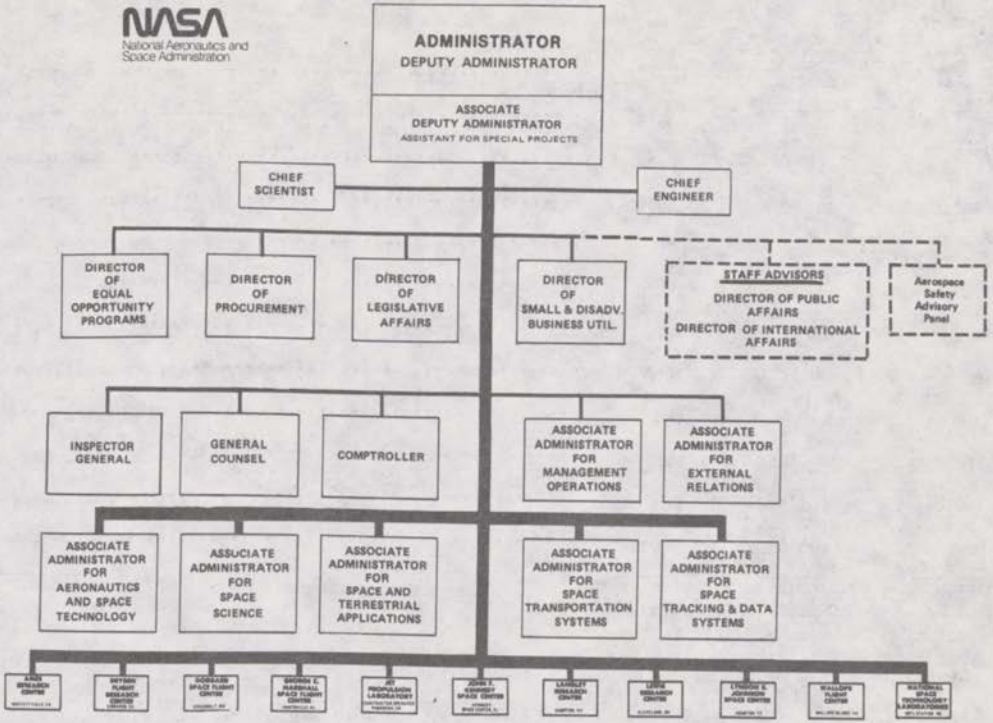
FISCAL YEAR 1981 ESTIMATES

TOTAL NUMBER OF PERMANENT POSITIONS

END OF YEAR

Installation	FY 1979 Actual	FY 1980 Estimate	FY 1981 Estimate
Johnson Space Center	3,504	3,469	3,494
Kennedy Space Center	2,193	2,191	2,201
Marshall Space Flight Center	3,636	3,561	3,561
National Space Technology Laboratories	104	103	103
Goddard Space Flight Center	3,482	3,440	3,440
Wallops Flight Center	398	395	395
Ames Research Center	1,666	1,658	1,658
Dryden Flight Research Center	480	461	461
Langley Research Center	3,005	2,980	2,980
Lewis Research Center	2,858	2,835	2,835
Headquarters	1,505	1,520	1,585
Total, Permanent Positions	22,831	22,613	22,713

AS 14


NASA
National Aeronautics and Space Administration
ADMINISTRATOR
DEPUTY ADMINISTRATOR
ASSOCIATE DEPUTY ADMINISTRATOR
ASSISTANT FOR SPECIAL PROJECTS
CHIEF SCIENTIST
CHIEF ENGINEER
DIRECTOR OF EQUAL OPPORTUNITY PROGRAMS
DIRECTOR OF PROCUREMENT
DIRECTOR OF LEGISLATIVE AFFAIRS
DIRECTOR OF SMALL & DISADV. BUSINESS UTIL.
STAFF ADVISORS
DIRECTOR OF PUBLIC AFFAIRS
DIRECTOR OF INTERNATIONAL AFFAIRS
Aerospace Safety Advisory Panel
INSPECTOR GENERAL
GENERAL COUNSEL
COMPTROLLER
ASSOCIATE ADMINISTRATOR FOR MANAGEMENT OPERATIONS
ASSOCIATE ADMINISTRATOR FOR EXTERNAL RELATIONS
ASSOCIATE ADMINISTRATOR FOR AERONAUTICS AND SPACE TECHNOLOGY
ASSUCIATE ADMINISTRATOR FOR SPACE SCIENCE
ASSOCIATE ADMINISTRATOR FOR SPACE AND TERRESTRIAL APPLICATIONS
ASSOCIATE ADMINISTRATOR FOR SPACE TRANSPORTATION SYSTEMS
ASSOCIATE ADMINISTRATOR FOR SPACE TRACKING & DATA SYSTEMS

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RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

GENERAL STATEMENT

The objectives of the National Aeronautics and Space Administration program of research and development are to extend our knowledge of the Earth, its space environment, and the universe; to expand the practical applications of space technology; to develop, operate and improve manned and unmanned space vehicles; to provide technology for improving the performance of aeronautical vehicles while minimizing their environmental effects and energy consumption; and to assure continued development of the aeronautics and space technology necessary to accomplish national goals. These objectives are achieved through the following elements:

SPACE TRANSPORTATION SYSTEMS: A program to provide all the transportation and related capabilities required to conduct space operations. The major development objective is the reusable Space Shuttle and other elements of a versatile, economical transportation system to provide a wide variety of users with round trip access to space during the 1980's and beyond.

SPACE SCIENCE: A program utilizing space systems, supported by ground-based and airborne observations, to conduct a broad spectrum of scientific investigations. The objective is to advance our knowledge of the Earth and its space environment, the Sun, the planets, interplanetary and interstellar space, the other stars of our galaxy and the universe.

SPACE AND TERRESTRIAL APPLICATIONS: A program, using space, aircraft, and ground-based systems, to identify and demonstrate the useful applications of space techniques in the areas of advanced communications satellite systems technology; materials processing research and experimentation; and, remote sensing to acquire information which will assist in solution of Earth resources and environmental problems. The program includes activities to accelerate the dissemination to both the public and the private sectors of advances achieved in NASA's research, technology and development programs.

AERONAUTICS AND SPACE TECHNOLOGY: A program to conduct the fundamental research and to develop the technology required to maintain United States leadership in aeronautics and space. The program also provides for identification and evaluation of elements of NASA's aeronautics and space technology which can benefit National energy programs.

TRACKING AND DATA ACQUISITION: A program, utilizing a worldwide network, to support deep space, Earth orbital, suborbital and aeronautical activities.

SPACE TRANSPORTATION SYSTEMS

Space Transportation Systems activities provide all the transportation and associated support capabilities required to conduct space operations. These activities currently focus on the development and testing of the Space Shuttle--the first reusable space vehicle and the key element of a versatile, economical Space Transportation System to provide domestic and international users with round trip access to space for the 1980's and beyond.

The Space Shuttle is the most important element of the Space Transportation System. Its versatility and reusability will open up a new era in expanding the uses of space for a wide variety of Earth applications, scientific, defense, and technological activities. The Shuttle will consist of a reusable delta-wing orbiter vehicle with three main engines, an expendable propellant tank, and reusable twin solid rocket boosters. The Shuttle will provide unique capabilities for placement and retrieval of satellites, in-orbit servicing of satellites, and delivery to Earth orbit of payloads and propulsive stages for higher altitude and planetary missions. The advent of readily available, economical transportation to and from low Earth orbit, for automated payloads, as well as for scientists and other personnel will revolutionize our concepts of using space and will expand the returns from space operations. The Shuttle's unique capabilities will not only lower the cost of space operations but will also lead to savings in the costs of payloads. These anticipated savings will result from repair and reuse of payloads and relaxation of weight and size constraints. The advantages offered by the Space Transportation System will enhance both the flexibility and the productivity of space missions compared to existing expendable launch vehicles.

The Shuttle development program is in the final stages of ground certification testing of flight configured elements. The design certification review of the overall configuration was completed in April 1979 validating the basic technical soundness of the Shuttle system design. The major emphasis in FY 1980 will be on preparations for First Manned Orbital Flight. The checkout of the Columbia at Kennedy Space Center is progressing, although the scope and complexity of the initial launch processing flow are greater than originally planned and have caused delays in orbiter flight readiness. Technical problems have also affected progress in the main propulsion system development, and manpower and hardware have been added to the program in an effort to avoid further delays in achieving engine maturity at the rated power level and provide increased confidence in achieving performance at full power level. Other elements of the program are progressing well. The engines and external tank and solid rocket boosters required for the initial flight are in the initial stages of processing at the launch site, and all facilities at KSC are complete and in place for first flight and software validation is in progress. The production of follow-on orbiters is underway with the objective of providing operational orbiters to meet performance requirements for critical Department of Defense and civil missions.

Although the Shuttle development is demonstrating good overall progress, the delays encountered in processing the Columbia for launch and the impact of engine test problems have resulted in adjustments to program schedules requiring additional resources in all elements of the Shuttle system and supporting activities. This situation

has led to the requirement for the recommended supplemental appropriation in FY 1980 and to FY 1981 funding requirements above those previously planned. The FY 1981 Design, Development, Test and Evaluation activities will focus on orbital flight testing of the entire system and main engine testing to achieve full power level of performance. The budget request provides for completion of external tank and solid rocket booster deliveries to support the orbital flight tests, continued launch preparations, checkout and accomplishment of the orbital flight tests, and for continued engine testing. In Shuttle production, fabrication efforts on the second orbiter will be nearly completed and fabrication efforts on the third and fourth orbiter vehicles will be increased for delivery in support of Department of Defense missions at Vandenberg Air Force Base. Engine fabrication for the production vehicles will continue and flight spares for the orbiters' main engine, and ground support equipment will be procured. Additional launch processing equipment for the second line at Kennedy Space Center will be in the manufacturing stage during this time period.

In summary, progress at this critical phase of the Shuttle development effort has been substantial, but technical problems and increased requirements in contractor and subcontractor activities have made it necessary to adjust the program schedules and to request the supplemental appropriation for FY 1980. The FY 1981 budget request, which assumes enactment of the supplemental appropriation in FY 1980, provides for continuation of development, flight testing and orbiter production on a schedule to meet National requirements.

Progress on the Space Shuttle will be matched in other activities vital to the establishment of the Space Transportation System operational capability and to preparations for early operational missions. The Spacelab, which will be a multipurpose laboratory carried in the large cargo bay of the Space Shuttle, will allow scientists, researchers, and technicians to conduct their experiments in the unique environment of space. The Spacelab is being designed and built by the European Space Agency, with ten European nations participating in this development. The Inertial Upper Stage (IUS), which is being developed by the Department of Defense, will be used to deploy Shuttle-launched payloads to high energy and escape orbits. The spinning solid upper stage is being developed commercially and will be used for payloads that do not require the IUS capability. Other development and acquisition activities related to the Space Transportation System include ground support and control equipment, multiuse mission support equipment, and training equipment.

Hardware procurement and other activities in preparation for early Space Transportation System operational missions are in progress. FY 1981 funding will provide for continued procurement, assembly and checkout of the solid rocket booster, external tank, upper stages, and for flight plans, avionics software, flight control systems and crew procedures required for these missions.

Space Transportation Systems activities during FY 1981 will also provide expendable launch vehicles and services, as well as engineering support, required during the transition to the Space Transportation System.

SPACE SCIENCE

The Space Science program utilizes space systems, supported by airborne and ground-based observations, to conduct scientific investigations of the Earth and its space environment, the Sun, the planets, and interplanetary and interstellar space, and the other stars of our galaxy and universe. Results from these investigations significantly contribute to our understanding of the universe, including the key questions of life, matter, and energy and the complex phenomena that have such a profound effect on life and environment on Earth.

The Sun exerts a primary influence on the Earth and its immediate environment. A series of Orbiting Solar Observatory missions have been conducted to study solar phenomena. The discoveries from these missions and from the experiments flown during the Skylab Program provide the foundation for the Solar Maximum Mission to be launched in 1980. The Solar Maximum Mission spacecraft, together with data from Explorer spacecraft and Spacelab missions, will provide scientists with an opportunity to study the Sun, including solar flares and other solar phenomena, during the period of peak solar activity. The International Solar Polar Mission, a joint NASA and European Space Agency mission, will be launched in 1983 to study the polar regions of the Sun--regions which cannot be observed from the Earth or from current spacecraft. To achieve the trajectories required to study these polar regions, two spacecraft will be launched by the Shuttle-IUS combination, will swing past Jupiter, and use the gravity of that giant planet to send one spacecraft over the north pole of the Sun, and the other spacecraft over the south pole. The measurements to be made are expected to yield previously unknown information about the Sun and its dynamics and to advance our understanding of the link between solar activity and weather and climate trends on Earth.

Development of the Space Telescope will continue. This multiple purpose telescope will be launched by the Shuttle in 1983, and will serve as a highly versatile astronomy observatory in space for over a decade. The Space Telescope will greatly expand the volume of space accessible for observation, contributing significantly to our understanding of the origin and evolution of the universe and its energy-generating mechanisms.

The three High Energy Astronomy Observatory missions have been successfully launched and are yielding important scientific information. These missions are designed to explore the high energy phenomena observable with X-ray, gamma ray, and cosmic ray instruments. Work is also underway on Explorer spacecraft to study ultraviolet and infrared astronomy and the Sun-Earth relationships, and on payloads which will capitalize on the unique capabilities of the Space Shuttle and Spacelab.

The recommended FY 1981 program also provides for initiation of the Gamma Ray Observatory, a logical next step in high energy astrophysics. This mission will conduct a comprehensive whole sky survey in the highest energy region of the electromagnetic spectrum, which will advance knowledge of the nuclear processes occurring in the universe, and of the nature and dynamics of pulsars, galactic gamma ray processes, neutron stars and black holes.

Orderly progress in the systematic exploration of the solar system is proceeding. The objectives of this effort are to understand the origin and evolution of the solar system and to better understand the Earth through comparative studies with other planets. Pioneer Venus orbiter continues to provide basic information about the massive cloud covered atmosphere of Venus. The Voyager missions, after providing a wealth of new information about Jupiter and its four largest moons, are on the way to Saturn. The Voyager results have added to our confidence that the Galileo mission to Jupiter will also be a major milestone in planetary exploration. The major effort in FY 1981 will be continued development effort on the Galileo mission which will carry a probe to make detailed measurements of the atmosphere of Jupiter and an orbiter to conduct extensive observations of the planet and its satellites. Because of launch capability considerations, it has become necessary to delay this mission from the previously planned launch during the January 1982 opportunity until the 1984 opportunity and to conduct separate launches of two spacecraft; one carrying the orbiter and the other the probe.

A concentrated scientific effort is underway to analyze and bring to bear on our understanding of the solar system the wealth of data acquired from all relevant sources, including the planetary flight missions, the Helios solar missions, the lunar flight programs, ground-based observations, laboratory investigations, and lunar sample studies.

The Life Sciences research and development program supports NASA's overall goals and objectives in the exploration and utilization of space by conducting studies in the areas of space biology and medicine and by expanding scientific knowledge in the area of the origin and evolution of life. The plan to achieve realization of these goals encompasses a program of research involving a composite of disciplines in ground-based research, in space flight experiments and in post-flight laboratory work building on the results of the flight experiments.

SPACE AND TERRESTRIAL APPLICATIONS

The objective of the Space Applications program is to develop, demonstrate and transfer space technology, systems and related capabilities which can be applied for practical benefits here on Earth. Space Applications research and development covers the areas of Resource Observations, Environmental Observations, Materials Processing and Communications. Technology Utilization activities are designed to accelerate and expand the availability and use of technology developed in all NASA programs into the private and public sectors of the economy.

In Resource Observations, identification and monitoring by means of remote sensing from space have demonstrated new capabilities to provide data useful in such areas as agricultural assessments, water resources management, coastal zone monitoring, improvement of maps, land use and surface mine monitoring, forestry and range resources inventory, and mineral and petroleum exploration. Landsat 3, launched in 1978, is providing a wide variety of data applicable in these areas. Landsat-D, which will have a second generation, high resolution remote sensing instrument--the thematic mapper--and the flight-proven multispectral scanner,

will continue in development leading to launch in late 1981. The Magnetic Field Satellite and the Heat Capacity Mapping Mission continue to provide valuable information for geophysical and geologic studies. Experiments designed to test the applicability of active microwave measurements, and of high resolution imagery for mapping investigations, are planned for flight on early Shuttle missions. Joint activities with the users continue to demonstrate specific applications of the remote sensing data in a wide variety of areas.

The joint effort in agricultural research with the Department of Agriculture, the Department of Commerce, the Department of the Interior, and the Agency for International Development will continue. This effort emphasizes the use of remote sensing data, together with other data sources, to improve our knowledge with emphasis on improved agricultural early warning and crop commodity forecasting.

Space capabilities are also used in the development of precise measurements of the movements of the Earth's crust and other dynamic characteristics of the Earth to support research in earthquake mechanisms. A joint effort with the United States Geological Survey, National Science Foundation, National Geodetic Survey, the Department of Defense, and with other countries, will begin to monitor the motion and internal stability of several major tectonic plates and to determine the crustal deformation in seismically active areas.

In the area of Environmental Observations, NASA is involved with the National Oceanic and Atmospheric Administration and others in improving the understanding of atmosphere and ocean processes, providing space observations of parameters involved in these processes and extending the capabilities to predict environmental phenomena and their interaction with human activities. Areas of research and development include upper atmospheric research; global weather prediction; severe storm research; climate research; environmental quality monitoring; and, oceanic processes research. This integrated approach encompasses the diverse fields of meteorology, climatology, atmospheric chemistry, atmospheric physics, and oceanography. The program focuses on the special contributions space-derived data can make in these fields.

NASA, in cooperation with other Federal agencies, is participating in a national program of climate research. Development will continue on the Earth Radiation Budget Experiment. This satellite system is designed to measure variations in the energy exchange between the Earth's atmosphere and space and other atmospheric factors important to climate research.

A National Oceanic Satellite System (NOSS) project will be initiated, in cooperation with the National Oceanic and Atmospheric Administration and the Department of Defense, to demonstrate an operational capability for application of remote sensing from space to the oceanographic program. The NOSS will be configured as a two satellite system, launched and capable of retrieval by the Shuttle, integrated with a single preprocessing and data distribution center on the ground.

Research and development will also be pursued in environmental quality monitoring and in oceanographic areas related to the remote sensing capabilities of spaceborne systems. Work will be in progress in FY 1981 on atmospheric experiments to be conducted on Spacelab missions.

Materials Processing research and development activities are designed to exploit the unique characteristics of the space environment to achieve results which are not possible or practical on Earth. Experiments are being conducted in laboratories and with sounding rockets to build on the results of tests conducted on previous space flights and to prepare for experiments to be conducted on future Spacelab missions. The FY 1981 program provides for continued development of equipment and related activities for experiments to be conducted on early Spacelab missions and for enhancement of research activities.

Communications research and development efforts concentrate on advanced technology for communications satellite systems with significantly improved capabilities and on providing technical support and consultation to other Government agencies. Development is proceeding on the search and rescue satellite system, a co-operative venture with other U.S. agencies, Canada, and France, to demonstrate improved capabilities for detecting and locating distress signals from aircraft and marine vessels. The FY 1981 program also includes continuation of advanced communications research activities, and definition studies and advanced technology development on an experimental wideband communications satellite to operate in the newly allocated 30/20 GHz spectrum bands.

Technology utilization activities are designed to accelerate the transfer to the nonaerospace industry, as well as State and local governments, of new knowledge and innovative technology generated by NASA and NASA contractors. During FY 1981, NASA will continue its efforts to assure effective and widespread dissemination of new technology through a variety of established mechanisms including publications, industrial applications centers, a computer software management and information center, State technology applications centers, special application teams, and applications engineering projects.

AERONAUTICS AND SPACE TECHNOLOGY

The objective of the Aeronautics program is the advancement of aeronautical technology to ensure safer, more economical, efficient and environmentally acceptable air transportation systems which are responsive to current and projected national needs. This technology is necessary to help maintain the competitive position of the United States in the international aviation marketplace and to aid the military in maintaining the superiority of the Nation's military aircraft.

Research and technology base activities concentrate on the disciplinary areas of materials, structures, propulsion, avionics, aerodynamics and human-vehicle interactions to provide advanced technology essential to meeting the future needs of civil aviation. A strong generic research and technology base is critical to continued growth and improvement in United States aeronautical capabilities. Emphasis will continue to be placed on developing the technology to improve performance, reduce energy requirements, enhance operating efficiency, reduce undesirable environmental effects, improve safety and reliability, and improve terminal area operations for a variety of aircraft types. These efforts are integrated with additional focused technology efforts to develop advanced long haul and short haul air transportation system concepts.

In the area of conventional take-off and landing aircraft, progress will continue on aircraft energy efficiency technology to provide, by the mid-1980's, the basis for a major reduction in fuel requirements for transport aircraft. In addition to efforts currently in progress, the recommended FY 1981 program includes a next step in advanced turboprop system technology to develop and verify propeller structural and aerodynamic scaling methodology for propellers for advanced turboprop propulsion systems.

In the area of rotorcraft, focused systems technology efforts initiated in FY 1980 will be continued. The near term objective is to develop verified design methods and design criteria for future quiet, efficient and all weather rotorcraft and to investigate configuration and component technology for advanced high speed and heavy lift/transport rotorcraft configurations.

Propulsion systems technology activities will include continuation of the variable flow propulsion system technology to develop and demonstrate the critical lower speed and lower temperature technologies unique to variable cycle propulsion systems for possible advanced supersonic cruise aircraft, and development of analytical models and predictive tasks required for designing turbine engine hot section components for increased durability and turbine life.

General aviation activities will focus on the reduction of noise emissions, crash worthiness and advanced low cost avionics systems. Work on vertical take-off and landing technology for potential future military and civil aircraft applications will be continued. Supersonic cruise research will focus on technology in the areas of propulsion, aerodynamics, structures, and controls. Research and technology efforts in the area of high performance aircraft will be conducted primarily in support of current and future military requirements.

The objectives of the Space Research and Technology program are to provide a technology base which will adequately support current and future space activities and to implement approaches for further reducing the costs of future space activities through improvement of components. The program provides a sound foundation of research and technology in the areas of materials, structures, sensing and detection, guidance and control, data reduction and distribution, chemical and electric propulsion, space energy systems and aerothermodynamics.

Systems technology efforts include studies to focus the technology activities in directions which provide maximum benefits to future space programs. Other systems technology efforts are directed at developing the technology for advanced space communications systems and for conducting selected experiments in space. During FY 1981, experiments will continue to be integrated with the Long Duration Exposure Facility which will be maintained ready for integration with the Shuttle. The development and integration of experiments to be conducted on early Shuttle, Spacelab, and free-flying missions will be continued.

In the standards and practices area, emphasis is being placed on completion of standard hardware for use on multiple missions, product improvement through component upgrading, and improvement of program practices, concentrating on such areas as specifications, testing, and flight project analysis. An independent assessment of Space Shuttle certification activities is being conducted.

Energy Technology efforts in NASA are primarily directed toward identifying the technology developed in the aeronautics and space program which has potential for making major contributions to the solution of energy problems on Earth. NASA provides technical support to the programs undertaken by other agencies to develop specific applications such as solar cells, solar heating and cooling, and electric power generation by wind power. NASA also makes its capabilities and facilities available to the Department of Energy and other agencies to accomplish energy technology activities on a reimbursable basis.

TRACKING AND DATA ACQUISITION

This program provides for continuation of tracking and data acquisition support for earth orbital spacecraft, planetary missions, sounding rockets, and research aircraft. This support is provided by a worldwide network of NASA ground stations, interconnected by a highly reliable communications system which provides the capability for instantaneous transmission of data and critical commands between spacecraft and the flight control centers. Facilities are also provided to process into meaningful form the large amounts of scientific, applications, and engineering data which are collected from flight projects.

The FY 1981 workload will remain high, with the Spacecraft Tracking and Data Network supporting an average of approximately 40 earth orbital scientific and applications spacecraft and the Deep Space Network supporting a full complement of planetary missions. Missions supported by the Spaceflight Tracking and Data Network include the High Energy Astronomical Observatories, the Heat Capacity Mapping Mission, Landsat-3, Magnetic Field Satellite, Nimbus-5, International Sun-Earth Explorers, International Ultraviolet Explorer, as well as international missions and missions of other U.S. Agencies. The Spaceflight Tracking and Data Network will also be supporting the Shuttle orbital flight tests. The support workload of the Deep Space Network will continue to include the Pioneer 6-11 missions, Helios 1 and 2 and Voyager 1 and 2 as well as Pioneer Venus.

A major aspect of the Tracking and Data Acquisition program in future years will be the Tracking and Data Relay Satellite System (TDRSS), which will support essentially all earth orbital spacecraft missions and will greatly improve NASA's earth orbital tracking and data acquisition capabilities. NASA will acquire this capability through an arrangement under which the contractor will establish the system and provide NASA with TDRSS services beginning in 1981.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED APPROPRIATION LANGUAGE

Federal Funds

General and special funds:

RESEARCH AND DEVELOPMENT*

*See Part III for additional information.

For necessary expenses, not otherwise provided for, including research, development, operations, services, minor construction, maintenance, repair, rehabilitation and modification of real and personal property; tracking and data relay satellite services as authorized by law; and purchase, hire, maintenance, and operation of other than administrative aircraft, necessary for the conduct and support of aeronautical and space research and development activities of the National Aeronautics and Space Administration[; and including not to exceed $116,100,000 for Project Galileo and not to exceed $18,300,000 for space transportation system upper stages, without the approval of the Committees on Appropriations, $3,807,500,000] *$4,569,500,000*, to remain available until September 30, [1981] *1982. (42 U.S.C. 2451, et seq.; Department of Housing and Urban Development—Independent Agencies Appropriation Act, 1980; additional authorizing legislation to be proposed.)*

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Program and Financing (in thousands of dollars)

Identification code 80-0108-0-1-999	Budget plan (amounts for research and development actions programed)			Costs and obligations		
	1979 actual	1980 est.	1981 est.	1979 actual	1980 est.	1981 est.
Program by activities:						
Direct program:						
1. Space transportation systems:						
(a) Space shuttle	1,638,300	1,586,000	1,873,000	1,588,332	1,601,000	1,897,000
(b) Space flight operations	299,700	446,600	809,500	307,039	412,100	688,000
(c) Expendable launch vehicle development	38,700	36,100	50,400	68,797	41,490	65,700
2. Scientific investigations in space:						
(a) Physics and astronomy	296,400	339,200	438,700	266,450	337,400	387,400
(b) Planetary exploration	183,400	219,900	179,600	189,501	209,300	204,800
(c) Life sciences	40,100	43,800	49,700	29,959	46,500	38,500
3. Space and terrestrial applications:						
(a) Space applications	295,200	364,300	387,000	277,342	362,110	366,100
(b) Technology utilization	9,100	12,100	13,100	7,571	9,800	9,800
4. Space research and technology	107,300	115,800	115,200	94,922	117,100	114,300
5. Aeronautical research and technology	264,100	308,300	290,300	244,275	279,700	302,800
6. Energy technology	5,000	3,000	4,000	6,887	3,700	4,100
7. Supporting activity:						
(a) Tracking and data acquisition	299,900	332,400	359,000	292,653	323,200	355,900
Total direct program	3,477,200	3,807,500	4,569,500	3,373,728	3,743,400	4,434,400
Reimbursable program:						
1. Space transportation systems:						
(a) Space shuttle	46,673	22,820	16,120	29,299	25,990	17,990
(b) Space flight operations	72,762	91,660	157,590	62,579	84,940	144,350
2. Scientific investigations in space:						
(a) Physics and astronomy	1,234	610	510	1,617	790	540
(b) Planetary exploration	10			6	4	
(c) Life sciences	297	233	180	255	230	198
3. Space and terrestrial applications:						
(a) Space applications	137,567	162,330	93,440	114,074	168,340	111,480
(b) Technology utilization	16,132	13,460	13,220	12,235	17,800	13,490
4. Space research and technology	1,055	−20	2	1,460	719	2
5. Aeronautical research and technology	19,763	12,240	−9,870	19,998	15,750	10,600
6. Energy technology	196,311	224,430	275,400	134,489	213,370	267,670
7. Supporting activity:						
(a) Tracking and data acquisition	4,300	4,410	4,668	4,354	4,240	4,680
Total reimbursable program	496,104	532,173	571,000	380,366	532,173	571,000
Total program costs, funded	3,973,304	4,339,673	5,140,500	3,754,094	4,275,573	5,005,400
Change in selected resources (undelivered orders and stores)				115,133	488,991	135,100
10.00 Total	3,973,304	4,339,673	5,140,500	3,869,227	4,764,564	5,140,500

General and special funds—Continued

RESEARCH AND DEVELOPMENT—Continued

Program and Financing (in thousands of dollars)—Continued

Identification code 80-0108-0-1-999

		Budget plan (amounts for research and development actions programed)			Costs and obligations		
		1979 actual	1980 est.	1981 est.	1979 actual	1980 est.	1981 est.
	Financing:						
	Offsetting collections from:						
11.00	Federal funds	−380,871	−412,130	−478,563	−380,871	−412,130	−478,563
14.00	Non-Federal sources	−115,233	−120,043	−92,437	−115,233	−120,043	−92,437
	Reallocation of prior year unobligated reimbursable orders to current year:						
11.00	Federal funds				25,552		
14.00	Non-Federal sources				10,021		
21.40	Unobligated balance available, start of year: For completion of prior year budget plans:						
	Direct				−240,403	−239,006	
	Reimbursable				−116,945	−185,885	
23.40	Unobligated balance transferred to other accounts				680		
24.40	Unobligated balance available, end of year: For completion of prior year budget plans:						
	Direct				239,006		
	Reimbursable				185,885		
25.00	Unobligated balance lapsing				282		
40.00	Budget authority (appropriation)	3,477,200	3,807,500	4,569,500	3,477,200	3,807,500	4,569,500
	Relation of obligations to outlays:						
71.00	Obligations incurred, net				3,408,696	4,232,391	4,569,500
72.40	Obligated balance, start of year				515,865	785,812	1,364,303
74.40	Obligated balance, end of year				−785,812	−1,364,303	−1,789,603
90.00	Outlays				3,138,749	3,653,900	4,144,200

Note.—Reconciliation of budget plan to obligations:

	1979 actual	1980 estimate	1981 estimate
Total budget plan	3,973,304	4,339,673	5,137,400
Deduct portion of budget plan to be obligated in subsequent years	348,368		
Add obligations of prior year budget plans	244,292	424,891	
Total obligations	3,869,227	4,764,564	5,137,400

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET PLAN SUMMARY

Code		FY 1979	FY 1980	FY 1981
		(Thousands of Dollars)		
	SPACE TRANSPORTATION SYSTEMS	2,011,600	2,403,300*	2,738,200
253	Space Shuttle	1,638,300	1,886,000*	1,873,000
253	Space flight operations	299,700	446,600	809,500
253	Expendable launch vehicles	73,600	70,700	55,700
	SPACE SCIENCE	505,400	600,800	668,000
254	Physics and astronomy	282,900	337,100	438,700
254	Planetary exploration	182,400	219,900	179,600
254	Life sciences	40,100	43,800	49,700
	SPACE AND TERRESTRIAL APPLICATIONS	283,900	343,900	394,800
254	Space applications	274,800	331,800	381,700
254	Technology utilization	9,100	12,100	13,100
	AERONAUTICS AND SPACE TECHNOLOGY	376,400	427,100	409,500
402	Aeronautical research and technology	264,100	308,300	290,300
254	Space research and technology	107,300	115,800	115,200
254	Energy technology	5,000	3,000	4,000
255	TRACKING AND DATA ACQUISITION	299,900	332,400	359,000
	Total	3,477,200	4,107,500*	4,569,500

*Includes proposed supplemental appropriation of $300,000,000 for Space Shuttle.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

SUMMARY OF BUDGET PLAN BY SUBFUNCTION

Code		FY 1979	FY 1980	FY 1981
			(Thousands of Dollars)	
253	Space Flight	2,011,600	2,403,300*	2,738,200
254	Space Science, Applications and Technology	901,600	1,063,500	1,182,000
255	Supporting Space Activities	299,900	332,400	359,000
(250)	Subtotal, General Science, Space and Technology	3,213,100	3,799,200*	4,279,200
402	Air Transportation	264,100	308,300	290,300
	Total	3,477,200	4,107,500*	4,569,500

*Includes proposed supplemental of $300,000,000 for Space Shuttle.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES

DISTRIBUTION OF RESEARCH AND DEVELOPMENT BUDGET PLAN BY INSTALLATION AND FISCAL YEAR
(Thousands of Dollars)

PROGRAM		TOTAL	Johnson Space Center	Kennedy Space Center	Marshall Space Flight Center	National Space Technology Laboratories	Goddard Space Flight Center	Jet Propulsion Laboratory	Wallops Flight Center	Ames Research Center	Dryden Flight Research Center	Langley Research Center	Lewis Research Center	NASA Headquarters
OFFICE OF SPACE TRANSPORTATION SYSTEMS, TOTAL	1979	2,013,800	1,095,557	232,554	586,148	12,250	44,052	---	---	10	824	10,835	12,300	17,692
	1980	2,403,300	1,239,650	294,271	840,150	13,100	50,745	200	---	1,400	5,264	14,992	14,998	179,604
	1981	2,736,200	1,314,800	338,200	865,000	10,700	50,400	100	---	700	1,300	9,300	14,300	171,300
Space Shuttle	1979	1,436,300	948,775	156,600	311,594	4,350	---	---	---	10	824	81	200	12,956
	1980	1,886,800	1,098,800	204,800	682,900	7,600	---	---	---	---	1,400	100	---	110,700
	1981	2,073,000	1,104,100	196,900	698,300	5,500	---	---	---	---	700	---	---	157,400
Space flight operations	1979	299,700	145,552	66,154	72,554	5,900	5,550	---	---	---	---	---	---	3,784
	1980	448,600	140,950	87,800	197,350	5,500	7,800	200	---	---	---	100	---	7,900
	1981	609,500	210,700	139,500	436,700	5,200	7,100	200	---	---	---	100	---	11,000
Expendable launch vehicles	1979	77,800	---	9,600	---	---	48,496	---	---	---	---	10,540	12,000	464
	1980	70,700	---	5,671	---	---	48,965	---	---	---	---	7,064	16,892	2,108
	1981	53,700	---	2,800	---	---	43,200	---	---	---	---	3,200	4,300	2,900
OFFICE OF SPACE SCIENCE, TOTAL	1979	505,400	24,177	360	125,099	---	87,048	128,983	7,028	74,323	193	1,052	185	56,765
	1980	600,800	37,148	2,536	155,271	---	83,645	195,484	5,678	58,036	184	100	---	72,502
	1981	660,000	34,381	3,447	177,458	---	111,606	184,600	8,874	53,078	188	33	---	87,945
Physics and astronomy	1979	282,900	346	335	124,275	---	83,299	19,514	7,028	20,401	---	1,052	185	26,665
	1980	357,100	1,713	1,813	155,226	---	79,904	33,450	5,678	12,617	---	34	---	28,836
	1981	438,700	4,191	2,358	177,583	---	117,628	80,977	8,874	8,901	---	37	---	37,951
Planetary exploration	1979	182,400	4,115	---	824	---	3,749	107,898	---	40,861	---	---	---	24,672
	1980	219,800	6,012	---	45	---	3,741	140,067	---	30,853	---	7	---	39,019
	1981	179,400	5,990	---	75	---	3,789	101,877	---	28,160	---	---	---	39,534
Life sciences	1979	40,100	19,716	325	---	---	---	1,770	---	13,061	185	---	---	5,123
	1980	43,800	19,423	723	---	---	---	1,877	---	14,266	164	40	---	7,307
	1981	48,700	22,310	1,129	---	---	---	1,744	---	15,817	188	40	---	8,450
OFFICE OF SPACE AND TERRESTRIAL APPLICATIONS, TOTAL	1979	283,900	24,291	620	24,974	3,199	159,941	23,820	3,118	8,716	34	10,449	5,709	17,239
	1980	345,900	25,430	1,328	29,253	3,040	183,120	20,163	2,715	10,930	37	15,348	11,148	53,864
	1981	384,800	32,140	343	24,480	3,795	189,450	23,560	3,765	14,345	30	13,485	12,750	63,855
Space applications	1979	251,800	24,166	520	24,452	3,189	159,076	22,951	3,114	7,983	---	9,789	5,294	12,314
	1980	331,800	25,330	1,428	28,708	2,960	181,580	18,663	2,915	14,010	---	14,548	10,368	27,779
	1981	281,700	31,990	193	23,950	3,720	186,770	21,870	4,380	10,295	---	12,805	17,000	39,013
Technology utilization	1979	9,100	145	100	562	---	865	569	4	733	34	710	415	4,643
	1980	12,100	100	100	590	100	800	1,700	300	920	37	800	600	5,893
	1981	13,100	150	150	540	75	880	1,990	375	1,430	30	885	750	5,900
OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY, TOTAL	1979	174,400	7,179	---	11,797	---	9,855	23,567	814	58,468	8,903	116,643	131,091	8,683
	1980	427,100	10,560	---	8,367	---	8,844	24,501	600	64,681	13,200	143,682	142,122	10,457
	1981	408,100	8,330	---	9,200	---	9,400	23,350	500	93,300	13,200	139,800	134,700	8,300
Aeronautical research and technology	1979	264,100	1,245	---	1,113	---	---	1,689	814	68,366	8,903	92,171	108,860	5,041
	1980	306,300	499	---	725	---	---	830	600	54,800	13,200	115,800	117,450	4,500
	1981	290,300	700	---	800	---	---	900	500	53,400	13,200	109,900	106,100	3,400
Space research and technology	1979	107,300	5,284	---	9,179	---	9,456	20,858	---	9,804	---	24,472	22,866	4,821
	1980	115,800	10,061	---	6,643	---	8,844	22,673	---	9,881	---	27,882	23,672	6,275
	1981	113,200	8,200	---	7,150	---	9,400	20,800	---	9,800	---	30,000	23,996	5,850
Energy technology	1979	3,000	650	---	1,205	---	---	1,180	---	---	---	---	1,265	720
	1980	5,000	---	---	1,000	---	---	1,000	---	---	---	---	976	22
	1981	4,080	130	---	1,150	---	---	1,750	---	---	---	---	700	150
OFFICE OF SPACE TRACKING AND DATA SYSTEMS	1979	298,900	---	---	---	---	214,551	39,021	5,800	---	3,330	---	---	15,373
	1980	332,400	---	---	---	---	234,000	69,850	6,200	---	5,300	---	---	16,800
	1981	358,000	---	---	---	---	249,700	74,400	9,800	---	3,600	---	---	21,500
TOTAL BUDGET PLAN	1979	3,477,200	1,151,174	233,534	747,818	15,449	519,276	233,091	16,560	142,517	13,114	138,827	149,185	115,673
	1980	4,107,500	1,302,348	300,335	853,963	16,140	560,389	310,360	14,993	139,647	18,291	164,405	170,182	255,233
	1981	4,569,500	1,395,671	342,032	1,056,368	14,495	630,456	306,110	21,939	155,823	17,838	151,972	156,750	331,284

*Includes supplemental request of $300 million.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES

RESEARCH AND DEVELOPMENT BUDGET PLAN FOR SPACE TRANSPORTATION SYSTEMS

Programs	1979 Actual	Budget Plan 1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
Space Shuttle	1,638,300	1,366,000	1,886,000*	1,873,000
Space flight operations	299,700	467,300	446,600	809,500
Expendable launch vehicles	73,600	70,700	70,700	55,700
Total	2,011,600	1,904,000	2,403,300*	2,738,200

*Includes proposed supplemental request of $300,000,000

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE TRANSPORTATION SYSTEMS — SPACE SHUTTLE PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
	(Thousands of Dollars)				
Design, Development, Test and Evaluation	1,270,300	830,500	1,030,500	683,000	
Orbiter	727,800	420,800	560,900	320,900	RD 1-7
Main engine	172,700	140,600	140,600	145,700	RD 1-11
External tank	104,800	68,400	79,400	48,000	RD 1-13
Solid rocket booster	115,400	57,500	61,200	14,000	RD 1-15
Launch and landing	149,600	143,200	188,400	154,400	RD 1-17
Changes/System Upgrading	---	---	100,000	150,000	RD 1-20
Production	368,000	755,500	755,500	1,040,000	
Orbiter	264,500	570,600	572,600	768,200	RD 1-22
Main engine	75,500	109,900	123,600	121,500	RD 1-23
Launch and landing	7,000	20,000	16,400	40,400	RD 1-23
Spares and equipment	21,000	55,000	42,900	109,900	RD 1-23
Total	1,638,300	1,586,000	1,886,000*	1,873,000	

*Includes Supplemental request of $300,000,000.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Distribution of Program Amount by Installation:				
Johnson Space Center	949,775	973,500	1,098,600	1,104,200
Kennedy Space Center	156,600	164,200	204,800	196,900
Marshall Space Flight Center	511,594	427,500	462,800	408,300
National Space Technology Laboratories	6,350	4,000	7,600	5,500
Ames Research Center	10	---	---	---
Dryden Flight Research Center	824	1,500	1,400	700
Langley Research Center	93	100	100	---
Lewis Research Center	200	---	---	---
Headquarters	12,854	15,200	110,700	157,400
Total	1,638,300	1,586,000	1,886,000	1,873,000

OFFICE OF SPACE TRANSPORTATION SYSTEMS

SPACE SHUTTLE PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The Space Shuttle is the key element of a versatile, economical space transportation system that will provide a wide variety of national and international users with round trip access to space beginning in the 1980's. The Space Shuttle will be the first reusable space vehicle, and will be configured to carry many different types of payloads to and from low earth orbit. Its development will provide multipurpose, economical space operations for earth applications, scientific, defense, and technological payloads. The Space Shuttle is, however, much more than just a transportation vehicle. It will offer unique capabilities that cannot be achieved with today's expendable launch vehicles -- to retrieve payloads from orbit for reuse; to service and repair satellites in space; to transport to orbit, operate, and return space laboratories; to transport materials and equipment to orbit; and to perform rescue missions. These capabilities will greatly enhance flexibility and productivity, and result in savings in the cost of space operations.

The Space Shuttle consists of four basic flight hardware elements -- the orbiter, the main engines, an expendable external propellant tank (ET), and twin solid rocket boosters (SRB) -- plus launch and landing systems. The orbiter is the spacecraft portion of the Space Shuttle. Its large payload volume of 285 cubic meters (370 cubic yards) and cargo carrying capacity of up to 29,500 kilograms (65,000 pounds) will permit payloads to be built to less restrictive design requirements. The orbiter vehicle will carry personnel and payloads into orbit to perform their assigned tasks and return them to earth. The orbiter is roughly the size of a DC-9 aircraft and contains three liquid fueled reusable main engines. It can also provide a habitable environment for the crew, which will include scientists and engineers.

MISSION PROFILE:

The Space Shuttle will be launched into space by the thrust of its three liquid oxygen/liquid hydrogen main engines, burning in parallel with the twin solid rocket boosters. Two minutes into the flight, at an altitude of about 45 kilometers (km) (24 nautical miles), the solid rocket boosters will burn out, separate, and descend by parachute to a soft splashdown in the ocean about 260 km (140 nautical miles) downrange. They will then be recovered for refurbishment and reuse. The orbiter will continue on into space, powered by its three main engines, for another six and one-half minutes. Just before orbital insertion, the engines

will be shut down and the external tank will be jettisoned. Following a ballistic trajectory, the empty tank will reenter, tumble, and break up over a remote ocean area about 18,500 km (10,000 nautical miles) downrange. The orbiter, aided by its orbital maneuvering engines, will enter Earth orbit to perform its mission. After completing the mission, the orbiter will again fire its orbital maneuvering engines to deorbit and reenter the atmosphere for its approach and landing.

The Space Shuttle will have a crew of three: the commander, the pilot, and the mission specialist. On some missions, up to four more mission or payload specialists may be added. The crew will experience forces no greater than three times that of gravity (3-g forces) during launch and landing, and will be able to perform their work in a shirt-sleeve environment.

STATUS:

The Space Shuttle Program is in the final period of development toward the first orbital flight (STS-1), expected in the last half of 1980. All Space Shuttle system flight elements have been delivered to the Kennedy Space Center (KSC) for STS-1, other elements are proceeding in test and manufacture, and major ground test programs are being conducted. The Mated Vertical Ground Vibration Test (MVGVT), conducted at the Marshall Space Flight Center (MSFC), was completed early in 1979 using Orbiter 101 (Enterprise), an ET and SRBs, and the data has been used to update dynamic math models of the Space Shuttle system. These mathematical models are being used to predict the vehicle response under vibration during the launch and ascent phases of flight. The test elements used in the MVGVT were delivered to KSC for launch facility verification tests, which were successfully completed. Orbiter 101 was then returned to Palmdale, CA, where it will be used for future tests, removal of critical flightworthy parts, and possible use as part of a facility verification vehicle for the Vandenberg Air Force Base (VAFB). The Main Propulsion Test (MPT) series, which started in 1978 at the National Space Technology Laboratories (NSTL), continued through 1979. This test involves three main engines mounted on an orbiter aft fuselage and coupled to an ET to test the entire propulsion system. MPT progress has been slowed due to failures in testing and necessary engine modifications, but the test activity is now beginning to increase again. A highly successful full-duration MPT static firing test of 550 seconds was conducted on December 17, 1979, which represents accomplishment of a significant milestone. This was the first full duration test of the total propulsion system and it included engine throttling and gimballing. Hardware certification testing is continuing across all elements.

FY 1980 activities support preparations for the first orbital flight. Orbiter 102 (Columbia), which will be used for the Orbital Flight Test (OFT) Program, is in final assembly and checkout at the Orbiter Processing Facility (OPF) at KSC. Thermal protection system (TPS) installation problems have been a major cause for delay in this orbiter final assembly. In 1980, this orbiter will be delivered to the vehicle assembly building (VAB) for assembly with the ET and SRB's to prepare for launch. The orbiter structural

test article (STA) testing was completed by Lockheed at Palmdale, CA, in 1979. The STA was then transferred back to Rockwell International (RI) where it is being modified to become the second flight orbiter (Orbiter 099 - Challenger).

A number of technical problems (i.e., main fuel valve, turbine seal, steerhorn, and incorrect grade of welding wire) have occurred in 1979 during various phases of the main engine test program. A nozzle steerhorn failed as a direct result of using an incorrect grade of welding wire that was too soft and was mixed in with the correct strength welding wire, which resulted in a severely weakened weld joint. However, we have now achieved over 60,000 seconds of test time, and are on our way to the 80,000 seconds, which we expect to reach prior to STS-1. The first phase of the Preliminary Flight Certification (PFC) has been completed with over 5,000 seconds accumulated on one engine, and a second series of PFC testing on a second engine has started. The three engines which will be used for the first orbital flight all completed acceptance test firings, are installed and are undergoing checkout in Columbia at KSC. Modifications will be made to these flight engines early in 1980 to correct recent problems detected during engine testing at NSTL -- steerhorn improvements and a new turbopump.

The first flight ET has been delivered to KSC for use in STS-1, and three other tanks are in various stages of manufacture at the Michoud Assembly Facility (MAF). The fourth solid rocket motor (SRM) development firing and two qualification motor firings were accomplished during 1979. The third and final qualification firing is planned for early 1980. In addition, the SRB components for the first orbital flight were delivered to KSC in 1979.

The flight hardware elements for STS-1 are all at KSC and are progressing well through element processing toward stacking and mating into the overall assembled vehicle. The SRB's are stacked on the mobile launcher awaiting the ET. The ET checkout will be completed and it will be mated with the SRB's during the first quarter of 1980. Columbia, which has been undergoing manufacturing, modifications, and testing throughout FY 1979, is being prepared for mating. Integrated vehicle processing is planned to continue through a flight readiness firing prior to the planned STS-1 launch.

The central computerized Launch Processing System (LPS) and ground support equipment (GSE) in the forward stations of the first line of facilities at KSC are operational and processing the flight elements for the first Space Shuttle orbital mission. Only the launch pad and the SRB retrieval and disassembly stations are still in the activation phase. They will be operational by mid-1980. The primary orbital flight test landing station at Dryden Flight Research Center (DFRC) in California is operational and an alternate landing strip is being prepared at the White Sands Missile Range in New Mexico. The KSC processing test and checkout procedures and software for each station or sequence are being developed and verified.

To establish a national fleet of operational orbiters, Space Shuttle production includes fabrication of two additional orbiters, refurbishment of Orbiter 102 (Columbia), after its use in the orbital flight tests

and early operations, and conversion of the orbiter STA to an operational orbiter (Orbiter 099-Challenger). Also included are the second series of launch and GSE at KSC for the simultaneous launch processing of two orbiters, and initial operational spares and equipment. Activities planned in FY 1980 include: orbiter subsystem hardware fabrication for converting the STA to orbital flight capability, structures fabrication for Orbiter 103 (Atlantis), and main engine hardware fabrication. Procurement of GSE required for the "second line" launch capability at KSC and initial operational spares and crew equipment has been initiated and will continue.

During 1979, a number of important reviews of Space Shuttle Program management were held. Findings included the following: original cost constraints were too severe and reserves were inadequate, schedules demanded more performance than could be delivered, and long-range planning was inadequate. Corrective actions have been implemented throughout the Space Shuttle Program, including management improvements at NASA Headquarters, NASA Centers, prime contractors, and at the major subcontractors.

CHANGES FROM FY 1980 ESTIMATE:

NASA is requesting a supplemental appropriation of $300 million for FY 1980 to meet additional Space Shuttle development requirements and to provide for the potential impact of necessary changes and systems modifications required to increase reliability and safety and to lower operating costs of the space transportation system. The additional development requirements result primarily from increased efforts to complete systems installation and test, particularly the orbiter thermal protection system and prelaunch processing of the first orbital vehicle; systems qualification and certification problems across all elements of the program; and the delay of the first orbital flight test until the last half of 1980. The FY 1981 budget request assumes approval and timely availability of the proposed FY 1980 Supplemental Appropriation.

MAJOR PROGRAM ACTIVITIES PLANNED IN FY 1981:

- Continue main propulsion testing to achieve 109% of rated power performance requirements
- Complete the second set of main flight engines
- Complete delivery of the third and fourth flight sets of solid rocket booster hardware to complete the OFT Program
- Complete delivery of three external tanks for the OFT program
- Complete analysis of the first manned orbital flight (STS-1) for application to the subsequent OFT flights
- Process development hardware at KSC, for the launch of orbital flights 2, 3, and 4
- Continue follow-on orbiter fabrication and assembly leading to a national fleet of operational orbiters
- Reconfigure Columbia for the first operational flight

DESIGN, DEVELOPMENT, TEST, AND EVALUATION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of dollars)		
Orbiter	727,800	420,800	560,900	320,900

OBJECTIVES AND STATUS:

The Space Shuttle orbiter is a reusable launch vehicle which serves as the orbiting spacecraft to deploy and retrieve payloads in low earth orbit and to provide quarters for the personnel. It reenters the atmosphere and lands as an unpowered aircraft, returning crew and payloads. A payload of 29,500 kilograms (65,000 pounds) can be placed in low earth orbit at an altitude of 185 km (100 nautical miles). The physical dimensions of the payload may be as large as 4.6 meters (15 feet) in diameter and 18.3 meters (60 feet) in length.

The Orbiter Columbia was assembled in Palmdale, CA, checked out, and delivered to the Orbiter Processing Facility (OPF) at KSC in March 1979. Considerable open work was transferred with the vehicle. The majority of open work and manufacturing has been completed with the exception of the installation and testing of TPS tiles. Orbiter integrated tests will be completed early in 1980, and the vehicle will be prepared for stacking and prelaunch checkout in mid-1980. The testing required to certify Columbia for the first flight test is scheduled to be completed in mid-1980.

Although the TPS presented the major orbiter problem during 1979, other difficulties were encountered in the auxiliary power units, avionics software, the landing wheels and tires, and structural modifications required by the latest derived loads data. Redesigns, improvements, and corrective actions are proceeding successfully in all these areas.

Tests of the STA, which has a flight type airframe, have been completed by Lockheed at Palmdale, CA. The vehicle has been returned to Rockwell at Palmdale, CA, and is undergoing demating for modifications and updating to the Challenger flight vehicle configuration. Orbiter 101 (Enterprise) completed full-scale ground vibration tests at MSFC, and was used at KSC for facility interface verification. The Enterprise has been shipped to Palmdale, CA, where hardware components will be used as test articles or for flight spares. The vehicle will be configured for facility verification at VAFB.

The overall avionics verification testing is underway at the Space Shuttle Avionics Integration Laboratory (SAIL) at JSC for ascent and at the Flight Systems Laboratory (FSL) at Rockwell in Downey, CA, for entry. Verification tests of various acceptable but off-nominal environment Space Shuttle vehicle equipment conditions, as well as equipment failure conditions, are underway. Initial testing is being conducted with the latest available flight software for the primary and backup flight control systems, and when the final configuration inspected flight software is received, the avionics flight verification testing will be completed. Engineering real-time simulations are being conducted to investigate flight control problem areas derived from structural and wind tunnel testing. Software modifications will be required to implement the changes resulting from the engineering simulations.

Preparations are underway to conduct SAIL testing with the Electrical Systems Test Laboratory (ESTL) at JSC. The ESTL provides real-time data representing both the ground and tracking and data relay satellite systems and communications links to verify that the tracking and communications flight systems in the SAIL function properly with the rest of the avionics system. Combined systems testing is planned at FSL to demonstrate the flight control actuation systems for the aerosurfaces and the main engine thrust vector controls with the Space Shuttle hydraulic system using the FSL--Hardware Evaluator and Flight Control Hydraulics Laboratories. Remote Manipulator System (RMS) verification testing on the guidance and control test stations at SAIL is also scheduled for 1980. Overall avionics verification testing will be conducted at SAIL to demonstrate the suitability of flight crew procedures and mission techniques using qualified flight crew members manning the crew station during verification tests. Final flight software initial conditions for the specific launch day data and vehicle configuration will be demonstrated prior to the STS-1 flight, and landing simulations on the Ames Research Center new moving base simulation facility are planned to provide further verification of the STS-1 landing capabilities and techniques.

RMS activities managed by JSC in FY 1980 will focus upon preparations to define and support RMS flight tests during the OFT. The generation of flight tests documentation will be based upon data analysis of the simulation operations performed during FY 1979, for payload handling, manipulator control, and operator training. The Canadian funded efforts are centered upon the manufacture and hardware acceptance tests (ground) for delivering the RMS in the second quarter of CY 1980, and support to JSC on development of flight test documentation and engineering support to integrate the RMS with

the orbiter at KSC. The change in delivery date of the design, development, test and evaluation (DDT&E) RMS from November 1979 to the second quarter of CY 1980 is due to additional testing and hardware redesign requirements.

Support activities managed by JSC will continue, including: software modifications in the Mission Control Center (MCC), use of crew training simulators, development of government furnished equipment such as space-suits, and the performance of tests to support the orbiter project. The emphasis for FY 1980 is on preparation for the OFT's.

We have accelerated the development of the Manned Maneuvering Unit (MMU) in order to have on-orbit inspection and repair capability for the TPS. A qualification unit and two flight articles will be produced, and crew training will begin on the contractor's simulator (Martin Marietta Corporation, Denver, CO). The MMU and associated equipment will be required in January 1981. It is not required for the first flight since the flight is designed for a benign environment and each tile will have been verified to safety factors of at least 1.4 times the full operational requirement.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The FY 1980 orbiter estimate has increased by $140.1 million. This increase resulted from the additional engineering and subcontractor activity due to problems encountered in the qualification and certification programs and the additional effort required to complete the application and testing of thermal protection tiles, and other subsystem installations at KSC. There have been a number of major changes such as on-orbit TPS repair and a heads-up display, as well as numerous changes required to make the system operate properly as determined by the comprehensive test programs. In addition, there have been a number of subcontractor cost increases due to development and producibility problems. Examples include: TPS tiles, auxiliary power unit, orbiter maneuvering system pod, the KU-band rendezvous radar, S-band communications subsystems, and extravehicular suit development. Other funding increases have been experienced in support areas caused by schedule delays, and in systems areas due to additional vehicle system testing planned for FY 1980.

BASIS OF FY 1981 ESTIMATE:

The OFT Program, using Columbia, is planned for initiation in the last half of 1980 with the first manned orbital flight (STS-1). Post flight analysis of this first flight will be conducted, and engineering will be provided to support follow-on development flights. Orbital flights are planned on an average of every three to four months. The OFTs are expected to continue throughout FY 1981.

During STS-1 final countdown and flight, the SAIL and FSL will be configured to provide real time support to the mission. In addition, these facilities will be used to analyze flight data, prepare analysis for post-flight reports and to investigate flight anomalies. Specific avionics verification programs will be conducted for each OFT to confirm the avionics operation with primary and backup flight software in the new configurations. These include operations of the RMS, KU-band radar, the Tracking and Data Relay Satellite (TDRS), and payloads' operations. Specific testing to verify the operation of the Space Shuttle avionics system with the Inertial Upper Stage (IUS) and its payloads will also be conducted. Flight support and post-flight analysis will be conducted for each subsequent orbital test flight. Testing and analysis of some specific mission operations involving vehicle maneuvering, extravehicular activity and payload operations will be conducted at SAIL and FSL to verify the avionics system support of the missions plans. A number of avionics equipment and flight software improvements have been identified to be incorporated during the OFT Program and early operational flights. The software deliveries are phased to be commensurate with avionics improvements and mission requirements. Each of these improvements will also be verified on SAIL and FSL.

The support activities necessary for each orbital flight will continue in FY 1981. The MCC will support integrated simulations with the Space Shuttle Mission Simulator to train the flight crews and flight controllers for these orbital flights.

Each development flight is a test to progressively support the verification of the Space Shuttle for operational use. Design certification and flight readiness reviews will be conducted before each flight to assure that there are no constraints to the specified flight mission assignment. The orbital tests are necessary to verify hardware and software operation, ground and flight procedures, system characteristics over a range of conditions, primary and backup operational modes, and overall performance. Flight test data on the systems performance will be reviewed after each flight and corrective action taken, where necessary, to meet operational requirements. Throughout the development flight test program, engineering will be provided to perform this analysis, resolve problems, and verify systems operations. These FY 1981 efforts will lead to the certification of the Space Shuttle's readiness to enter the operational phase in FY 1982:

MAJOR PROGRAM ACTIVITIES PLANNED IN FY 1981:

- Complete orbiter analysis of the first OFT (STS-1)
- Support OFT flights 2-4 in preparation, data analysis, engineering, and incorporation of necessary changes
- Complete certification of Orbiter 102 flight readiness for follow-on OFTs
- Deliver Mission/MOD kits for specific orbital flights
- Continue life demonstration tests on critical orbiter subsystems
- Develop improved TPS for follow-on operational vehicles

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	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Main Engine	172,700	140,600	140,600	145,700

OBJECTIVES AND STATUS:

The Space Shuttle orbiter will use three high pressure liquid hydrogen/oxygen engines, each with a 2,100,000 newton (470,000-pound) vaccum thrust level. The Space Shuttle Main Engine (SSME) represents a major advance in propulsion technology, and incorporates maximum utilization of existing technologies. In addition, it has the advantage of a long operating life. It is the first large liquid fuel rocket engine designed to be reusable, and will require minimum maintenance between flights. An engine-mounted controller is used to ensure operation within the limits of the high temperatures and pressures in the combustion cycle. Performance has been increased by using a two stage combustion process with a high expansion ratio nozzle, which results in more efficient engine operations.

During FY 1979, problems with several main engine components continued to delay the test program causing the main engine project to accumulate fewer test seconds than planned. Engine development testing was proceeding at a good pace until a nozzle steerhorn failure (May 14, 1979) destroyed most of the internal parts of Engine 0201. A main fuel valve failure on a Main Propulsion Test Article (MPTA) Engine 2002 (July 2, 1979) caused further temporary suspension of testing. During main propulsion testing (November 4, 1979), an early shutdown was initiated when a high pressure oxygen turbopump (HPOTP) turbine seal failed on Engine 0006. During the shutdown, another nozzle steerhorn failed destroying most of the internal parts of Engine 2002. An investigation determined that the second steerhorn failure was the result of a "soft" weld caused by use of the incorrect grade of welding wire mixed in with the correct strength welding wire. Failure modes and causes of these failures (main fuel valve, nozzle steerhorn, HPOTP turbine seal) have been identified, modifications incorporated, and testing resumed. Another engine has been assigned to the MPT Program. The successful full duration MPT test lasting 550 seconds (December 17, 1979), represented a significant milestone in the main propulsion development program. As a result of the problems during 1979, completion of the MPT Program in support of STS-1 has slipped to mid-1980.

In spite of these problems, progress this year has been significant. The first certification cycle of the Preliminary Flight Certification (PFC) program was completed. Sixteen tests were conducted for a total of 5,245 seconds on Engine 2004. This included four flight mission profile tests of 520 seconds, one flight mission profile over-stress test (102% rated power level (RPL), and two abort mission simulations of 665 and 823 seconds. A repeat of the PFC program is now in progress on the same engine (2004).

Seven of the thirteen objectives have been accomplished with a total of 3,000 seconds accumulated to date. A total of four PFC cycles will be conducted on two or more engines with at least two certifications on one engine. To date, a total of approximately 530 tests have been conducted accumulating over 60,000 seconds of operation with about 175 tests and over 28,000 seconds at RPL. This past year, we conducted about 130 tests and accumulated over 22,000 seconds of operation with about 100 tests and over 17,000 seconds at the RPL. Thus, over 77% of the test seconds accumulated this past year has been at RPL or higher. Much of the time not at RPL is start transient time and throttling time to various power levels to determine engine performance at the lower power levels.

Testing will continue on flight configured engines during 1980 leading to the main engine flight certification for STS-1. It is planned to accumulate approximately 80,000 seconds of test time prior to flight including: single engine, main propulsion testing, and PFC testing. The MPTA, consisting of a cluster of three engines, a flight-weight external tank, and the aft fuselage of the orbiter, is maintained in the STS-1 configuration and will continue in testing during the fiscal year. Data from main propulsion testing will constitute a part of engine verification. PFC testing will be completed accumulating approximately 20,000 seconds on two or more engines. Single engine testing will also be intensive to prove the durability of each component of the system. Full power level (FPL-109% of RPL) testing will start late in FY 1980. By mid-1980, all engine modifications will have been incorporated in the flight engines installed in Orbiter 102 to support the flight readiness firing and the first orbital flight.

In addition to the development and test work by Rocketdyne and the subcontractors, the main engine activities provide the necessary project support efforts. These efforts include the procurement of propellants for test firing the engine and its components, the maintenance of the engine systems hardware simulation laboratory, logistic support, and the evaluation of materials and processes.

BASIS OF FY 1981 ESTIMATE:

During FY 1981, continuing support will be provided for the OFT. This effort will include a full complement of component and full engine test capability and analytical support for the flight conditions. Single engine testing will continue in order to accomplish PFC of the engine at FPL. During the certification program, the engine must demonstrate reliability and performance at 109% of rated power. The last two MPTA tests are scheduled for FY 1981 to demonstrate this 109% power level operation of three engines in a cluster. FY 1981 main engine funding will also support the engine system simulation laboratory, engine software integration, and procurement of propellants for the test programs at Santa Susana and at NSTL.

MAJOR PROJECT ACTIVITIES PLANNED IN FY 1981:

- o Continue engine testing to achieve final flight certification at FPL
- o Complete fabrication and delivery of the second set of flight engines
- o Provide laboraboty, test, and analytical support for the OFT Program

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
External Tank (ET).....	104,800	68,400	79,400	48,000

OBJECTIVES AND STATUS:

The ET will contain all the propellants for the orbiter's three main engines -- liquid hydrogen as the fuel, and liquid oxygen as the oxidizer. The liquid propellants are consumed by the orbiter's main engines from liftoff to main engine cutoff, which occurs just before orbital insertion. Following the main engine cutoff, the ET will separate from the orbiter and tumble through a ballistic trajectory to break up over a designated remote ocean area. The ET is a single assembly approximately 8.5 meters (27.5 feet) in diameter, and 47 meters (154 feet) long. It will contain approximately 700,000 kilograms (1.55 million pounds) of propellant at liftoff. The liquid hydrogen volume is 1,530 cubic meters (54,000 cubic feet) and the liquid oxygen volume is approximately 565 cubic meters (20,000 cubic feet).

During 1979, structural testing of the liquid hydrogen tank was successfully accomplished at MSFC. The ground vibration test tank was shipped to KSC where it was mated to a set of inert SRB's and the Orbiter Enterprise for a thorough checkout of the launch facilities, GSE, and supporting interface equipment. The tank was then shipped to MAF for storage and eventual reuse as a flight tank after modifications are accomplished.

During the summer, a design change was implemented to prevent the formation of ice on the tank protuberances which if dislodged during ascent could damage the orbiter tiles. This will be accomplished by a newly designed KSC ground purge system and the addition of spray-on foam insulation (SOFI) and electrical heaters around the potential ice forming areas. The determination of aerodynamic crossflows from the SRB's, and newly defined air loads which could exceed the cable trays' structural strength, will be resolved by the addition of large SOFI ramps. The first flight tank, delivered to KSC in mid-1979, is in the process of having these changes incorporated, including the ice/debris and air load SOFI ramps. It is expected that all modifications will be completed in early 1980.

The second flight tank is in the process of having its TPS applied. Delivery to KSC of this tank is planned for the third quarter of 1980. The third and fourth flight tanks will be structurally assembled, the TPS applied, and readied for shipment to KSC during the year. Deliveries of these two tanks will take place in FY 1981.

During FY 1980, a major engineering effort will be expended on the lightweight tank (LWT) design. The goal of reducing the weight of the tank by 6,000 pounds will be achieved by optimizing the thickness of the basic skin, ribs, and chords of the intertank, liquid oxygen, and liquid hydrogen tanks. Early in FY 1980, 20% of the LWT design had been released for raw material ordering and vendor fabrication of components. A preliminary design review was held during this quarter, and a critical design review is planned for May 1980 which will support the delivery of the first LWT before the end of 1981.

In FY 1980 efforts are being undertaken to improve the producibility of the ET. The basic objective is to develop new techniques and processes to build the ET more efficiently, and more economically. Areas of activity include improved welding techniques and an automated inspection system; an alternate foam material for the liquid hydrogen tank aft dome; and improvements in tank priming, cleaning and protection. In the thermal protection area, SOFI, and ablator improvements are being developed, and improvements in the forming and chemical milling processes have started.

At the beginning of FY 1980, the liquid boost module was selected as the thrust augmentation baseline concept to achieve increased ascent performance capability for the Space Shuttle. This concept employs Titan hardware (engines and modified propellent tankage) mounted under the ET. Since this liquid propulsion module impacts the ET structure of the liquid hydrogen tank, design studies were initiated in FY 1980 which will continue into 1981.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The ET estimate for FY 1980 has increased by $11.0 million. This increase was principally caused by changes, particularly to protect against protuberance icing and to accommodate additional air loads data. The ET project cost also grew because of increased estimates to perform weight reduction and the additional ET producibility efforts.

BASIS OF FY 1981 ESTIMATE

The third and fourth development tanks will be in the final phases of assembly and checkout at MAF with deliveries planned for the first half of 1981. Design modification efforts of the LWT will peak during the year. This work will result in optimizing to reduce the amount of material in the major structural elements of the ET while still keeping manufacturing costs low. Producibility improvements

in assembly and manufacturing techniques will be a major engineering effort during the year in order to reduce operational costs. ET design studies for thrust augmentation to accommodate the liquid boost modules will also be in progress in FY 1981.

MAJOR PROJECT ACTIVITIES PLANNED IN FY 1981:

- o Deliver last two development ET's (ET-3 and -4)
- o Complete final ET installation at KSC for STS-2, 3 and 4
- o Evaluate flight data performance (STS-2 and -3 flights)
- o Continue designs for:
  - Lightweight tank
  - Producibility improvement
  - ET thrust augmentation

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Solid Rocket Booster (SRB).....	115,400	57,500	61,200	14,000

OBJECTIVES AND STATUS:

The Space Shuttle propulsion system includes two reusable SRBs which burn in parallel with the orbiter main engines at launch to provide the necessary thrust from liftoff to booster staging. Each SRB weighs approximately 583,600 kilograms (1.29 million pounds) and delivers approximately 11.6 million newtons (2.6 million pounds) average vacuum thrust. These boosters are approximately 3.6 meters (12.2 feet) in diameter and 45.5 meters (149 feet) long and are attached to the ET. After burnout, at an altitude of about 45 kilometers (150,000 feet), they separate from the ET. The SRBs will descend by parachute and land in the ocean about 260 kilometers (140 nautical miles) from the launch site. They will be recovered by ship and returned for refurbishment and reuse.

The main element in the SRB system is the Solid Rocket Motor (SRM), which is being developed by Thiokol, Wasatch Division, Utah. Other booster system elements such as the recovery system , Thrust Vector Control (TVC), attach structures, forward and aft skirt, and separation motors are being procured separately. MSFC is performing designated systems integration tasks, and has the responsibility for total systems integration of the SRB effort.

In 1979, the booster separation motor qualification test firings were successfully completed, and the flight motors for the first two OFTs were delivered to KSC. The structural test program, to verify the major structural elements for flight loads, were completed during 1979, and water impact loads testing started. These tests are scheduled for completion early in 1980. Fabrication of the flight structural components is progressing very well. Delivery of the major structural components to KSC required for the four OFTs has been completed. Fabrication of the parachutes for the orbital flights is continuing with the flight sets for the first two flight missions delivered to KSC. The TVC systems testing was completed at MSFC to verify the overall performance characteristics, and successful TVC system operation was completed during the SRM test firings at Thiokol. The TVC systems for STS-1 have successfully completed hot firing and are installed on the flight aft skirts. The booster assembly contractor has been actively involved with the assembly and checkout of the boosters for STS-1, and they have delivered the hardware to the VAB high bay area for stacking.

The component qualification test program for all the SRB major systems has progressed satisfactorily with approximately a 75% completion of the qualification testing required for the first flight. The total test program is scheduled for completion in early 1980. During 1979, the fourth and final development motor was loaded and test fired. Two of the three SRM qualification tests of the flight configuration have been successfully fired, and the third will be tested in early 1980. All SRM segments for STS-1 have been delivered and stacked at KSC.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The SRB estimate for FY 1980 has increased by $3.7 million. This change was caused by cost increases in the SRB subsystems, qualification test problems, and technical changes; as well as DDT&E flight hardware delivery delays to support the slipped development flight schedule.

BASIS OF FY 1981 ESTIMATE

Manufacture and assembly of flight hardware for the DDT&E flights will continue through 1980. The booster assembly contractor will assemble and checkout the SRB's for all the flight missions, and will be involved with the refurbishment and checkout of recovered hardware for use in all orbital development flights continuing into 1981. During FY 1981, the major activities will consist of the assembly and checkout of the boosters for the orbital development flights, and the refurbishment and checkout of recoverable hardware. The capability to verify the acceptability of refurbished hardware for reuse will be completed. An OFT flight utilizing refurbished hardware will also be accomplished during 1981.

MAJOR PROJECT ACTIVITIES PLANNED IN FY 1981:

- o Complete delivery of all OFT hardware
- o Complete assembly and checkout of flight SRB's at KSC for OFT Program
- o Refurbish and launch first reusable hardware flight set
- o Continue production efficiency and cost improvements plan

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
			(Thousands of Dollars)	
Launch and Landing.....	149,600	143,200	188,400	154,400

OBJECTIVES AND STATUS

The Space Shuttle launch and landing project includes the preparation of a series of Space Shuttle landing, ground processing, and launch station sets at KSC and the DFRC and their operation through the OFT phases. These station sets include: handling, testing, and servicing systems; and GSE. The Launch Control Center (LCC) at KSC contains the heart of the computerized automated Launch Processing System (LPS), which connects to many of the station sets for remote monitoring and control of the vehicle testing, servicing, checkout and launch processing. In addition to the landing facilities at KSC and DFRC, landing support facilities are planned for construction at the White Sands Missile Range, New Mexico, to provide a backup lake bed landing site for early OFTs.

Activation of the various launch and landing station sets has been paced to match the flight hardware development, certification, and readiness for flight. However, the launch support team has been fully implemented, and all personnel are on board and engaged in prelaunch checkout. The Space Shuttle landing stations at DFRC and KSC, and the OPF and LPS at KSC were activated in FY 1979, and were operational at the beginning of FY 1980. The mobile launcher, parachute packing, propulsive element checkout (SRB, ET, SSME), and vehicle assembly stations in the VAB were activated in the first quarter of FY 1980. The launch pad and SRB retrieval and disassembly station are progressing on schedule toward activation and operational status in the third quarter of FY 1980. A second firing room and LPS control set will also be activated in FY 1980 to allow the development and checkout of ground test software in parallel with vehicle testing. During FY 1980 construction of facilities at White Sands is being accomplished to handle the orbiter processing in event of landings at that site.

Delivery and installation of most of the required KSC GSE was completed during FY 1979 and early FY 1980. About 98% of the required KSC provided GSE (approximately 290 models) and 90% of the contractor provided GSE (approximately 680 models) have been delivered and installed in the processing stations. Both GSE and flight systems replacement spares are being laid in, processing fluids are being supplied to support checkout and testing, and propellants are being accumulated for the first launch.

The processing station activation remaining for FY 1980 includes the completion of activation of the launch pad and SRB retrieval and disassembly stations. The fuel cell and hypergolic propellant loading systems are still in the test certification phase, an ice protection and purge swing arm is being installed at the launch pad, and the remaining GSE is being implemented on schedule.

The major portion of launch and landing work now is the operation of the station sets and the processing and launch of the flight hardware. Processing includes test and checkout of the individual flight elements, stacking and mating of the elements to assemble the overall space vehicle, and testing, servicing, and launching the vehicle. The development contractors which provide on-site launch support include Rockwell International, Martin Marietta, United Space Boosters, Inc. and Thiokol.

The Orbiter Columbia has been in processing in the OPF since its delivery to KSC in March 1979. It was delivered without some flight systems and TPS tiles installed, and has since been undergoing manufacturing completion in parallel with systems testing. Most systems have now been tested. Some qualification and certification tests have been performed, and some performance and integration tests remain to be completed. The first flight ET was delivered in July 1979, and it is now being processed in the VAB. The first set of flight SRB's, which were delivered in November and December 1979, have undergone subassembly of skirts and nose frustrums to motor segments and stacking on the mobile launcher in the vehicle assembly station in the VAB.

The vehicle processing still to be accomplished in FY 1980 includes: completion of fabrication and testing of the Orbiter Columbia, mating the ET, orbiter, and SRBs; and processing the mated vehicle through vehicle interface test, flight readiness firing, countdown, and launch. After launch, the SRB's will be retrieved and disassembled for refurbishment and reprocessing. The orbiter will land at DFRC after the STS-1 mission, be deserviced, then mated with the carrier aircraft and ferried back to KSC; where it will be inspected, repaired, and reprocessed including the replacement of a number of TPS tiles. Other flight elements will be processed for STS-2 during FY 1980, and work on the turnaround of Columbia will be initiated immediately after STS-1.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The primary reason for the $45.2 million increase in the budget for the launch and landing project is the additional time and effort required to prepare for the launch of STS-1. This additional effort has impacted the funding requirements because Orbiter 102 has been in processing in the OPF longer than planned, while the test and checkout phase of launch preparation is being completed. In addition, the test and checkout phase is proving to be more complicated and require more manpower than had originally been estimated. The capacity of the LPS computers required expansion, and many changes necessary to make the ground system operate properly continued to be required to prepare GSE for operational use.

BASIS OF FY 1981 ESTIMATE:

During FY 1981, the principal activities in the launch and landing project will focus on processing flight elements and vehicles for STS-2 through STS-4. The fiscal year effort should start with the assembled space vehicle for STS-2 in the VAB, proceed with interface testing there, and then the full processing procedure at the pad. This FY 1981 processing activity is supported with the LPS, logistics, transportation, propellants, and spares provisioning. There are also provisions for facility and equipment modifications and required changes throughout this development period.

MAJOR PROJECT ACTIVITIES PLANNED IN FY 1981:

- o Complete space vehicle processing and launch for STS-2
- o Perform element and space vehicle processing and launch for subsequent OFT missions
- o Retrieve reusable flight hardware from OFTs

CHANGES AND SYSTEMS UPGRADING

	FY 1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Changes and Systems Upgrading	-	-	100,000	150,000

OBJECTIVES AND STATUS:

Recent management and cost reviews at various levels throughout the Space Shuttle Program at NASA and with major contractors have emphasized the need for an adequate allowance for likely changes and potential systems modification to achieve improved performance. Such funds are necessary, particularily at this time, to provide for the modificatons which are most likely to result from the orbital flight tests, necessary changes to increase reliability and safety, and to lower operating costs of the space transportation system.

Space Shuttle system areas in which these changes and upgrading efforts are likely to be required include the elevon actuators, the radiator door configuration, the launch processing system, plus changes in the fuel cells, inertial measurement unit, and the auxiliary power unit. As these requirements develop and are approved they will impact the funding estimates for either development or production and the funding will be applied accordingly.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

This provision for changes and systems upgrading is a newly identified requirement consistent with the recommendations of the program management reviews and constitutes a part of the proposed FY 1980 supplemental appropriation for the Space Shuttle Program.

BASIS OF FY 1981 ESTIMATE:

In FY 1981, the orbital flight test program will be in progress with flights scheduled on a three to four month intervals. It is anticipated that changes and systems modifications will be identified from our flight test experience. To provide an adequate allowance against the expectation of these unknown requirements materializing due to the flight activity, the FY 1981 estimate has been increased over that planned in FY 1980.

PRODUCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
		(Thousands of Dollars)			
Orbiter	264,500	570,600	572,600	768,200	RD 1-22
Main Engine	75,500	109,900	123,600	121,500	RD 1-23
Launch and Landing	7,000	20,000	16,400	40,400	RD 1-23
Spares and Equipment	21,000	55,000	42,900	109,900	RD 1-23
TOTAL PRODUCTION	368,000	755,500	755,500	1,040,000	

OBJECTIVES AND STATUS:

Space Shuttle production provides for modification of the orbiter STA to orbital flight configuration (Orbiter 099), refurbishment of Orbiter 102 after the OFT program and early operations period, and the fabrication and assembly of two additional orbiters to establish a national fleet of operational orbiters. Production activities also include fabrication of main engines, preparation of the second series ("second line") of Space Shuttle ground processing and launch support equipment at KSC to permit simultaneous processing of two Space Shuttle vehicles, and the necessary Space Shuttle spares and equipment required to establish the initial inventory to support the operational flight rate capability of the Space Shuttle.

The structural test program performed at Palmdale, CA, utilizing the orbiter STA airframe, was completed in 1979. The test data is being used to certify the structural capability of the orbiter. After completion of the planned structural testing, the STA was returned to the Rockwell plant at Palmdale to be converted to an orbital configuration (Orbiter 099 -- Challenger) for delivery in mid-1982. The modifications which have been started consist of the removal of specific elements and instrumentation required during testing; installation of a flight-type crew module; addition of functional subsystems such as the orbital maneuvering system, the reaction control system, the atmospheric revitalization system, and the flight control and communications systems; and the application of the TPS.

Fabrication and assembly of the major subsystems of Orbiter 103--Atlantis, which is scheduled for delivery late in 1983, has begun at Rockwell International and at the major structural subcontractors. The crew module and the forward and aft-fuselage elements are in assembly at Rockwell; and the wings, vertical stabilizer, and mid-fuselage are in assembly at Rockwell's subcontractors. Some long lead ordering of critical parts was also accomplished for Orbiter 104 (Discovery) during FY 1979. Orbiter 104 is scheduled for delivery at the end of 1984. During 1979, NASA defined a weight reduction program for implementation on Orbiters 099, 103, and 104. A definitized contract, replacing the letter contract placed in effect in FY 1979, is to be negotiated and signed in FY 1980 for the manufacture of the RMS for the production orbiters. Funds appropriated for FY 1979 to maintain the option for possible fabrication of a fifth orbiter were used to begin procurement of critical long lead time items. NASA only ordered items which were common to a four or five orbiter program and not specifically for a fifth orbiter.

FY 1980 funding provides for continuation of long lead time material and component procurements for those additional flight engines required for the operational orbiter fleet. Engine component procurements include hot gas manifold and preburner body forgings, turbopump castings, main combustion chamber parts, and selected raw materials and plate stock for engine component fabrication. In addition, fabrication of liquid hydrogen and liquid oxygen high and low pressure turbopump components has been initiated, and assembly of the first set of production engines will begin during FY 1980.

In order to provide the "second-line" capability required at KSC during the operational years, the procurement of necessary additional ground and launch support equipment was initiated during FY 1979. This equipment will be installed in the OPF and the LCC at KSC. NASA has also initiated the procurement of flight crew equipment for the extravehicular mobility unit (spacesuit), communications equipment, and the portable oxygen system. In addition, procurements for ET and SRB rate tooling will be initiated in FY 1980.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The current FY 1980 estimates are the same in total as projected in the FY 1980 budget. There has been a rebalancing to reflect the revised orbiter delivery schedules and the acceleration of engines to provide backup hardware to support the development program.

BASIS OF FY 1981 ESTIMATE:

Orbiter

Modification of Orbiter 099 to orbital flight configuration will continue during FY 1981 for delivery to KSC in mid-1982. Fabrication of a new crew module and other major subsystems, such as the orbital maneuvering system and the reaction control system, will be continued for assembly into Orbiter 099.

Fabrication of the major structural elements for Orbiter 103 will continue in FY 1981 for delivery in late 1983. These activities will include the aft fuselage, crew module, wings, and TPS tiles. In addition, manufacturing activities will be initiated on subsystems such as the orbital maneuvering system, reaction control system, flight control and communciations systems, and environmental control systems.

In FY 1981, fabrication will begin on the fourth flight vehicle, Orbiter 104, which is planned for delivery at the end of 1984. The efforts will consist of continuing the procurement of long-lead items such as basic materials and forgings by the major structural subsystem contractors. Selected subassembly vendors with a long lead time fabrication cycle will also continue manufacturing hardware for Orbiter 104. The weight saving activities initiated in FY 1979 will continue during FY 1981 to support Orbiter 099, 103 and 104 deliveries.

In FY 1981, Remote Manipulator System (RMS) production will also continue in order to provide the arms, spares, and GSE for follow-on operational use.

Main Engine

Production engine materials and component procurement will continue during FY 1981. Component deliveries such as forgings, turbopumps, main combustion chamber parts, and other engine parts will be phased to support the fabrication and assembly operations. Fabrication and assembly of engines for installation into Orbiter 099, will be completed and the engines will be delivered to KSC during FY 1981. Fabrication and assembly of engines for installation into Orbiter 103 will be underway by the end of FY 1981. Early delivery of production engines will provide additional hardware in the event it is needed for development testing. All engines will also undergo acceptance testing at NSTL before delivery to KSC.

Launch and Landing

The capability at KSC to support simultaneous launch processing and checkout of two orbiter vehicles requires the procurement of additional ground and launch support equipment. In FY 1981, the procurement of this "second-line" capability will be continued. The FY 1981 efforts will increase for GSE purchases, installation in the OPF Bay No. 2 and the two remaining high bays of the VAB, modifications to the second mobile launch platform, and installation of launch processing system equipment in the Launch Central Center's (LCC's) second firing room.

Spares and Equipment

Space Shuttle spares and equipment include: orbiter flight and GSE spares, main engine spares, KSC launch site GSE spares, and crew equipment. SRB and ET rate tooling required to increase the rate of production during the operational years is also provided. During FY 1981, NASA will initiate procurement of flight spares for the required orbiter subsystems and main engine component spares, and will continue purchasing tooling for the increased SRB and ET production rate required for future operations.

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE TRANSPORTATION SYSTEMS

SPACE FLIGHT OPERATIONS PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
		(Thousands of Dollars)			
Space transportation systems operations capability development	64,500	69,800	54,100	89,000	RD 2-3
Development, test and mission support	177,200	172,600	172,600	183,500	RD 2-13
Advanced programs	7,000	13,000	13,000	10,800	RD 2-19
Spacelab	26,700	58,800	58,800	151,700	RD 2-21
Space transportation system operation	24,300	153,100	148,100	374,500	RD 2-23
Total	299,700	467,300	446,600	809,500	
Distribution of Program Amount by Installation:					
Johnson Space Center	145,752	170,800	140,850	210,700	
Kennedy Space Center	66,154	71,700	87,800	138,500	
Marshall Space Flight Center	72,554	208,450	197,350	436,700	
National Space Technology Laboratories	5,900	5,500	5,500	5,200	
Goddard Space Flight Center	5,556	6,700	7,800	7,100	
Jet Propulsion Laboratory	---	---	200	200	
Ames Research Center	---	---	---	---	
Langley Research Center	---	---	100	100	
Lewis Research Center	---	---	---	---	
Headquarters	3,784	4,150	7,000	11,000	
Total	299,700	467,300	446,600	809,500	

OFFICE OF SPACE TRANSPORTATION SYSTEMS — SPACE FLIGHT OPERATIONS PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The Space Flight Operations program includes Space Transportation Systems Operations Capability Development; the common support activities conducted under Development, Test and Mission Support; Advanced Programs; Spacelab; and Space Transportation System Operations.

Space Transportation Systems (STS) Operations Capability Development provides for space transportation system development activities other than the Space Shuttle. These development and support activities are necessary to the orderly transition to STS operations. Principal areas of activity include the STS Upper Stages, Multi-mission and Payload Support Equipment, Mission Control Center Upgrading (Level II), Payload and Operations Support and Thrust Augmentation.

Development, Test and Mission Support provides the common engineering, scientific and technical support required at the Johnson Space Center, the Kennedy Space Center, the Marshall Space Flight Center, and the National Space Technology Laboratories for space transportation systems research and development activities.

The Advanced Programs effort provides technical as well as programmatic data for the definition and evaluation of potential future space missions and systems. In support of this effort, advanced development activities are conducted to provide a basis for obtaining significant performance reliability improvements and reducing future program risks and development costs through the effective use of new technology.

The Spacelab is a major element of the Space Transportation System. The program is being carried out jointly by NASA and the European Space Agency (ESA). NASA's support of ESA's Spacelab development effort includes development of support equipment not provided by ESA. Other activities include procurement of flight hardware, and system activation activities which assure Spacelab compatibility with the orbiter and which will lead to an operational capability.

Space Transportation System Operations will provide the transportation services and operational activities to bring about a new era in capitalizing on the unique advantages of space to achieve expansion of human knowledge and practical benefits on Earth. The Space Transportation System Operations activities integrate the Space Shuttle system, the Spacelab, the Upper Stages into a versatile and economical system; accomplish mission planning; provide the operational recurring hardware and consumables; and support all launch, flight, recovery, crew and related activities.

Space Transportation System (STS) Operations Capability Development

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
		(Thousands of Dollars)			
Space transportation system upper stages	19,300	18,300	18,300	39,000	RD 2-5
Multimission and payload support equipment	10,400	9,600	9,600	13,000	RD 2-7
Mission control center (MCC) upgrading (Level II)	10,300	16,000	12,900	15,800	RD 2-8
Payload and operations support	10,000	10,900	10,900	11,200	RD 2-9
Thrust augmentation	4,000	15,000	2,400	10,000	RD 2-11
Teleoperator retrieval system	10,500	---	---	---	---
Total	64,500	69,800	54,100	89,000	

OBJECTIVES AND STATUS:

The Space Transportation Systems Operations Capability Development activity includes five major areas of effort: Space Transportation System Upper Stages; Multimission and Payload Support Equipment; the Mission Control Center (MCC) Upgrading (Level II); Payload and Operations Support and Thrust Augmentation. The STS Upper Stages, which consist of the Inertial Upper Stage (IUS) and the Spinning Solid Upper Stage (SSUS), are an integral part of the Space Transportation System. They are expendable, propulsive stages required to provide the capability to deploy Shuttle-launched payloads to high energy orbits not attainable by the Shuttle alone. The IUS, being developed by the Department of Defense, is a multi-stage, solid propellant expendable vehicle which will become operational in 1981. The IUS will be used for delivery of up to 5,000 pound payloads to geosynchronous orbit and for high energy planetary missions. The Spinning Solid Upper Stages (SSUS), being developed by the McDonnell Douglas Corporation as a commercial venture are spin-stabilized solid propellant expendable upper stages sized to be used for Delta and for Atlas-Centaur class payloads to be launched into geosynchronous orbit.

Multimission and Payload Support Equipment consists of ground and flight hardware used for interfaces between the payloads and the Space Transportation System, as well as test equipment to verify payload integration compatibility. This class of hardware will be developed into a standard, reusable inventory for a variety of payloads.

The Mission Control Center (MCC) Upgrading (Level II) is the reconfiguration of the Johnson Space Center Mission Control Center to support the STS operational flight schedule requirements. Level II will provide additional hardware, equipment, and software to upgrade the MCC to provide the capability to support two simultaneous orbiter missions, the ground simulation network, and an MCC-launch site interface.

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The Payload and Operations Support activity consists of three major efforts: Operations Management Support, Orbital Flight Test (OFT) Payload Integration, and the Payload Operations Control Center (POCC). The Operations Management Support efforts are focused on determining the most efficient method of operating the Space Transportation System. The Orbital Flight Test Payload Integration provides for integrating payloads on the OFT flights during the 1980-1981 period. The POCC, to be located at the Johnson Space Center, will provide facilities for command and control of Shuttle/Spacelab attached payloads.

Thrust Augmentation is the definition of requirements and specifications to provide the additional thrust necessary to insure full Space Shuttle system payload deployment capability of orbiter missions launched from the Vandenberg Air Force Base. Of the possible Thrust Augmentation options studied, the selected approach is the addition of a liquid boost module, using Titan hardware mounted under the External Tank.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The STS Operations Capability Development estimate changes are explained within each project.

BASIS OF FY 1981 ESTIMATES:

STS Upper Stages funds are required in FY 1981 to continue to support the development of the NASA-Unique IUS configuration, hardware, software, IUS mission planning, and implementation.

FY 1981 funding for the Multimission and Payload Support Equipment (MMPSE) is required to complete development, initial testing and orbiter installation of MMPSE mission kits and the payload specialist station (PSS); complete testing of the trace gas analyzer and the first set of cargo integration and test equipment (CITE); continued design of mixed cargo hardware and CITE dual capability.

FY 1981 funding is required to continue support in upgrading the Mission Control Center (Level II) at the Johnson Space Center, including completion of the design specifications for multi-vehicle command and control software and related systems and the initiation of systems integration and testing.

In addition, FY 1981 funds are required to complete checkout and testing of the Payload Operations Control Center in support of operational flight schedule requirements and support of orbital flight test mission payloads. Operations Management Support will continue to focus on efficient modes of operating the Space Transportation System (STS).

Thrust Augmentation effort must continue in FY 1981 on Phase B design studies to conclude definition of design specifications and to study the impact of the Thrust Augmentation concept with respect to thermal and loads impact on the total Shuttle system and facilities.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Space Transportation System (STS) Upper Stages.....	19,300	18,300	18,300	39,000

OBJECTIVES AND STATUS:

The Space Transportation System (STS) Upper Stages are required to provide the capability to deploy Shuttle-launched payloads to orbits not attainable by the Shuttle alone. These Upper Stages are the Inertial Upper Stage (IUS) and the Spinning Solid Upper Stage (SSUS) required for delivery of payloads to geosynchronous orbits and for high energy missions, such as planetary exploration missions.

The Inertial Upper Stage is being developed by the Department of Defense (DOD). It is a multi-stage, solid propellant expendable vehicle and will be operational in 1981. NASA is coordinating the incorporation of NASA-unique and other non-DOD requirements during the design, development, test, and evaluation phase to insure IUS operations compatibility with the space transportation system. The IUS will be used for delivery of up to 5,000 pound payloads to geosynchronous orbit and for high energy planetary missions.

The Inerial Upper Stage (IUS) payload capability exceeds the capability needed by many geosynchronous payloads using today's expendable launch vehicles. The Spinning Solid Upper Stage is being developed commercially for these smaller payloads in two weight classes. The Delta class (SSUS-D) will be capable of injecting up to 2750-pound payloads into geosynchronous transfer orbit, while the Atlas Centaur class (SSUS-A) will be capable of injecting 4,400-pound payloads into the same orbit. Spacecraft apogee motors place the spacecraft (1,400 and 2,250 pounds, respectively, for SSUS-D and SSUS-A) into final geosynchronous orbit. The SSUS-A and SSUS-D offer launch cost economies to the user community. These relatively low cost upper stages have simple physical and functional interfaces for payloads and facilitate an early and orderly transition from the current expendable launch vehicles to the operational STS. Two SSUS-A's or four SSUS-D's with their spacecraft can be flown on a single Shuttle flight. As a result, the launch costs to the user can be significantly reduced. The SSUS emphasis is on servicing the commercial spacecraft user and his requirements.

The DOD two-stage IUS configuration and the NASA unique twin and twin spinner vehicle developments are proceeding on schedule to meet scheduled launches beginning in late 1981.

The critical design review has been successfully completed and vehicle and airborne support equipment component qualification is underway and scheduled for completion early in 1980. Six motor case burst tests, three motor skirt tests, and two full-scale motor firings were satisfactorily conducted this year. Also in FY 1980, systems qualification of the two-stage vehicle and its airborne support equipment will be completed. The two-stage IUS will support the first launch of TDRSS in late 1981.

The systems level preliminary design review has been held for the NASA unique twin and twin spinner IUS with a delta design review scheduled for early 1980. Vehicle and airborne support equipment designs have been modified to allow incorporation of changes (primarily structural) that were selected to provide performance improvements necessary to meet design reference mission requirements. The NASA unique development program is in the process of being rephased to a schedule which will support an International Solar Polar Mission first launch in early 1983. As a result, the critical design review will be rescheduled for late 1980. The development of ground and flight operations capability and IUS/Orbiter integration analyses and testing is continuing.

The commercial development of the SSUS-A and SSUS-D by McDonnell Douglas Corporation is proceeding on schedule to meet anticipated launch requirements. The design has been completed and critical design reviews accomplished. Materials and components have been procured and most elements are manufactured and ready for assembly. SSUS-D motor development has been completed and qualification is beginning; two development motors were successfully tested at simulated altitude in May and September of 1979, and the first qualification motor was tested in November. Testing to determine the spacecraft vibration environment induced by SSUS-A motor burn was completed in December. The SSUS qualification program is now starting and will be the principal development activity during 1980. During FY 1980, planning and analyses to integrate the SSUS with the Shuttle will be continued.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

Although no change from the FY 1980 budget is shown at this time, present estimates indicate that it will be necessary to provide some additional funding to continue upper stage development on a schedule consistent with flight missions requirements. Appropriate notification will be provided to Congressional committees as the extent of this additional requirement is more clearly defined.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 STS Upper Stages funding is required to continue to support the development of the NASA-unique IUS configuration. This effort includes completion of the critical design review of the NASA unique developments and initiation of component and software qualification. In addition, the funding will support continuation of the development of NASA IUS launch site ground operations capability; IUS/Orbiter integration analyses and testing; and the development of IUS mission planning and flight operations capability.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Multimission and Payload Support Equipment.....	10,400	9,600	9,600	13,000

OBJECTIVES AND STATUS:

Multimission and Payload Support Equipment consists of equipment required to integrate and check out payload elements, and a class of ground and flight hardware that will provide an interface between the payloads and elements of the Space Transportation System (STS). These requirements can be satisfied more economically from a standardized equipment inventory than by individual payload users. This reusable equipment is being developed to integrate, check out, transport, and operate a wide range of applications, science, and technology payloads.

Examples of this type of standardized equipment are:

(1) Payload Transportation Equipment - Intrasite payload equipment is being developed for use at the launch site to transport integrated cargoes to and from the Shuttle orbiter. Ground and flight transportation equipment will also be used for cross-country transportation of payloads (regular and outsized) to and from the Kennedy Space Center and the Western Test Range.

(2) Payload Specialist Station Equipment - This equipment is required to conduct payload operations from the orbiter's aft flight deck. A concept utilizing existing technology has been defined and will satisfy the majority of payload functional command and display requirements, as well as mixed cargo integration and operations on early space transportation system missions. This approach will minimize the need for payload-unique equipment and operational changeout time.

(3) Mixed Cargo Support Equipment - This equipment will provide maximum flexibility for mixing cargoes in the orbiter bay, as well as decreasing installation and checkout time. The use of identical equipment for different payload configurations will allow simple crew interface and training. Examples of this equipment include standard cable harnesses which will allow command and data feedback simultaneously for up to four payloads in the orbiter cargo bay; and timing buffers which will provide various time signals to the Shuttle attached payloads while they are active.

(4) Flexible Multiplexer/Demultiplexer - The flexible multiplexer will combine the orbiter data stream and up to five separate payload telemetry or command data streams into a single output signal. The function

of the flexible demultiplexer is to separate the combined data signal, either telemetry or command, back into the appropriate orbiter or payload data streams.

(5) Cargo Integration and Test Equipment (CITE) - This equipment is required to integrate and checkout payload elements as they are assembled into a complete cargo to be flown on the Space Transportation System. CITE will verify the compatibility of the cargo to Shuttle interfaces, and assure that cargo elements do not interfere with each other.

(6) Trace Gas Analyzer - The trace gas analyzer system will perform in-flight monitoring of the aggregate "offgassing" constituents from payloads and metabolic sources in the Spacelab pressurized module. Its primary subsystems consist of a gas chromatographic column to detect the presence of an atmospheric substance and a mass spectrometer to measure the concentration of each of the atmospheric constituents.

(7) Mission Kits - The mission kits consist of standard and optional flight hardware designed to extend the capabilities of the payload and/or the orbiter to support the mission as dictated by the payload requirements. Examples of these items are self-contained payload containers and nitrogen tanks.

In Fy 1980, manufacture of multimission and payload support equipment such as the intersite transportation equipment and the trace gas analyzer will be completed. Other activities include activation of the first set of cargo integration and test equipment (CITE); initial design and development of the dual CITE capabilities; continued design of the mixed cargo hardware, mission kit equipment and the self-contained payload containers; and continued development of the payload specialist station.

BASIS OF FY 1981 ESTIMATE:

FY 1981 funds are required for development, initial testing and orbiter installation of multimission and payload support equipment such as the self-contained payload containers, mission kits and payload specialist station. Testing of the trace gas analyzer and the first set of Cargo Integration and Test Equipment (CITE) will be completed. FY 1981 funds will also provide for the continued design of the mixed cargo hardware and CITE dual capability.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Mission control center (MCC) upgrading (Level II)	10,300	16,000	12,900	15,800

OBJECTIVES AND STATUS:

Mission Control Center (MCC) Upgrading (Level II) is the reconfiguration of the Johnson Space Center Mission Control Center to support the STS operational flight schedule requirements. MCC Level I, funded under the Shuttle development program, provides hardware and software to configure the MCC to support Shuttle development flights. The MCC during the operational era will require additional flight control rooms, support rooms, hardware and software to accommodate two simultaneous orbiter missions, a ground simulation network, dual launch site interfaces, and Spacelab and IUS systems monitoring.

Upgrading the Mission Control Center (Level II) at the Johnson Space Center will continue in FY 1980 with the completion of design specifications for dual vehicle command and control software and initiation of detailed systems design, development and implementation. Development completion and initial testing of the Flight Planning System II, consisting of flight design and crew activity planning elements, will be achieved, in support of early flight rate requirements.

CHANGES FROM FY 1980 BUDGET ESTIMATES:

The Mission Control Center (MCC) Level II budget in FY 1980 has been reduced by $3.1 million by rephasing the development of MCC capabilities in conjunction with operational payload requirements consistent with the Shuttle schedule adjustment. Of this reduction, $2.4 million has been reallocated to Thrust Augmentation definition studies. The remaining $.7 million reduction is a portion of the general appropriation reduction in Research and Development.

BASIS FOR FY 1981 ESTIMATE:

Upgrading the Mission Control Center (Level II) will continue during FY 1981. Funds will be required for procurement of communication interface equipment and the reconfiguration software development, as well as design, checkout, and testing of the trajectory, telemetry and command software systems.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Payload and operations support	10,000	10,900	10,900	11,200

OBJECTIVES AND STATUS:

The Payload and Operations Support activity consists of three major areas of effort: Payload Operations Control Center (POCC); Operations Management Support; and Orbital Flight Test (OFT) Payload Integration.

The Payload Operations Control Center, to be located at the Johnson Space Center, will provide for command and control of attached payloads that operate in the Shuttle and Spacelab. It will operate in conjunction with the JSC Mission Control Center. Funding is required for the acquisition of computers, displays, communication links, and associated software.

In FY 1980, development of hardware and software systems for the Payload Operations Control Center at the Johnson Space Center will continue to allow payload command and control and some real time data review and analysis; and analytical integration activities will be completed for the Orbital Flight Test Payloads.

Operations Management Support will focus on defining the most efficient mode of operating the Space Transportation System (STS). FY 1980 studies will continue the examination of options in STS management during the operational era, the analysis of elements of STS cost per flight, the retrieval of payload data from nonstandard STS orbits, and range safety requirements. Some of the tasks for FY 1980 include a review of analytical techniques for plume impingement and contamination, computerized safety assessments and toxic material control and disposal techniques.

The Orbital Flight Test (OFT) Payload Integration provides for the integration of payloads on the OFT flights. The activities include management integration such as planning, scheduling, and coordinating all elements; interface definition in environmental, structural and thermal areas; safety analysis; hardware integration; flight support; and development of the interface control document. The FY 1980 funds will continue to support conceptual flight planning, launch site planning, and thermal and loads analysis for payloads to be flown on the Shuttle orbital flight test missions.

BASIS OF FY 1981 ESTIMATE:

FY 1981 funds will be used to complete checkout and testing of the Payload Operations Control Center in support of the operational flight schedule requirements and for operation of those parts of the POCC which will support the orbital flight test mission payloads. Funding for Operations Management Support will be used to continue the focus on efficient modes of operating the Space Transportation System (STS).

Orbital Flight Test Payload Integration funding in FY 1981 is required for the integration and handling of payloads for the OFT missions in the late 1980 through the 1981 time period.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Thrust Augmentation	4,000	15,000	2,400	10,000

OBJECTIVE AND STATUS:

As the Space Shuttle development has progressed, it has become clear that the required payload capability will not be sufficient for certain important missions, primarily out of the Vandenberg Air Force Base. This deficiency results primarily from increases in Orbiter weight as a result of design/equipment changes. Approved payload programs scheduled for early STS operational flights from Vandenberg Air Force Base can be accommodated by the Space Shuttle orbiter with currently projected performance capability by limiting certain single payloads to that capability, by restricting the total cargo weight for multiple payload missions, and by limiting the experiment weights and/or durations of Spacelab missions. However, these limitations reduce cost effectiveness and prevent full utilization of the Space Shuttle Orbiter's design potential and its new and unique capabilities. Additional thrust is necessary to ensure that the full Space Shuttle system payload deployment capability of 32,000 pounds and 25,000 pounds retrieval capability can be achieved for the 98° inclination, 150 NM circular Shuttle mission launched from Vandenberg Air Force Base. The current projected capability is not sufficient to perform this mission. The thrust augmented STS meets all design and performance reference mission requirements and offers the potential to accommodate payload growth, new payloads, and concepts. Consequently, it is important to the future national space capability that thrust augmentation be developed and made available to support payload requirements which exploit the full capability of the STS.

NASA performed preliminary evaluations of alternative performance augmentation concepts of which the most promising, from both the performance and cost aspects, were solid rocket motor strap-ons to the SRB and/or the ET, and a liquid rocket engine package placed under the external tank (ET). The liquid rocket engine, the liquid boost module concept for Space Shuttle Thrust Augmentation was adopted as the baseline concept. This concept employs existing Titan engines and tankage, modified as required, to be mounted under the External Tank. Thrust Augmentation will increase Space Shuttle performance from Vandenberg Air Force Base by 12,000 pounds to 36,000 pounds. Total development and integration costs were assessed by NASA as being comparable for the liquid and solid concepts; however, the liquid rocket engine package offers a greater increase in capability for the baseline case.

FY 1980 work includes systems engineering tests and wind tunnel and model tests, structural and aerodynamic loads analyses, and Phase B studies to identify the design specifications and performance requirements for the liquid boost module. The FY 1980 effort will also consist of systems engineering activities to understand the

aerothermal, structural, dynamic, and vibroacoustic impact of the liquid boost module on the external tank and solid rocket boosters. Facility requirements will also be studied.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The NASA budget request of $15 million for FY 1980 was authorized. However, no funds were included in the NASA appropriation for thrust augmentation activities. During the discussion in both the House and Senate upon the presentation and adoption of the appropriations conference report, it was agreed that NASA could use other funds for continuation of design work for thrust augmentation. Consistent with this stipulation and the currently projected operational need date at Vandenberg Air Force Base, funds in the amount of $2.4 million have been reallocated from within the Space Flight Operations line item to continue ongoing studies of the baselined liquid boost module thrust augmentation concept.

BASIS OF FY 1981 ESTIMATE:

In order to achieve the necessary operational capability in calendar year 1985, effort must continue in FY 1981 primarily to conclude the definition of the liquid boost module design specification and to study the impact of thrust augmentation on each element (orbiter, external tank, and solid rocket booster), as well as the impact on the overall system and launch facility.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

DEVELOPMENT, TEST AND MISSION SUPPORT

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
		(Thousands of Dollars)			
Research and test support	42,016	41,900	31,100	32,400	RD 2-14
Data systems and flight support	55,617	47,000	35,900	40,200	RD 2-15
Operations support	34,476	39,500	43,600	45,900	RD 2-16
Launch systems support	45,091	44,200	62,000	65,000	RD 2-17
Total	177,200	172,600	172,600	183,500	

OBJECTIVES AND STATUS:

Development, Test, and Mission Support (DTMS) provides the common engineering, scientific and technical support required to conduct ongoing and proposed space transportation systems (STS) research and development at the Johnson Space Center (JSC), the Kennedy Space Center (KSC), the Marshall Space Flight Center (MSFC), and the National Space Technology Laboratories (NSTL). DTMS functions include research and test support, data systems and flight support, operations support, and launch systems support. These common efforts are necessary to support early project definition; to provide engineering support for indepth technical examination of development efforts of prime and major subcontractors on space transportation systems projects; to provide common support equipment and supplies; and to perform backup design, testing and analysis in high technology areas of design and development.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The total funding for DTMS has not been changed in FY 1980. However, there has been a reallocation within the total to reflect current requirements in support of the revised Space Shuttle schedules. Operations Support and Launch Systems Support requirements have increased. In addition, certain Research and Test Support and Data Systems and Flight Support activities have been integrated into the direct program budget because of the intensified requirements for Shuttle development and test.

BASIS OF FY 1981 ESTIMATE:

FY 1981 funding provides for the common engineering, scientific and technical support required for activities performed in the Space Shuttle program, the STS Operations Capability Development (OCD), and Advanced Programs.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Research and Test Support.....	42,016	41,900	31,100	32,400

OBJECTIVES AND STATUS:

Research and test support encompasses a broad spectrum of technical, engineering, scientific, reliability and quality assurance, and safety operations. These activities complement the work of the major development contractors located across the country in contractor plants and U. S. Government facilities. Examples of FY 1980 activities include: (1) support of the Space Shuttle Main Engine (SSME) static test firing activities and integrated component testing as well as the qualification of the main propulsion system; (2) support of refurbishment efforts for the solid rocket booster (SRB); (3) engineering support for the Space Shuttle Orbital Flight Test (OFT) activity; and (4) flight evaluation of the external tank (ET), SRB, SSME and related systems.

CHANGES FROM THE FY 1980 BUDGET ESTIMATE:

The current estimate for FY 1980 is $10.8 million less than the budget estimate reflecting the reallocation of resources within DTMS and provision for intensified Space Shuttle Avionics Integration Laboratory (SAIL) activities supporting testing and integration of the Space Shuttle avionics system within the Space Shuttle Program estimates.

BASIS OF FY 1981 ESTIMATE:

During FY 1981, research and test support efforts will be focused primarily on critical Space Shuttle activities, including the Space Shuttle OFT activity. Also supported will be design and development activities and research and development efforts in STS OCD, and Advanced Programs. Engineering and test support is provided to assure achievement of technical goals as they relate to each program.

Examples of FY 1981 Space Shuttle support activities include: (1) support of laboratories to do certification and verification testing of flight hardware; (2) continuing support of the communications and tracking systems space to ground compatibility and performance testing; and (3) analysis and certification of government furnished equipment, environmental control life support systems, structural and propulsion subsystems, and crew station training through utilization of mockups, neutral buoyancy crew station trainers, and the remote manipulator facility. FY 1981 research and test support funds are also required to support Space Shuttle certification inspections, test, configuration control panels, and integration efforts.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Data Systems and Flight Support.....	55,617	47,000	35,900	40,200

OBJECTIVES AND STATUS:

Data systems and flight support efforts are associated with the ground-based flight data systems, flight simulation systems, special purpose and general purpose data systems, and flight support.

The ground-based flight data systems effort supports the definition, design, implementation, and checkout of hardware and software modifications to the JSC's MCC, including the real-time computer complex in support of the Space Shuttle OFTs, as well as operation and maintenance of those facilities in preparation for operational mission support. Also included is the operation of the JSC central data computation facility and special purpose data system required to support center-wide activities in mission analysis, systems engineering development, and test functions for the Space Shuttle Program.

Flight support provides for development of Space Shuttle flight control and recovery plans and procedures, flight plans, flight data compilation, crew procedures and training, and other elements of the data base required for crew activities, operation and maintenance of the T-38 training aircraft, flight data management, and support of Space Shuttle payload accommodation and integration.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The current estimate for FY 1980 is $11.1 million less than the budget estimate reflecting provision for flight simulation support activities required for the orbital test flight missions within the estimates for Space Shuttle Design, Development, Test and Evaluation. The flight simulation support activities include operation and maintenance of the mission and part-task simulators used for flight crew training and flight procedures development and validation.

BASIS OF FY 1981 ESTIMATE:

FY 1981 funding of ground-based flight data systems supports the upgrading of the MCC, the central computing facility, flight support and flight data management functions for the OFT effort.

Aircraft operations' activities which will be supported in FY 1981 include partial maintenance, modification, and engineering support services relating to the T-38 training aircraft. FY 1981 funding requirements also provide for the flight control, crew training, and engineering support of flight operations planning control for the OFT missions.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Operations Support	34,476	39,500	43,600	45,900

OBJECTIVES AND STATUS:

Operations support provides for contractor effort and related supplies and equipment to operate and maintain on-site activities at JSC, MSFC, KSC, and at NSTL, and also for off-site operations at the White Sands Test Facility.

CHANGES FROM FY 1980 ESTIMATE:

Operations support funding estimates for FY 1980 have increased by $4.1 million to provide for additional flight documentation requirements and operations support in preparation for the first manned orbital flight (STS-1).

BASIS OF FY 1981 ESTIMATE:

FY 1981 funding will provide for the maintenance of technical facilities and equipment, chemical cleaning, engineering design, technical documentation and analyses, telecommunications, component fabrication, photographic support, and logistics support. Examples of specific services to be provided in FY 1981 include: (1) operation and maintenance of specialized electrical and cryogenic systems, and maintenance of test area cranes; (2) operation of shops to do metal furbishing, anodizing, plating stripping, and etching of selected items of in-house fabricated flight hardware; (3) cleaning of hoses, gauges, tubing, and related flight items that are fabricated in-house; (4) engineering, installation, operation, and maintenace of closed circuit fixed and mobile television required for support and/or surveillance of tests; (5) photo-

graphic services, including still and motion picture processing, and audio visual mission support; (6) fabrication of models, breadboards, and selected items of flight hardware; (7) technical documentation services, telecommunications, and graphics; (8) technical services in support of Center operations including receipt, storage and issue of research and development supplies and equipment, and transportation services; and (9) management services in support of Center operations, including data management, microfilming, and preparation of technical documentation.

In addition, FY 1981 funds will provide the basic level of support to the NSTL for the static test firing and integrated component testing of the SSME and the qualification of the main propulsion system.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Launch Systems Support.....	45,091	44,200	62,000	65,000

OBJECTIVES AND STATUS:

Launch systems support provides for the development and test of the checkout and launch facilities and associated GSE, as well as the technical services required to support the test, checkout and launch of the Space Shuttle and payloads for the development test flights.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

FY 1980 launch systems support funding was increased by $17.8 million to meet additional manpower and overtime requirements for KSC facility operations support in preparation for the Space Shuttle orbital flight testing.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 launch systems support requirements at KSC are for the continuing preparation of the launch facilities to accommodate the Space Shuttle OFT missions. FY 1981 activities will support the integration and checkout of the space vehicle, its payloads, and ground support systems to accommodate the Space Shuttle flight hardware and payload systems.

Funding in FY 1981 will provide for mechanical ground system activities involving operation and maintenance of launch systems and facilities for the Space Shuttle; support for development testing of KSC designed Space

Shuttle equipment in the launch equipment test facility; maintenance and operation of the KSC electrical and mechanical utilities systems; and operation of technical shops and the precision cleaning laboratory which supports maintenance activities.

FY 1981 funding will also support the electrical/electronic and launch instrumentation systems, such as automated checkout equipment, operational voice and TV communications, measurements, and telemetry. These activities include operations and maintenance support of communication, computational and instrumentation systems for the Space Shuttle, and instrumentation and measurement support for development testing of the KSC designed Space Shuttle equipment in the launch equipment test facility.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

ADVANCED PROGRAMS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Advanced Programs.....	7,000	13,000	13,000	10,800

OBJECTIVES AND STATUS:

The Advanced Programs objective is to provide technical as well as programmatic data for the definition and evaluation of potential future space programs and systems. The definition includes identifying future systems requirements, costs, and capabilities in order to provide the basis for selection of new flight systems. These efforts have continually provided the basis for new programs and systems, such as Apollo, Skylab, and the Space Shuttle. In support of these activities, subsystem studies and supporting development activities are conducted to demonstrate significant performance and reliability improvements and to reduce future program risks and development costs through the effective use of new technology.

In FY 1980, activities will be concentrated on definition of future orbital power systems and space platforms for use in both low earth orbit and geosynchronous orbit; advanced orbital capabilities including definition of concepts and experiments to fabricate and erect structures in space; the provision of satellite services (i.e., placement, retrieval, and on-orbit maintenance and repair); the definition of advanced transportation systems concepts such as manned orbital transfer vehicles including crew and propulsion modules for geo-synchronous operations; the concepts definition and analysis of satellite placement and retrieval systems remote from the orbiter; and the definition of the Solar Electric Propulsion System (SEPS).

BASIS OF FY 1981 ESTIMATE:

In FY 1981 major emphasis will be placed on continuing studies, engineering investigations, and definition of near-term mission options that are possible because of the operational capability and flexibility of the space transportation system. In the future power systems and platform area, the emphasis will include definition of low earth orbit platforms for operations with a power system, design studies of geosynchronous platforms, and life and crew support engineering activities required for extended duration orbital missions. The 25 KW power system design definition and key subsystems studies to support the design definition of this system will be completed. In the advanced orbital capabilities area, investigations of potential tools and equipment used in extravehicular activity and teleoperator operations will be carried out.

The definition of space structures experiments will be continued, and the deployable antenna flight experiment definition study will be completed. In addition, structures engineering activities including testing of beam builders and preparation of simulations will be continued. Studies of extravehicular activity operations essential for satellite and platform maintenance as well as studies of assembly and repair of future structures in space will be continued. Concept and engineering development efforts on teleoperator systems to permit remote satellite servicing and studies on extravehicular activity support equipment as well as automated rendezvous and proximity operations techniques will be continued. Other planned activities for FY 1981 include continuation of studies of future upper stages to enhance the space transportation system capabilities and permit improved geosynchronous operations.

Appropriate subsystems studies and supporting development will be undertaken in support of the above activities in order to provide technical depth to the varied definition activities.

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BASIS OF FY 1981 FUNDING REQUIREMENTS:

SPACELAB

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Spacelab	26,700	58,800	58,800	151,700

OBJECTIVES AND STATUS:

The Spacelab is a major element of the Space Transportation System. The program is being carried out jointly by NASA and the European Space Agency (ESA) to provide a versatile, reusable space laboratory which will be flown to and from Earth orbit in the cargo bay of the Shuttle. The Spacelab will consist of a pressurized module and unpressurized pallet segments which can be used in various combinations to support mission requirements. It will permit researchers to personally conduct a wide range of experiments in a ground-type laboratory while operating in the unique environment of space.

Ten European nations, of which nine are members of the European Space Agency, are participating in the program. NASA and ESA are committed to bear the cost of their respective program responsibilities. ESA responsibilities include the design, development, production and delivery of the first Spacelab and associated ground support equipment to NASA, and establishment of the capability to produce additional Spacelabs. NASA funding responsibilities include development of flight and ground support equipment not provided by ESA, development of Spacelab operational capability and procurement of additional hardware needed to support NASA's missions.

In FY 1980, fabrication of the crew transfer tunnel will be continued. This tunnel will link the Spacelab module to the Shuttle Orbiter cabin. Manufacture, test and validation of verification flight instrumentation equipment which includes sensors, electronic measuring and monitoring devices, and related flight and ground support equipment required to verify the performance of Spacelab subsystems and to monitor the environment to which payloads will be subjected, will also be continued.

Development of United States ground support equipment will continue in 1980. Integration of the Spacelab simulator with the Shuttle mission simulator used for crew training will also be continued in FY 1980. The outfitting of ESA pallet structures with systems being developed for use during orbital flight tests will be completed in FY 1980. The Software Development Facility will also be completed and used to generate computer programs such as the experiment computer operating system.

In FY 1980, the Spacelab integration contractor will perform systems engineering, logistics planning, systems software preparation, and analytical experiment integration to prepare for the orbital flight tests in 1981 and the two Spacelab verification flights scheduled for 1982. The interface between the Shuttle orbiter and the Spacelab will continue to be defined and fabrication of hardware required for mating the orbiter with the Spacelab will proceed.

NASA plans to enter into a contract with the European Space Agency to start procurement of follow-on Spacelab hardware. The production of this hardware is scheduled to span six years.

BASIS OF FY 1981 ESTIMATE:

FY 1981 funding is required to continue incremental procurement of the Spacelab flight hardware from ESA. This procurement includes a second set of Spacelab flight elements and initial spares to support the early flights.

FY 1981 funding will also be applied to the manufacture and test of the crew transfer tunnel and the ground support equipment to be used for integration and checkout of the Spacelab engineering model and flight hardware at the Kennedy Space Center. Also, fabrication of the support equipment to be used for transporting flight hardware between the integration and launch sites will be continued. Other items of flight hardware procured by NASA such as a flight recorder and closed circuit television switching network will be delivered in FY 1981. Spare parts for hardware manufactured in the United States will also continue to be procured.

At the Johnson Space Center the Spacelab simulator and the less sophisticated single systems trainer will be placed into operation. The hardware to be used for mating the Spacelab with the Space Shuttle orbiter is planned to be delivered in FY 1981. The Software Development Facility, completed in FY 1980, at the Marshall Space Flight Center, will be used to checkout and integrate both ground and flight compter programs.

The McDonnell Douglas Technical Services Company, the Spacelab integration contractor, will continue to develop the procedures for integration, maintenance and on-ground repairs for the early Spacelab missions. These procedures will be tested with the Spacelab Engineering Model and flight unit which are scheduled to be delivered beginning in FY 1981.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

SPACE TRANSPORTATION SYSTEM OPERATIONS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Shuttle operations	15,100	114,600	119,300	320,500
Spacelab operations	--	800	--	1,600
Upper Stages operations	2,900	22,300	18,700	32,900
Payload Support operations	6,300	15,400	10,100	19,500
TOTAL	24,300	153,100	148,100	374,500

OBJECTIVES AND STATUS:

Space Transportation System Operations will provide the transportation services and operational activities to bring about a more effective access to, and utilization of, space for the expansion of human knowledge and for practical benefits on Earth, while reducing the cost of space operations. The Space Transportation System will provide for the delivery of free-flying payloads to low Earth orbit; facilitate the conduct of experiments using the Shuttle orbiter as a carrier vehicle for experiments mounted in Spacelab pressurized modules and on Spacelab pallets in the orbiter payload bay; deliver payloads to synchronous and other high energy orbits using the combined capabilities of the Shuttle and upper stages; retrieve free-flying payloads from low earth orbit; and provide on-orbit servicing of satellites.

The Space Transportation System Operations activities integrate the Space Shuttle system, the Spacelab and the upper stages into a versatile and economical space transportation system. Shuttle mission planning, procurement planning for recurring hardware and consumables, and support planning for operations involving launch, flight recovery crews and related activities are well underway. In addition, procurement of long lead items for major expendable hardware components has been initiated.

Spacelab Operations provide for development and implementation of Spacelab ground-turnaround and flight operations, including mission planning, Spacelab to Shuttle integration and ground support operations. Upper stage operations provide for the procurement of upper stage hardware and related support necessary for orbital placement of spacecraft following low orbit deployment from the Shuttle orbiter. The upper stages include Inertial Upper Stages (IUS) for 5,000-pound class geosynchronous (IUS/two-stage) spacecraft

and planetary (IUS/twin spin) spacecraft, Spinning Solid Upper Stages (SSUS) for 4,400-pound Atlas Centaur class (SSUS-A) and up to 2,750-pound Delta class (SSUS-D) geosynchronous spacecraft.

Payload Support Operations provide for optional payload related hardware, services and launch site capability development required to meet a users transportation requirements outside the scope of currently defined standard Space Transportation System services.

CHANGES FROM 1980 BUDGET ESTIMATE:

FY 1980 funding reflects the unspecified $5.0 million Congressional reduction in Space Flight Operations. The schedule delay in the first operational flight and subsequent early flights provided the flexibility to rephase and defer Spacelab mission planning, upper stage hardware procurement, and payload support.

BASIS OF FY 1981 ESTIMATE:

Shuttle Operations - FY 1981 funding is required for Space Shuttle flight hardware components which include the external tank and solid rocket boosters. External tank components will be delivered to the Michoud Assembly Facility in Louisiana for fabrication and assembly of the liquid oxygen and liquid hydrogen propellant tanks. After final testing, the external tank will be shipped by barge to the Kennedy Space Center (KSC) in Florida. Segments for the solid rocket motors (SRM) will be prepared at the contractor's plant and shipped to KSC for SRM case assembly. Other solid rocket booster components such as electronic and instrumentation parts, thrust vector control components, recovery systems, attach structures, forward and aft skirts, and separation motors, will be shipped to the Kennedy Space Center where final assembly and checkout will be performed prior to flight. FY 1981 funding is required for pre-launch preparations at KSC and for the development of Shuttle flight plans using standardized avionics software, mission planning, trajectory analyses, and crew procedures.

Spacelab Operations - FY 1981 funding is required for mission operations and crew operations planning for the early operational missions. Mission operations efforts include computer software programming and engineering maintenance for the Mission Control Center and the Payload Operations Control Center. Crew operations include establishment of the flight data file, crew procedures, and system handbook as well as training of the command controller personnel for the Payload Operations Control Center.

Upper Stage Operations - Funding in FY 1981 is required to support the procurement of major components and initial subsystem assembly of the first IUS twin/spin vehicle. Continued funding for production of IUS and SSUS upper stages is also needed in FY 1981 to support NASA missions including Tracking and Data Relay Satellites, International Solar Polar Mission, Galileo and Active Magnetospheric Particle Tracer Explorer.

Payload Support Operations - Funding in FY 1981 is required to support on-going payload integration analysis and implementation for currently scheduled launches. NASA payloads requiring significant support in 1981 include: International Solar Polar Mission, Long Duration Exposure Facility, Space Telescope, early Spacelab missions, and the Tracking and Data Relay Satellite System.

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE TRANSPORTATION SYSTEMS — EXPENDABLE LAUNCH VEHICLES PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
Scout	10,600	7,300	5,100	2,200
Centaur	17,320	18,300	18,300	5,600
Delta	45,680	43,100	46,100	47,900
Atlas-F	---	2,000	1,200	---
Total	73,600	70,700	70,700	55,700
Distribution of Program Amount by Installation:				
Kennedy Space Center	9,600	3,800	3,700	2,800
Goddard Space Flight Center	40,496	40,400	43,000	43,500
Langley Research Center	10,540	7,200	5,000	2,200
Lewis Research Center	12,000	16,400	16,900	4,300
Headquarters	964	2,900	2,100	2,900
Total	73,600	70,700	70,700	55,700

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

OFFICE OF SPACE TRANSPORTATION SYSTEMS — EXPENDABLE LAUNCH VEHICLES PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The objective of the expendable launch vehicles program is to provide for the centralized procurement of launch vehicles and launch support services for NASA's automated spacecraft missions. The program includes the procurement of launch vehicle hardware, launch services, engineering and maintenance, and, as required, development of improved vehicle systems, including the necessary ground support equipment. Launch vehicles currently being procured are: Scout, Centaur, Delta, and Atlas-F.

The expendable launch vehicles program includes funding for vehicle hardware, such as solid rocket motors, boosters, upper stages, shrouds, adapters, mission-unique hardware, and launch support including preparation of hardware for launch, guidance and control services, mission software, prelaunch and postlaunch engineering analysis, transportation, propellants, and range support. It also includes procurement of vehicle hardware to be used as backup support for early users transitioning to the Space Transportation System Operations. In addition, an uprating program to improve the performance of the Delta launch vehicle is being initiated to provide sufficient capability to launch NASA's Landsat mission and various reimbursable customers missions.

Launches under this program are conducted from sites located at the Eastern Test Range in Florida, the Western Test Range in California, the Wallops Flight Center in Virginia, and the San Marco platform off the coast of Kenya, Africa.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

There has been no change in the total FY 1980 estimates, however, funding adjustments were made within the total to reflect current program requirements including extension of Delta backup capability in support of Space Transportation System users, resulting from delay in the Shuttle first manned orbital flight.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

SCOUT

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Scout	10,600	7,300	5,100	2,200

OBJECTIVES AND STATUS:

The Scout launch vehicle was initiated by NASA in 1959 with the goal of economically launching a wide variety of small scientific satellites, space probes, and re-entry experiments. The first Scout launch occurred in July 1960. In the ensuing 19 years, there have been 101 launches, and 87 of these launches have been successful.

The Scout vehicle is the smallest launch vehicle employed by NASA. It is a four-stage, solid propellant launch vehicle. The vehicle is approximately 22.4 meters in length (73 feet) and the first stage booster has a diameter of 1.14 meters (3.75 feet). It is capable of placing a 180 kilogram (400 pound) payload in a 556 kilometer (300 nautical mile) orbit.

The Langley Research Center, located at Hampton, Virginia, has managed the Scout project since its inception. The prime contractor for the production, checkout, and launch of Scout is the Ling-Temco-Vought Aerospace Corporation, located in Dallas, Texas. Scout vehicles are launched from the Western Test Range, California; from Wallops Island, Virginia; and from the San Marco platform off the African coast near Kenya.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The estimate has been reduced by $2.2 million because of better definition of NASA requirements and a greater share of the costs being born by DOD users. The $2.2 million has been reallocated to the Delta project to be applied to STS transition backup requirements.

BASIS FOR FY 1981 ESTIMATE:

The funds required in FY 1981 will be used for engineering, technical support, vehicle testing and checkout, launch operations and maintenance of launch facilities and ground equipment. FY 1981 funds will provide for preparation and launch of two San Marco cooperative missions from the African San Marco launch platform. These launches will complete NASA's use of the Scout launch vehicle.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

CENTAUR

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Centaur	17,320	18,300	18,300	5,600

OBJECTIVES AND STATUS:

This project provides for the procurement and launch of the Atlas booster stage and the Centaur upper stage. The Centaur is a high performance upper stage, which is the most powerful used by NASA for automated missions. It is being used with the Atlas booster for high energy missions, particularly planetary and synchronous orbits. The Atlas Centaur vehicle is 40 meters (131 feet) in length and has a diameter of 3.1 meters (10 feet).

In addition, the Centaur has been previously used with the Titan booster to launch heavier spacecraft beyond the capability of the Atlas Centaur. In this configuration, the Titan Centaur has successfully launched two Helios missions, two Viking missions, and two Voyager missions. Since NASA has no future plans to use the Titan Centaur vehicle combination, it has been phased out.

BASIS OF FY 1981 ESTIMATE:

The last NASA mission requiring the Atlas Centaur launch vehicle was the HEAO-3 launched in September 1979. However, use of this vehicle is being continued by reimbursable customers under NASA management and control. The funding required in FY 1981 is for an orderly phaseout and closeout of the Atlas Centaur program. This closeout includes restoration of contractor-owned facilities which are being used to produce the Atlas Centaur launch vehicle and the vital components that are integral to this vehicle system. In addition, it includes the mothballing and teardown of facilities that will not be required for future requirements. Our current planning is based on a closeout of the program by the end of 1981.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

DELTA

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Delta	45,680	43,100	46,100	47,900

OBJECTIVES AND STATUS:

The Delta launch vehicle is the most widely used vehicle in NASA's expendable launch vehicle family. Since its first use in 1960, this vehicle has been utilized in 150 launches and has experienced a success record of over 91 percent. It is presently operational with two and three stage configurations and a multiburn second stage capability. The first stage is an elongated Thor booster with three, six, or nine strap-on solid motors for thrust augmentation.

The second stage Delta, which provides a multiple restart capability, uses an inertial guidance system for guiding the first stage booster and the second stage Delta. The third stage utilizes the Thiokol TE-364 solid motor, which is spin stabilized. This vehicle, in its three-stage configuration, is approximately 35 meters in length (115 feet) and has a diameter of 2.44 meters (8 feet). It is capable of placing a 1,772 kilogram payload (3,900 pounds) into a 555 kilometer (300 nautical mile) orbit.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The $3.0 million increase in the Delta project estimate is required to extend the Delta production and launch capability and initiate development of an uprated Delta vehicle. These requirements result from delays in the Shuttle first manned orbital flight. As a result of the Shuttle delays, backup capability must be extended and a vehicle capable of launching a heavier spacecraft must be developed. These funds will allow for a continued backup capability through September 1980. This increase is provided for by reallocation of funding from the Scout and Atlas-F projects.

BASIS OF FY 1981 BUDGET ESTIMATE:

The FY 1981 funding will be used to continue the Delta launch vehicle procurements initiated in prior years to support NASA spacecraft requirements and to sustain a minimum production capability to back up early users scheduled on the Space Transportation System. Funds are also required for technical and engineering support

to sustain vehicle test and checkout and launch operations, and to support maintenance of launch facilities and ground equipment. In addition, a vehicle uprating is being initiated to increase the performance capability to 2,750 pounds to geosynchronous transfer orbit to support Landsat and reimbursable mission requirements. The Delta uprating will allow continued capability to retrieve the Landsat mission and allow NASA to offer the capability to launch heavier spacecraft to other users.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

ATLAS-F

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Atlas-F	---	2,000	1,200	---

OBJECTIVES AND STATUS:

The Atlas-F is a one and one-half stage vehicle which uses liquid oxygen and kerosene as propellants. The vehicle is a refurbished surplus Intercontinental Ballistic Missile (ICBM) being managed by the USAF for space missions. NASA has used this vehicle to launch the TIROS-N and Seasat missions, both of which were successfully launched during 1978.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The $2.0 million requested in the FY 1980 budget provided for modifying the Atlas vehicle, the fairing and for the vehicle integration of the Search and Rescue missions. The Search and Rescue missions will be launched as piggyback missions with National Oceanic and Atmospheric Administration satellites beginning in late 1982 or early 1983. The decrease of $800 thousand is a result of the requirements to modify these vehicles. These funds have been reallocated to the Delta project to cover Space Transportation System backup transition vehicle support for Shuttle users.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES

RESEARCH AND DEVELOPMENT BUDGET PLAN FOR SPACE SCIENCE PROGRAMS

Programs	1979 Actual	Budget Plan 1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Physics and astronomy	282,900	337,500	337,100	438,700
Planetary exploration	182,400	220,200	219,900	179,600
Life sciences	40,100	43,900	43,800	49,700
Total	505,400	601,600	600,800	668,000

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE SCIENCE

PHYSICS AND ASTRONOMY PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
	(Thousands of Dollars)				
High energy astronomy observatories (HEAO) development.	10,647	4,800	2,100	---	RD 4-8
Solar maximum mission (SMM) development	16,700	600	3,100	---	RD 4-9
Space telescope (ST) development	79,200	112,700	112,700	119,300	RD 4-10
International solar polar mission (ISPM) development	12,500	50,000	47,900	82,600	RD 4-12
Gamma ray observatory (GRO) development	---	---	---	19,100	RD 4-14
Shuttle/Spacelab payload development and mission management	34,900	41,300	40,900	72,100	RD 4-16
Explorer development	31,288	30,400	32,300	33,000	RD 4-19
Mission operations and data analysis (MO&DA)	25,453	36,500	37,100	38,900	RD 4-21
Research and analysis (R&A)	44,005	34,300	34,100	42,800	RD 4-24
Suborbital program	28,207	26,900	26,900	30,900	RD 4-29
Total	282,900	337,500	337,100	438,700	
Distribution of Program Amount by Installation:					
Kennedy Space Center	335	---	1,813	2,358	
Johnson Space Center	346	216	1,713	6,181	
Marshall Space Flight Center	124,275	158,112	155,226	177,583	
Goddard Space Flight Center	83,299	76,963	79,908	117,828	
Jet Propulsion Laboratory	19,314	58,353	53,950	80,977	
Wallops Flight Center	7,028	5,219	5,678	6,874	
Ames Research Center	20,401	4,157	12,817	8,901	
Langley Research Center	1,052	855	59	37	
Lewis Research Center	185	---	---	---	
Headquarters	26,665	33,625	25,936	37,961	
Total	282,900	337,500	337,100	438,700	

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

OFFICE OF SPACE SCIENCE

PHYSICS AND ASTRONOMY PROGRAM

LAUNCH SCHEDULE

PROJECT	MISSION	CALENDAR YEAR
Solar Maximum Mission	SMM	1980
International Solar Polar Mission	ISPM	1983
Space Telescope	ST	1983
Gamma Ray Observatory	GRO	1985
Space Shuttle Orbital Flight Test Payloads	OSS-1	1981
Spacelab	Spacelab-1	1982
	-2	1982

(Shuttle/Spacelab Payloads in support of Space Science objectives will build to a flight rate of approximately 2.5 equivalent Spacelab missions per year by 1984).

Explorers:

Dynamics Explorer	1981
San Marco-D/Low Orbit	1981
San Marco-D/Multistationary	1982
Solar Mesosphere Explorer	1981
Infrared Astronomical Satellite	1981
Cosmic Ray Isotope Experiment	1981

LAUNCH SCHEDULE (CONTINUED)

PROJECT	MISSION	CALENDAR YEAR
	Active Magnetospheric Particle Tracer Explorer	1983
	Cosmic Background Explorer	1985
	Extreme Ultraviolet Explorer	1985
Suborbital Programs:		
Sounding Rockets		About 60 launches per year
Balloon Flights		About 20 launches per year
Airborne		About 80 flights per year with C-141 Airborne Observatory

OFFICE OF SPACE SCIENCE

PHYSICS AND ASTRONOMY PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The major objective of the Physics and Astronomy program is to increase our knowledge and understanding of the solar terrestrial space environment and the origin, evolution, structure, and composition of the universe, including the Sun, the stars, and the other celestial bodies. Space-based research is being conducted to investigate the physics, chemistry and transport processes occurring in the Earth's magnetosphere, ionosphere, and atmosphere, and the responses of the transport processes to solar phenomena and variability; the structure and dynamics of the Sun and its long- and short-term variations; cosmic ray, X-ray, gamma ray, ultraviolet, optical, infrared, and radio emissions from stars, interstellar gas and dust, pulsars, neutron stars, quasars, black holes, and other celestial sources; and the laws governing the interactions and processes occurring in the universe. Many of the phenomena being investigated in the Physics and Astronomy program are not detectable from ground-based observatories because of the obscuring or distorting effects of the Earth's atmosphere.

To achieve the objectives of the Physics and Astronomy program, NASA employs theoretical and laboratory research; aircraft, balloon, and sounding rocket flights; Shuttle/Spacelab flights; and free-flying spacecraft. Research teams involved in the Physics and Astronomy program are located at universities, industrial laboratories, NASA field centers, and other government laboratories.

The scientific information obtained and the technology developed in the Physics and Astronomy program are made available to the scientific and technical communities for applications to and the advancement of scientific knowledge, education, and technology.

The Physics and Astronomy missions undertaken to date have been extraordinarily successful. The High Energy Astronomy Observatories (HEAO's), the most recent series of large observatory missions, are making major contributions to our understanding of the high energy processes and of the distribution and characteristics of X-ray emitting objects. Explorer satellites, a program involving a series of relatively low cost missions whose origin dates back to the beginning of our country's space program, continue to make major discoveries about celestial phenomena, as well as about the nature of the solar terrestrial interactions and their effect on the near-earth environment. For example, the International Ultraviolet Explorer has recently observed evidence of a halo of hot gas around our own galaxy and has provided evidence, in conjunction with HEAO-2 observations, which may imply the existence of massive black holes in some globular star clusters. The International Sun-Earth Explorers are now successfully investigating fundamental processes occurring as a result of the extremely

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complex solar wind/magnetosphere/ionosphere interactions. The Explorer program also plays a key role in development of technology and serves as a further test opportunity for the technologies necessary for later, more complex observatories.

Major accomplishments during FY 1979 included the launch of the second and third observatories of the HEAO series. The first HEAO mission has been successfully completed. The second of the HEAO series, HEAO-2, is currently conducting unique high resolution imaging X-ray observations. The third of the HEAO series, HEAO-3, is carrying out a preliminary survey of the sky for gamma ray lines and is measuring the composition of cosmic ray particles. Significant scientific results obtained from the HEAO missions to date include the discovery by HEAO-1 of more than 1,000 new X-ray sources, the demonstration by HEAO-2 that a much wider variety of stars emit X-rays in greater quantities than previously predicted, and new information provided by HEAO-3 concerning the detailed composition of cosmic rays in the iron, nickel, cobalt groups of elements. Small-scale, high velocity structures in the Sun's upper atmosphere have been discovered through the use of instrumented sounding rocket flights. A new technique has been successfully tested for measuring the temperature and velocity of the solar wind as it orginates within the Sun's corona, and several sounding rocket payloads of specialized X-ray instruments have been prepared for correlative flights during the operation of the Solar Maximum Mission. Major progress was also made in the development of experiments and other flight equipment for future Physics and Astronomy flight missions. The Solar Maximum Mission, the Space Telescope, the International Solar Polar Mission, the Dynamics Explorer, the Infrared Astronomical Satellite, and the Solar Mesosphere Explorer are in various stages of flight development. The Solar Maximum Mission experiments and spacecraft have, in fact, been integrated and tested in preparation for launch in early 1980. All the experimenters are under contract for the International Solar Polar Mission and the prime contractor for the U. S. spacecraft has been selected. The instrument development for the initial Physics and Astronomy Shuttle payload, OSS-1, progressed in FY 1979. The experiments on OSS-1 will gather solar physics data, evaluate the ambient and induced Shuttle space environment, and provide data on payload thermal control technology. Significant progress has also been achieved in the preparation of the Spacelab 1 and 2 missions, which are operational demonstration flights of Spacelab hardware produced by the European Space Agency. During FY 1979, selection of the initial follow-on Shuttle/Spacelab Physics and Astronomy experiments was made, some of which will fly as early as 1983. Also selected for future development were three facility class instruments, the Solar Optical Telescope, the Chemical Release Module, and the Shuttle Infrared Telescope Facility.

During FY 1979, the Spacelab mission management responsibility for all NASA Spacelab missions was consolidated within the Physics and Astronomy program. Responsibility for the design and development of the actual experiments for other than the Physics and Astronomy program remains with the respective disciplines: Life Sciences, Space Applications, and Space Research and Technology.

FY 1980 funding will support the continued development and launch of major flight projects including launch operations and data analysis associated with the Solar Maximum Mission planned for an early 1980 launch. The Solar Maximum Mission investigations will involve some 200 scientists. The period of solar maximum activity is nearly twice as high as the average (as measured by sunspot count) and thus promises many flares and other energetic phenomena for study.

In FY 1980 development activities will continue on the Space Telescope leading to a Shuttle launch in 1983. The Space Telescope will allow research at the forefront of optical and ultraviolet astronomy for decades. Work will also continue on the International Solar Polar Mission which will be the first mission to explore the three-dimensional space around the Sun. The Dynamics Explorer, which will investigate the interaction of the Earth's magnetosphere and ionosphere, is in final development leading to launch in 1981. Preparations will continue for the launch of the Infrared Astronomical Satellite (IRAS), a cooperative mission with the Netherlands and the United Kingdom, in 1981. The IRAS will perform an infrared, all-sky survey and will study, in more detail, selected galactic and extragalactic sources. Development work on the San Marco-D missions, which are cooperative missions with Italy, will be continued, leading to launches in 1981 and 1982. Development will also be continued on the Cosmic Ray Isotope Experiment, which will be launched on a Department of Defense satellite in 1981. Finally, development efforts will be continued on the Solar Mesosphere Explorer, which will be launched in 1981. The Solar Mesosphere Explorer will determine solar ultraviolet flux, and study corresponding changes occurring in ozone and related chemistry as a result of the ultraviolet radiation.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The FY 1980 estimate for the Physics and Astronomy program has changed only slightly in total--a reduction of $400 thousand as a result of a general Congressional reduction in the NASA budget request. A number of adjustments have been made among the individual subprogram elements in order to respond to technical problems, and successes, and to other unforeseen circumstances. All of these adjustments have been accommodated within the total budget for the program, and in the context of balanced programmatic priorities.

Significant reductions in two projects have permitted the application of additional resources to problem areas: (1) the successful launch of the third and last mission in the High Energy Astronomy Observatories program, HEAO-3, with fewer technical/schedule problems than anticipated, allowed a reduction of $2.7 million in the FY 1980 estimate; (2) in the International Solar Polar Mission development project, a revision in the phased funding of the effort, to match requirements under the recently-awarded spacecraft contract, has permitted a reduction in the FY 1980 estimate.

Resources made available by these reductions have been applied to those projects which have experienced technical/schedule problems and repricing adjustments, primarily the Solar Maximum Mission and Explorer Development. These funding adjustments are discussed in the narrative sections in each of the affected program areas.

BASIS OF FY 1981 ESTIMATE:

In FY 1981, a new project will be initiated, the Gamma Ray Observatory, leading to a 1985 launch. The Gamma Ray Observatory is a comprehensive mission designed to study the full sky over the total range of the gamma ray energies. Gamma rays are the most energetic electromagnetic radiation known. It is believed that their study will reveal details of fundamental cosmic nuclear and high energy processes, especially those occurring in active galaxies and quasars as well as in supernovae.

FY 1981 funding will provide for the launch of the Space Science payload which will be flown on an orbital flight test mission; and development will continue on the Space Telescope. In FY 1981, an unusually high level of launch activity will take place, including the launch of the Dynamics Explorers, the Infrared Astronomical Satellite, the Solar Mesosphere Explorer, the first of the San Marco-D missions, and the Cosmic Ray Isotope Experiment. Development will start on the Active Magnetic Particle Tracer Explorer (AMPTE). Design and definition studies will also be carried out for several potential future explorer missions.

In FY 1981, work will continue on the mission management efforts for all NASA Spacelab payloads. The FY 1981 funds will also provide for the instrument development and mission management for Spacelab 1 and 2, and for instrument development and mission management activities for future Spacelab missions.

FY 1981 Mission Operations and Data Analysis activities will focus on the operation and analysis of data from satellites which are producing valuable scientific data. These satellites include the High Energy Astronomy Observatories, the International Ultraviolet Explorer, the International Sun-Earth Explorers, and an Atmosphere Explorer. Mission Operations and Data Analysis will also be underway for the Solar Maximum Mission and the Dynamics Explorers. FY 1981 funding will also support preparations for science operations for the Space Telescope.

For Suborbital programs, FY 1981 funds will provide for continuation of sounding rocket activity, and continuing scientific investigation through balloon and aircraft flights.

FY 1981 Research and Analysis funding will support a broad range of efforts to provide the research and technology base required for well-conceived and defined future programs. In our supporting research and technology program, tasks critical to maintaining a firm scientific base for physics and astronomy will continue. In the area of Spacelab Payload definition, efforts will continue on detailed studies of specific instruments. The data analysis activity will include operation of the National Space Science Data Center (NSSDC) and the general data analysis activities.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

HIGH ENERGY ASTRONOMY OBSERVATORIES (HEAO) DEVELOPMENT

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
HEAO spacecraft	7,496	2,300	1,900	---
HEAO experiments	2,853	1,400	100	---
Ground operations	298	1,100	100	---
Total	10,647	4,800	2,100	---
Basic mission operations and data analysis	(5,439)	(5,351)	(6,336)	(128)
Extended mission operations and data analysis	(3,714)	(8,549)	(8,548)	(10,606)
Atlas/Centaur (expendable launch vehicle program)	(4,905)	(---)	(1,515)	(---)

OBJECTIVES AND STATUS:

A major scientific objective of the HEAO program is to observe and investigate not only those X-ray sources that are already known, but also a much larger number, which either because of their distance or their low intensity, remained undetected before the advent of HEAO. A product of this work has been the detection of classes of intrinsically weak X-ray sources within our own galaxy, as well as the observation of the stronger sources outside our galaxy. Other equally important objectives include the observation of rare species of cosmic rays, which are crucial to our understanding of heavy element formation, and the search for nuclear gamma ray lines, which are important in understanding the origin of the elements. This program promises to advance our understanding of newly discovered processes that release extraordinary amounts of energy. It will also enhance our understanding of the creation of matter, and it will deepen our knowledge of observed phenomena such as quasars, plusars, novae and supernovae.

The HEAO Program consists of three missions utilizing Atlas-Centaur launch vehicles launched from the Eastern Test Range. HEAO-1, an X-ray survey mission, was launched in August 1977, and completed 19 months of highly successful operations prior to its reentry in March 1979. HEAO-1 results included the discovery of over 1,000 X-ray sources, as well as an isotropic plasma of many million degrees temperature. HEAO-2 was successfully launched in November 1978, and carries a grazing incidence X-ray telescope to make detailed studies of specific X-ray sources. The third mission (HEAO-3) was successfully launched in September 1979, and carries a combination of cosmic ray and gamma ray instruments. Results obtained to date from the HEAO missions are discussed under Mission Operations and Data Analysis.

CHANGES FROM FY 1980 ESTIMATE:

The FY 1980 estimate reflects a reduction in funding requirements for the HEAO-3 spacecraft associated with the on-time, successful launch; fewer technical and schedule problems were experienced than had been anticipated. These savings have been applied to increased baseline HEAO operations costs and to the Explorer program to resolve technical problems in ongoing development projects.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

SOLAR MAXIMUM MISSION (SMM) DEVELOPMENT

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
Spacecraft	10,911	---	2,269	---
Experiments	4,139	---	689	---
Ground operations	1,650	600	142	---
Total	16,700	600	3,100	---
Basic mission operations and data analysis	(---)	(4,900)	(4,500)	(3,400)
Extended mission operations and data analysis	(---)	(---)	(---)	(1,600)

OBJECTIVES AND STATUS:

The major objective of the Solar Maximum Mission (SMM) is to conduct detailed studies of the solar flare processes and the associated solar active regions during the next period of peak solar activity, which will occur in 1979 through 1981. The investigations will be conducted over a broad spectral range with high spectral, spatial and time resolution, and with the objective of explaining the underlying physical mechanisms and complex energy transfer and high energy particle acceleration processes involved.

To achieve the scientific objective, SMM will be launched near the period of maximum solar activity in order to observe a sufficient number of large and small flare events. The study of flares is currently considered to be one of the most timely and important in the NASA solar physics programs, both by virtue of the significance of the phenomenon and by the state of readiness of the technology required to capitalize on the phenomenon. A great deal has already been learned about the flare process through instruments flown

on the Orbiting Solar Observatories and Skylab. The SMM instruments will be the first to make simultaneous observations over the necessary broad range of wavelengths.

In the area of solar terrestrial relationships, indications of a link between some form of solar activity (radiation, particles, and magnetic fields) and the Earth's weather and climate are increasing. With the basic capabilities of the flare payload, the inclusion of solar constant instrumentation, and the complementary International Sun-Earth Explorer research, the SMM will make a significant contribution to our understanding of the effects of solar phenomena.

The procurement, assembly, and test of the experiments and spacecraft subsystems for SMM were completed in FY 1978. During FY 1979, the experiments and the spacecraft were integrated. In FY 1980 the observatory system is being tested, calibrated, and will be launched. In addition, the mission operations teams have been trained, and the guest investigator teams formed.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase of $2.5 million in FY 1980 funding requirements is the result of a delay in the launch of the SMM from the fourth quarter of 1979 to the first quarter of 1980. Technical problems were encountered during final testing of the observatory which required rework and retest of the spacecraft system. Resources were made available from within the Physics and Astronomy program, as discussed in the FY 1980 CHANGES section of the introduction.

BASIS OF FY 1981 FUNDING REQUIREMENT:

SPACE TELESCOPE (ST) DEVELOPMENT

	1979	1980		1981
	Actual	Budget Estimate	Current Estimate	Budget Estimate
	(Thousands of Dollars)			
Spacecraft	52,900	82,500	76,900	95,100
Experiments	26,300	30,200	35,800	24,200
Total	79,200	112,700	112,700	119,300
Mission operations and data analysis	(---)	(1,800)	(1,800)	(6,700)
Space transportation system operations	(100)	(100)	(100)	(3,200)

OBJECTIVES AND STATUS:

The Space Telescope will make a major contribution to understanding the stars and galaxies, and the nature and behavior of the gas and dust between them; and the broad question of the origin and scale of the universe. Operating in space above the atmospheric veil surrounding the Earth, the Space Telescope will increase by several hundredfold the volume of space accessible for observations. With its significant improvements in resolution and precision, in light sensitivity and in wavelength coverage, the Space Telescope will permit scientists to conduct investigations that could never be carried out using ground-based observatories due to the obscuring and distorting effects of the Earth's atmosphere.

The Space Telescope will enhance the ability of astronomers to study radiations in the visible and ultraviolet regions of the spectrum. It will be more sensitive than ground-based telescopes and will record greater detail about the objects under study. It will make possible observations of objects so remote that the light will have taken many billions of years to reach us. As a result, we will be able to look far into the distant past of our universe. It will also contribute significantly to the study of the early stages of stars and the formation of solar systems and to the observation of such highly evolved objects as supernova remnants and white dwarf stars. With the Space Telescope, we may be able to determine the nature of quasars, and the processes by which they emit such enormous amounts of energy. It will also be possible to study individual stars in nearby galaxies and perhaps determine if they have planetary systems.

The Space Telescope will be an automated observatory, delivered into orbit in 1983 by the Space Shuttle. Data from its scientific instruments will be transmitted to Earth via the Tracking and Data Relay Satellite System. The Space Telescope will differ from existing automated satellites in that its design will permit in-orbit maintenance, repair, and retrieval by the Space Shuttle for return to Earth, refurbishment and reuse.

During FY 1979, continued progress was made in the design and development of the Space Telescope. The first primary mirror blank was fabricated and shipped to the Optical Telescope Assembly contractor for grinding and polishing. Polishing of the mirror, which will be performed by a new computer-controlled polishing machine, was demonstrated by polishing a 60-inch mirror to Space Telescope specifications. A backup to the flight primary mirror was fabricated and delivered in August 1979, for polishing, using traditional manually controlled polishing machines. The observatory contractors completed design activities leading to Preliminary Design Reviews in the last half of FY 1979. Detailed designs were initiated following these reviews. The Preliminary Design Reviews for the Science Instruments were conducted in early FY 1979, after which the payload selection was confirmed and detailed instrument designs initiated. In addition, a contract was awarded for the development of the control and data handling system for the scientific instruments, and for the preparation of the verification and acceptance activities associated with the instruments.

FY 1980 activities support detailed design and development of the Optical Telescope Assembly, the Support Systems Module, and the Scientific Instruments. Polishing of the flight primary mirror will begin in April 1980. The Crticial Design Reviews for the Optical Telescope Assembly and the Scientific Instruments are scheduled for completion by mid-1980. After these reviews, fabrication and assembly activities will begin. In late FY 1980, the fine guidance sensor engineering model and the star simulator are scheduled to be delivered to the support systems module contractor for Space Telescope Pointing Control Subsystem Development Tests. Preliminary coding of flight software for the Support Systems Module will also be completed in FY 1980.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The total FY 1980 funding requirement for the Space Telescope development is unchanged. However, there is a redistribution between spacecraft and experiments which is based on revised estimates prepared at the time of confirmation of the science payload. This adjustment is consistent with scheduling of the overall project milestones.

BASIS OF FY 1981 ESTIMATE:

FY 1981 funding will support the fabrication and assembly activities of the Optical Telescope Assembly, the Scientific Instruments and the Support Systems Module. The fabrication and assembly of the Scientific Instruments is scheduled to be completed in mid-FY 1981, with verification testing to follow. The Primary Mirror of the Optical Telescope Assembly (OTA) is scheduled to be completed and assembly of the OTA subsystems is scheduled to begin in mid-FY 1981. The Critical Design Review for the Support Systems Module will be completed in FY 1981, after which fabrication and assembly activities will begin. Final coding of flight software will be completed and its validation begun in early FY 1981.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

INTERNATIONAL SOLAR POLAR MISSION (ISPM) DEVELOPMENT

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Spacecraft	2,969	35,000	32,900	62,600
Experiments	9,252	14,000	14,000	14,500
Ground operations	279	1,000	1,000	5,500
Total	12,500	50,000	47,900	82,600

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Space transportation systems operations.....	(1,700)	(6,700)	(9,700)	(15,700)

OBJECTIVES AND STATUS:

The International Solar Polar Mission is a joint NASA and European Space Agency mission designed to obtain the first view of the solar system from a new perspective -- a view from far above and far below the plane in which the planets orbit the Sun's equator. The two spacecraft will aid in the study of the relationship between the Sun and its magnetic field and particle emissions (solar wind and cosmic rays) as a function of solar latitude, and hence may allow us to gain insight into the possible effects of solar activity on the Earth's weather and climate.

The objective of the International Solar Polar Mission is to conduct an exploration of those regions of the heliosphere above and below the equatorial plane of the Sun. Observations in the extreme, high latitude regions of the Sun have not been made before, and evidence indicates that this region of space is greatly different from the region in which the Earth is located. Based on the growing evidence of a link between solar activity and terrestrial weather and climate, the need to understand the processes that might result from such a link becomes more pressing. The characteristics of the solar wind vary with the solar cycle, and the variability is becoming progressively better known as a result of continuing space exploration. The high latitude features on the Sun are believed to affect the solar wind conditions at Earth. The Solar Maximum Mission and the International Sun-Earth Explorers will study the solar process from essentially the solar equatorial plane.

NASA and the European Space Agency (ESA) will each provide one spacecraft of approximately equal and complementary capabilities. Science experiments have been assigned to each of the two spacecraft by a joint selection committee. Launch, tracking and data acquisition, and mission operations will be carried out by NASA, with ESA participation.

Employing a concept that exploits the gravitational pull of Jupiter, the launch of the mission is planned for February 1983. Both the NASA and ESA spacecraft will be launched from a single Shuttle/Inertial Upper Stage vehicle on a trajectory to Jupiter. The gravitational force of Jupiter will be used to swing the two spacecraft on mirror image courses (north and south) back over the Sun, well above the solar equatorial plane. Both spacecraft will then pass over the north and south poles of the Sun.

During FY 1979, the experiments were confirmed, flight instrument design began, interface specifications were established, and the spacecraft system contractor was selected.

During FY 1980 the preliminary designs of the spacecraft, experiments, and ground operations will be developed. Long lead time components and subsystems will be procured.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The reduction of $2.1 million in the FY 1980 estimate reflects a rephasing of funding requirements to match the current schedule of development activities, and the associated contractual funding pattern, under the spacecraft contract awarded in late 1979.

The International Solar Polar Mission launch plan was examined during 1979 in connection with the general review of the projected early system capabilities of the Space Transportation System. While it was determined that the baseline plan (single launch in 1983 of NASA/ESA spacecraft) would be retained, it was deemed prudent to maintain the option of dual launches for these two spacecraft in 1983. The preliminary cost estimates for maintaining this option and for the impact on the Solar Polar Mission of the slip of the Galileo mission to 1984 (which now makes Solar Polar the first planetary-type mission to be launched by STS) are currently under detailed review by the Agency.

BASIS OF FY 1981 ESTIMATE:

FY 1981 funding will provide for continued development of the spacecraft systems and experiments. Detailed designs, hardware procurement, and bread-board testing will be accomplished.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

GAMMA RAY OBSERVATORY (GRO) DEVELOPMENT

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Spacecraft	---	---	---	2,830
Experiments	---	---	---	16,100
Ground operations	---	---	---	170
Total	---	---	---	19,100

OBJECTIVES AND STATUS:

The objective of the Gamma Ray Observatory (GRO) program is to measure gamma ray radiation from the universe and, thus, to explore the fundamental physical processes powering it. Certain celestial phenomena are accessible only at gamma ray energies. The observational objectives of GRO are thus to search for direct evidence of the synthesis of the chemical elements; to observe high energy astrophysical processes occuring in supernovae, neutron stars and black holes; to locate gamma ray burst sources; to measure the diffuse gamma ray radiation for cosmological evidence of its origin; and to search for unique gamma ray emitting objects.

Gamma rays represent one of the last frontiers of the electromagnetic spectrum to be explored because the required technology has only recently been developed. The low flux levels of gamma ray quanta, and the high background they produce through their interaction with the Earth's atmosphere, coupled with the demand for better spectral, spatial, and temporal resolution of source features, combine to require that large gamma ray instruments be flown in space for a prolonged period. Gamma rays provide unique information on the most astronomically intriguing objects yet discovered, including quasars, neutron stars, and black holes. Astronomy is now to the point where our understanding of these objects is being seriously impaired by lack of data in the gamma ray region of the spectrum. Comprehensive research in gamma ray astronomy has therefore consistently been given high priority by the science community.

The GRO will be launched by the Space Shuttle. The spacecraft is designed to accommodate five gamma ray instruments. It is planned that four of the instruments will have their principal axes pointing in the same direction. The spacecraft will point these instruments in a fixed direction in space for long periods of time (hours to weeks). The accessibility of different regions of space at any given time will only be limited by solar array pointing and seasonal constraints.

The current planning estimate for the GRO is $180-225 million. This includes development through launch plus thirty days in-flight checkout. The estimate for support during the two-year mission operations period and for analysis of the scientific data is $30-45 million. The estimate for Space Transportation System support is approximately $40 million.

BASIS FOR FY 1981 ESTIMATES:

The FY 1981 funding requirements will support the initiation of design and development for the Gamma Ray Observatory. A competitive procurement is planned during FY 1980 leading to the selection of two or more contracts to perform parallel, independent mission concept studies. Following these studies, a contractor will be selected from among the study participants to develop a spacecraft, to integrate the spacecraft and scientific instruments, and to support the mission operations. Scientific instruments for GRO have been selected for definition from responses by the scientific community to an Announcement of Opportunity.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

SHUTTLE/SPACELAB SCIENCE PAYLOAD DEVELOPMENT AND MISSION MANAGEMENT

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
Science experiments	24,692	25,800	16,900	25,200
Mission management	10,208	15,500	24,000	46,900
Total	34,900	41,300	40,900	72,100
Space transportation systems operations	(2,600)	(20,100)	(13,200)	(32,100)

OBJECTIVES AND STATUS:

The objectives of the Shuttle/Spacelab science payload development and mission management are to acquire new knowledge in the disciplines of Physics and Astronomy, and to manage the mission planning and execution of the complete NASA Spacelab payload program. The science experiment funding provides for the development of Physics and Astronomy experiments and the analysis of the flight data. Mission management funding provides for system management and engineering of the payload hardware, flight hardware and software necessary to support the experiment complement, payload specialist support, physical integration of the payload with the Spacelab, flight operations, and data dissemination to the science investigators for all NASA Spacelab flights.

Shuttle Orbital Flight Test (OFT) and Spacelab-1 and -2 Payload Development

The experimental payload scheduled for launch in 1981 on a Shuttle orbital flight test will consist of six instruments that will gather solar physics data, evaluate the Shuttle environment, and provide data on thermal control technology. These instruments are mounted on a Spacelab pallet, and a Life Sciences experiment is located inside the orbiter cabin. In FY 1979, the instrument design and development activities were completed. The FY 1980 budget will support completion of instrument fabrication and assembly and test of the integrated payload. Flight operations planning has been in process since FY 1979 and will be completed this year. Launch and flight operations will occur in FY 1981.

Spacelab 1, which will consist of a pressurized module plus a pallet will carry a complement of 38 instruments from the U.S., Europe and Japan, and will be flown in 1982. The primary objective of the mission is to demonstrate the capabilities of the Spacelab system, and the secondary objective is to obtain multidiscipline scientific data with emphasis on atmospheric and space plasma physics. Spacelab 1 activities underway in FY 1980 include selection of the flight instrument complement, continuation of experiment development, completion of mission peculiar equipment final design, development of mission operations, and continuation of analytical integration and payload specialist training.

The Spacelab 2 development activities are on schedule for flight in 1982. Spacelab 2 will be the first flight of an all-pallet configuration of Spacelab. Although the primary objective of the mission is to verify the Spacelab system, the secondary objective is to obtain scientific data with emphasis on astrophysics and solar physics. The payload consists of eleven U.S., and two United Kingdom astrophysics and solar physics experiments. The instrument pointing system, developed by the European Space Agency, will be flown for the first time on this mission. Spacelab 2 activities in FY 1980 include final design and operation reviews on the integrated payload and mission peculiar equipment, continuation of experiment development, development of missions operations, and continuation of analytical integration and payload specialist training.

Shuttle/Spacelab Principal Investigator and Multiuser Payloads

Physics and Astronomy experiments to be flown on the Shuttle/Spacelab are divided in two classes: principal investigator instruments and multiuser instruments. Principal investigator instruments are those proposed for a specific scientific investigation by a single investigator who may have co-investigators. Multiuser instruments have a broad scientific capability, can accommodate a number of principal investigator-furnished focal plane or ancillary instruments, and have a large user community. In general, principal investigator and multiuser instruments will fly together, making scientifically coordinated payloads. In response to an Announcement of Opportunity, issued in 1978, soliciting proposals for investigations to be conducted on missions after Spacelab 3, forty-two principal investigator instruments were selected for definition studies. In the multiuser class, after extensive instrument feasibility and definition studies, NASA selected the Solar Optical Telescope, the Chemical Release Module and the Shuttle Infrared Telescope Facility for development. The Solar Optical Telescope will allow high resolution observations of the solar surface features using a number of focal plane instruments. The system will be designed for changes of focal plane instrumentation between successive flights. The Chemical Release Module will be used to trace the atmospheric motions of neutral constituents to map magnetic and electric fields, to display plasma instabilities, and to study, using test particles, particle behavior. The Shuttle Infrared Telescope Facility will conduct high resolution studies of selected celestial infrared objects and will provide valuable insight into many questions of modern astrophysics including the early stages of star formation and the later stages of star evolution, the unusually high energy output of the nuclei of certain galaxies and quasars and the early evolution of galaxies and the universe itself.

During FY 1979, the mission management responsibility for all NASA Spacelab payloads was assigned to the Office of Space Science. Beginning in FY 1981, funding support for the NASA-wide Spacelab payload mission management will be budgeted in this program area.

The FY 1981 payload development effort will concentrate on missions which will be flown in 1983. These missions are predominately life science payloads and a mission drawing from the Physics and Astronomy science disciplines. Currently under development is the Annular Suspension Pointing System, an advanced, highly stable and accurate pointing system designed to satisfy instrument requirements for early Shuttle/Spacelab missions.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The $400 thousand reduction in the total Shuttle/Spacelab science payload development and mission management project is the result of a general Congressional reduction to the NASA FY 1980 R&D appropriation. Within the project, there has also been a realignment between the science experiments and the mission management efforts. First, a subproject definition change is reflected in the FY 1980 Budget Estimate column: support equipment ($4.1 million) budgeted under the Science Experiments line last year is now carried under Mission Management. Secondly, the selection and contracting process for future Spacelab science experiments has required more time than planned. This factor, together with the adjusted Space Transportation System flight schedule, has permitted a reduction in the FY 1980 estimates for Science Experiments. On the other hand, further definition activity, along with experience gained in the planning for the early missions, has made evident the greater scope of work required in the mission management function. This fact, together with the plan to contract for certain mission planning work on Spacelabs 1 and 2 previously planned to be accomplished by civil service staff, is reflected in the increase in the FY 1980 estimate for mission management.

BASIS OF FY 1981 ESTIMATE:

OSS-1 and Spacelab 1 and 2

The FY 1981 budget request provides for the mission management and science experiment data analysis of the experiments which will be flown on a Shuttle orbital flight test in 1981. This level of funding will also provide for the completion of Spacelab 1 and 2 hardware, initiation of integration of the Spacelab 1 and 2 hardware with the Spacelab system, and final preparation of launch and operations plans.

Shuttle/Spacelab Principal Investigator and Multiuser Payloads

FY 1981 funding provides for the development of Physics and Astronomy principal investigator instruments now selected and under definition. The Solar Optical Telescope, Chemical Release Module, and Shuttle Infrared Telescope Facility will be under development in FY 1981.

The FY 1981 mission management funds will support the ongoing mission integration activities for NASA missions. Missions involved in this program in FY 1981 will include Space Applications, Space Research and Technology, Life Sciences, and Physics and Astronomy areas. FY 1981 funds will also be utilized to support the engineering and analysis for interface definition and mission definition of Shuttle/Spacelab instruments during development phases.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

EXPLORER DEVELOPMENT

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Dynamics explorer (DE)	11,022	11,100	11,900	12,600
Solar mesosphere explorer (SME)	2,413	6,900	7,460	4,078
Infrared astronomical satellite (IRAS)	15,840	5,700	10,213	5,066
Active magnetospheric particle tracer explorer (AMPTE)	---	---	---	6,600
Other explorers	2,013	6,700	2,727	4,656
Total	31,288	30,400	32,300	33,000
Mission operations and data analysis (MO&DA)	(12,350)	(13,000)	(13,707)	(14,783)
Scout and Delta (expendable launch vehicles program)	(8,600)	(---)	(800)	(---)
Space transportation system operations	(---)	(3,700)	(1,900)	(4,200)

OBJECTIVES AND STATUS:

The Explorer program provides the principal means of conducting astronomical studies and long-term investigations of solar physics and of the near-Earth interplanetary environment having limited, specific objectives and not requiring major observatories.

Included in the present program are missions to study atmospheric and magnetospheric physics; the several magnetospheric boundaries; interplanetary phenomena; and X-ray, ultraviolet, and infrared astronomy.

Studies are conducted to define future high priority science Explorer missions. NASA engages in cooperative missions with other U.S. Government agencies and other nations whenever such cooperation will assist in achieving NASA objectives.

Solar Terrestrial and Atmospheric Explorers provide the means for conducting studies of the Earth's near-space environment. The program requires a wide variety of satellites in orbits extending from the very lowest reaches of the upper atmosphere, to the interplanetary medium beyond the Earth's magnetosphere. The Solar Terrestrial program is in a transition from the early discovery and mapping phase conducted over the past decade to a phase in which specific problems will be investigated in more depth, frequently using simultaneous multipoint measurements. Efforts underway include development activity for the Solar Mesosphere Explorer (SME), the Dynamics Explorer (DE) and the San Marco-D missions. The SME is designed to investigate the stability of the Earth's ozone layer with emphasis on determining the response of ozone to changes in the solar ultraviolet flux. DE will provide data on the strong interactive processes coupling the hot convecting plasmas of the magnetosphere and the cooler plasmas and gases of the Earth's ionosphere and upper atmosphere. The San Marco-D, cooperative missions with Italy, will conduct a group of experiments to study the relationship between solar activity and Earth meteorological phenomena. Definition studies for several missions are underway, including the Active Magnetospheric Particle Tracer Explorer (AMPTE), a cooperative program with the Federal Republic of Germany, with development activity planned in FY 1981.

Astrophysics Explorers have been instrumental in conducting the first astronomical sky surveys in the gamma ray, X-ray, ultraviolet, and infrared and low frequency radio regions of the electromagnetic spectrum. Major efforts underway include continuation of hardware and subsystems procurement and experiment fabrication for the Infrared Astronomical Satellite (IRAS); continuation of development work for the Cosmic Ray Isotope Experiment (CRIE), a cooperative program with DOD in which NASA will provide a scientific instrument for flight on an Air Force spacecraft; and future mission definition studies including the Cosmic Background Explorer (COBE), the Extreme Ultraviolet Explorer (EUVE), and the X-ray Timing Explorer (XTE).

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase in FY 1980 funding requirements is the result of technical problems encountered in the development of spacecraft and instruments in ongoing projects. In particular, the Infrared Astronomical Satellite has experienced a number of technical difficulties which have resulted in increased costs, including cryogenic system fabrication, mirror polishing, and focal plane detector systems development.

BASIS OF FY 1981 ESTIMATE:

FY 1981 funding will provide for completion of development activity, launch, and initial orbital operations for the IRAS, SME, DE, and San Marco-D/L missions; completion of development work on CRIE for launch on an Air Force spacecraft; initial development activity for the AMPTE mission; and design and definition studies for future Explorers including the COBE, EUVE, XTE, and Solar Corona Explorer (SCE) missions.

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BASIS OF FY 1981 FUNDING REQUIREMENTS:

MISSION OPERATIONS AND DATA ANALYSIS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
High energy astronomy observatory (HEAO) basic mission	5,439	5,351	6,336	128
HEAO extended mission	3,714	8,549	8,548	10,606
Solar maximum mission (SMM) basic mission	---	4,900	4,500	3,400
SMM extended mission	---	---	---	1,600
Space telescope (ST)	---	1,800	1,800	6,700
Explorers	12,350	13,000	13,707	14,783
Orbiting astronomical observatory	2,450	2,900	2,209	1,683
Orbiting solar observatory (OSO)	1,500	---	---	---
Total	25,453	36,500	37,100	38,900

OBJECTIVES AND STATUS:

The purpose of the effort is to conduct operations and to analyze data from the Physics and Astronomy satellites after launch. This program also supports the continued operations of a number of spacecraft after their originally planned objectives have been achieved for purposes of conducting specific investigations that have continuing high scientific significance.

The first two High Energy Observatories (HEAO-1 and -2) have provided new and complementary data on a wide variety of cosmic X-ray sources. HEAO-1 completed a highly successful mission of mapping the entire X-ray sky with unprecedented sensitivity and reentered the atmosphere in March 1979. Among the primary results were the discovery of more than one thousand new sources; the determination of precise locations of many sources allowing optical identifications; the establishment of whole new classes of X-ray emitting objects; the detection of line emission from hot, highly ionized iron in neutron star binaries, supernova remnants, active galaxies, and clusters of galaxies; the discovery of the ubiquity of X-ray emission by normal stars; and the measurement of the spectrum of the diffuse X-ray sky background which is suggestive of an origin in a hot, tenuous gas at a temperature of 400 million degrees Kelvin.

HEAO-2 completed its first year of operation in November 1979, and has yielded a series of impressive results. For example, HEAO-2 has confirmed the stellar X-ray emission detected by HEAO-1 and demonstrated

that a much wider variety of stars emit X-rays in greater quantities than previously predicted. Similarly HEAO-2 observations of supernova remnants have had a profound impact on theories of the supernova explosion and the neutron star formation process. Beyond our own galaxy, HEAO-2 has mapped both the Milky Way's nearest neighbor galaxies, as well as the most distant quasars observed with optical telescopes. During its first year of operation, nearly 400 proposals have been submitted to use the HEAO-2 in a guest observer mode. These proposals have come from over 80 research groups around the world.

HEAO-3 was launched in September 1979. All instruments are returning excellent scientific data. The galactic plane has been extensively scanned with the gamma ray spectrometer, and preliminary analysis of the data shows the detection of line features from several known sources. The cosmic ray instruments have provided new information of the detailed composition of cosmic rays in the iron, nickel, and cobalt group.

The Solar Maximum Mission (SMM) is planned for launch in the first quarter of 1980. The SMM spacecraft will make detailed observations of the solar flare processes during the coming period of maximum solar activity, which is currently predicted to be 20 to 30% above the 130-year average cycle throughout 1980 and 1981. The SMM will carry instruments to permit detailed coherent investigations of flare-accelerated electrons and nucleons, of flare plasmas over a wide range of temperatures, and of coronal disturbances resulting from flares. In addition, coordinated observations by the SMM and the currently operational International Sun-Earth Explorers (ISEE) will permit studies of the source of specific solar wind disturbances and their effect on the Earth's magnetosphere.

In addition to the normal support required for mission operations, the Space Telescope program presents several unique aspects which must be provided for well in advance of launch. The Space Telescope is designed for operation for more than a decade, based on in-orbit maintenance, recovery, refurbishment, and relaunch and in-orbit changeout of the scientific instruments at the focal plane. During the operational period, it will be used primarily by general observers scheduled on the basis of proposals submitted in response to periodic solicitations. NASA has determined that the most efficient and scientifically satisfactory approach to science operations will involve establishment of an independent Science Institute which will operate under a long-term contract with NASA. While NASA will retain operational responsibiltiies for the observatory, the Institute will implement NASA policies in the areas of planning, management, and scheduling of the scientific operations of the telescope.

Several Explorer spacecraft remain operational and are providing valuable data. The International Ultraviolet Explorer (IUE) and International Sun-Earth Explorers (ISEE) continue to perform their missions well, with very productive guest investigator programs. The last Atmospheric Explorer (AE-E), launched in 1975, is still functioning well, and is providing insight into thermospheric and atmospheric variations not otherwise obtainable. For example, AE is providing interesting new data which seems to show solar ultraviolet input correlating in a different way with sunspot activity than it did during the last solar cycle. The

Interplanetary Monitoring Platforms continue to provide data on solar wind, cosmic rays, and on the Earth's geomagnetic tail from locations needed to correlate with spacecraft in other locations.

The Orbiting Astronomical Observatory (OAO-3), Copernicus, which was launched in 1972, continues to provide a three-axis stabilized automated facility for observing celestial objects and interstellar material in the X-ray and ultraviolet spectral ranges. OAO-3 is the only currently operating satellite capable of making spectroscopic observations in the important 900-1,150 angstrom wavelength region. During the past seven years, new techniques have been developed which have enhanced the usefulness of OAO-3 by allowing the observation of objects six times fainter than could be observed when the satellite was first launched. As a result, many new classes of objects have been studied by this observatory. FY 1980 funds support the operation of OAO-3 and the analysis of data obtained. The program has involved over 160 investigators and 170 different scientific projects. During the past year, however, the far ultraviolet detectors aboard OAO-3 have suffered a rapid degradation due to increased levels of solar activity. This degradation limits the science that OAO-3 can perform and it has been decided to terminate the mission in the fall of 1980. This will allow sufficient time for an orderly completion of the highest priority science.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The FY 1980 changes reflect (1) an increase in the mission operations and data analysis phase of the HEAO program in order to cover increased cost for baseline operations; (2) a decrease in SMM operations costs due to a delay in the launch date; (3) a decrease in the guest investigator program for OAO-3 based on the decision to terminate operations in November 1980; and (4) an increase in the mission operations phase of the Explorer program in order to provide additional support for guest investigations on the IUE mission.

BASIS OF FY 1981 ESTIMATE:

FY 1981 funds will provide support for the continued operations of the HEAO-2 and HEAO-3 missions and related data analysis activity; the operations and data analysis activity for the Dynamics Explorers-A and -B missions scheduled for launch in 1981; data analysis activity for CRIE scheduled for launch on an Air Force spacecraft in 1981; extension of operations and data analysis activity for IUE, ISEE-A, -B, and -C, and AE-E; and support for continued analysis of the extensive archive of data obtained by OAO-3 and the Small Astronomy Satellite (SAS) C mission. FY 1981 funding will also support the operations and data analysis activities of the Solar Maximum Mission (SMM) as well as the continuation of preparations of science operations for the Space Telescope, including the initiation of a Space Telescope Science Institute.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

RESEARCH AND ANALYSIS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
		(Thousands of Dollars)			
Supporting research and technology (SR&T)	19,776	21,500	21,500	24,900	RD 4-27
Spacelab science payload definition	2,968	3,200	3,000	6,100	RD 4-28
Advanced technological development	200	2,500	2,500	2,700	RD 4-28
Data analysis	8,624	7,100	7,100	9,100	RD 4-29
Upper atmospheric research	12,437	---	---	---	
Total	44,005	34,300	34,100	42,800	

OBJECTIVES AND STATUS:

This program provides for the research and technological base necessary to plan and support flight projects. Preliminary studies to define missions and/or payload requirements are carried out, as are theoretical and ground-based supporting research, and Advanced Technological Development (ATD). Activities included are Supporting Research and Technology (SR&T), Spacelab Science Payload Definition, ATD, and Data Analysis. Beginning in FY 1980, the Upper Atmospheric Research program and direct supporting activities were included in the Space Applications program.

Supporting Research and Technology (SR&T)

The objectives of Supporting Research and Technology are: (1) to enhance the value of current space missions by carrying out complementary and supplementary ground-based observations and laboratory experiments; (2) to develop theories to explain observed phenomena and predict new ones; (3) to optimize the return expected from future missions by problem definition, development of advanced instrumentation and concepts, and sound definition of proposed new missions; and (4) to strengthen the technological base for sensor and instrumentation development and to conduct basic research necessary to support our understanding of Astrophysics and Solar Terrestrial relationships.

Research is supported in several disciplines of space physics and astronomy. The work in space physics is largely devoted to tasks related to the physics of the Earth's environment and comparative studies of other

planetary environments, including the study of Sun-Earth environmental factors. The work in solar physics involves studies of the solar atmosphere and the influence of the Sun on interplanetary and planetary environments. Research supported in astrophysics involves studies of stars, galaxies, interstellar and intergalactic matter and cosmic rays. The development of new instruments, laboratory and theoretical studies of basic physical processes, and observations by ground-based and balloon-borne instruments are also supported.

A major activity in SR&T is the Solar Terrestrial Theory program which is designed to provide for theoretical investigations of the predominately plasma physical processes important to solar physics and the solar terrestrial environment. The intent of the program is to enhance and assure the systematic development of scientific investigations of solar system plasmas and for this to play a vital role in the planning of future space missions and research efforts.

The SR&T program funds tasks at universities, nonprofit and industrial research institutions, NASA Centers, and other government agencies. Current emphasis is being placed on studies for advanced instrumentation which will increase both the sensitivity and resolution of detectors. Feasibility and scientific definition studies are being conducted on several potential candidate future missions, including the Gravity Probe-B which will carry out an experimental test of Einstein's General Theory of Relativity in which measurements would be obtained of the relativistic precession of an extremely stable, cryogenic gyroscope in Earth's orbit. Scientific definition will also be started for the Cosmic Ray Observatory (CRO), a mission which will carry large cosmic ray instruments to measure particles of very high energy and low flux.

Spacelab Science Payload Definition

Spacelab Science Payload studies have provided the data necessary to establish a sound foundation for the Physics and Astronomy experiments to be conducted on Shuttle/Spacelab missions. The initial studies concentrated on establishing the feasibility of performing discipline-dedicated missions and multidisciplinary missions employing both facility-class and principal investigator-class instrumentation. The studies have identified the benefits which can be realized by reflying instruments and facilities. Instruments selected for study were those identified as having both complementary and evolutionary scientific uses. By planning to reuse and evolve instrument capabilities and to use instruments together as ensembles when they become available, a forceful and efficient research strategy for Spacelab use has evolved.

Multiuser Class Instruments (MUI's) now being defined include: the Shuttle Infrared Telescope Facility (SIRTF), a cryogenically cooled telescope which will carry out high sensitivity infrared observations, the Solar Soft X-Ray Telescope, the Tethered Satellite System, and the Shuttle Ultraviolet/Optical Telescope (STARLAB), a meter-class UV/optical facility which will be used for high angular resolution imaging investigations of sources that have too great an angular extent to be observed efficiently with the Space Telescope.

During FY 1980, further payload definition involving detailed description of instruments, payload configurations and operational missions will continue.

Advanced Technological Development

The Advanced Technological Development (ATD) activities support detailed planning and definition of new Physics and Astronomy missions. ATD activities assure that advanced missions address the scientific questions most important to the evolution of knowledge in the field, and that those missions use the appropriate technology and techniques available. Funding is applied to the definition and preliminary design of subsystems and elements critical to eventual mission development in order that technical readiness and resources may be better known before the missions are proposed for implementation.

Candidate missions for the 1980's that require ATD activities include the Origin of Plasmas in Earth's Neighborhood (OPEN), the Advanced X-ray Astrophysics Facility (AXAF), the Solar Probe, and the Solar Internal Dynamics Mission (SIDM). The OPEN project will study systematically the origin, storage, transport and loss of plasmas in the Earth's environment from input by the solar wind and ionosphere to loss in the atmosphere. The mission will assess the importance to the terrestrial environment of variations in energy input to the Earth's atmosphere caused by geospace processes. The AXAF will study stellar structure and evolution, active galaxies, clusters of galaxies and cosmology. The AXAF 1.2 meter class imaging X-ray telescope is planned to have a sensitivity approximately 20 times that of HEAO-2. The Solar Probe Mission will perform detailed scientific observations of the Sun from a high elliptical orbit whose aphelion takes it to within four solar radii of the Sun's surface. The Solar Internal Dynamics Mission (SIDM) will investigate the oscillations visible on the Sun and use the data obtained to study the dynamic state of the Sun's interior. During FY 1980, major emphasis is being given to definition of the GRO mission in preparation for FY 1981 development activity and to preliminary feasibility studies on the OPEN mission.

Data Analysis

The acquisition, analysis and evaluation of data represents the primary purpose of our laboratory, balloon, rocket and spacecraft activities. While a considerable amount of analysis is done during the prime project phase, experience has shown that considerably more time is generally required to reap the full benefit from these programs. More specifically, it is the time when the data may be correlated with other projects, when detailed cause-and-effect studies are made with data sets from other sources, when very long-term (solar cycle) effects can be studied using complementary sets of data, and when many new ideas can be tested that originate from the results of the initial analysis.

For example, long-term observations of the X-ray source Vela X-1 provided important constraints on the internal structure of neutron stars. Thus, additional data is processed and analyzed, multi-instrument studies are made, and various proposed models or theories are critically tested by use of the data.

Support of the operation of the National Space Science Data Center (NSSDC) is also provided under this program. The NSSDC, located at the Goddard Space Flight Center (GSFC), was established to serve as a central repository and clearing house for scientific data resulting from space investigations. The NSSDC is now in a stage of transition from a repository to a facility where correlative research can be accomplished using data sets from many sources, including active spacecraft. The Satellite Situation Center at NSSDC computes the expected positions of operational spacecraft, so that data acquisition and analysis efforts can be concentrated at times when several spacecraft are especially favorably situated for correlative geophysical studies.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The reduction of $200 thousand in the FY 1980 estimate results from a slight adjustment in activity associated with payload planning under the revised Shuttle flight schedule.

BASIS OF FY 1981 ESTIMATE:

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Supporting research and technology	19,776	21,500	21,500	24,900

During FY 1981, the Supporting Research and Technology program will support those tasks which contribute to maintaining a firm base for a viable Physics and Astronomy program. Emphasis will be placed on infrared detector development and on expansion of technology activities related to large X-ray mirrors and advanced X-ray detectors and instrumentation. Feasibility and scientific definition studies will be conducted on several potential candidate missions for future years, including Gravity Probe-B. Emphasis will also be placed on the development of a large area electrographic camera for astronomical use, and on the continued development of large array multichannel plate and intensified charge coupled imagery devices.

In the area of Solar Physics, activities will support the Solar Maximum Mission through both ground-based observations and theoretical studies of high energy phenomena. New thrusts will be initiated concerning the development of advanced generation instruments, especially for the extreme ultraviolet and X-ray wavelengths, and for analyzing the internal structure and dynamics of the solar interior. New thrusts will also be

established in the area of Atmospheric Electrodynamics. In the area of Theoretical Studies, investigations will be carried out by concentrated groups of theorists in the fields of solar, interplanetary, magnetospheric, ionospheric and atmospheric physics in a coordinated program aimed at the understanding of the detailed behavior of each of these components of the solar terrestrial relationship and their interrelationships.

BASIS OF FY 1981 ESTIMATE:

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Spacelab science payload definition.....	2,968	3,200	3,000	6,100

In FY 1981, further definition of new concepts, as well as those presently under study, will be performed. The studies will provide descriptions of instruments and facilities, payload configurations and operational mission profiles. In addition, concepts and methods of extending time in orbit beyond the present Spacelab capability are being studied and evaluated. The detailed scientific definition of those facility instruments that are strong candidates for hardware development in the early 1980's will also be carried out in FY 1981. In the area of Spacelab Mission Integration, activities will be undertaken to identify user requirements and define interfaces for investigations which have yet to be assigned to a specific mission. New ways to reduce Spacelab mission integration costs as well as to permit Spacelab missions to be responsive to user demands will be pursued. Definition studies on the requirements and uses of the Space Platform concept will continue.

BASIS OF FY 1981 ESTIMATE:

Advanced Technological Development (ATD).....	200	2,500	2,500	2,700

FY 1981 funding will provide for continuation of studies and definition of future missions planned for the 1980's. The FY 1981 funding will allow for further system definition studies, and instrument definition for investigations selected in FY 1980 for the OPEN mission. In addition, funding will support studies on the Advanced X-Ray Astrophysics Facility (AXAF), the Solar Probe, and the Solar Internal Dynamics Mission (SIDM). Within the FY 1981 funding, contractor definition studies will be accomplished to assure the technological and scientific readiness of the candidate future missions.

BASIS OF FY 1981 ESTIMATE:

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Data Analysis	8,624	7,100	7,100	9,100

Emphasis in the Data Analysis project, to be carried out at universities and government research Centers, will be placed on correlative studies involving data acquired from several sources (spacecraft, balloons, sounding rockets, research aircraft, and ground observatories). Several workshops will be held during FY 1981 devoted to specific physical problems (e.g., preflare storage of energy). FY 1981 funds will also support the operations of the National Space Science Data Center.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

SUBORBITAL PROGRAMS					Page No.
Sounding rockets	21,307	21,700	21,700	25,000	RD 4-29
Airborne research	4,600	4,000	4,000	4,500	RD 4-31
Balloon program	2,300	1,200	1,200	1,400	RD 4-32
Total	28,207	26,900	26,900	30,900	
Sounding rockets	21,307	21,700	21,700	25,000	

OBJECTIVES AND STATUS:

The Sounding Rocket program provides versatile, relatively low cost research tools that complement the capabilities of balloons, aircraft, free-flying spacecraft and the Space Shuttle in all the space science disciplines, including the study of the Earth's ionosphere and magnetosphere, space plasma physics, stellar astronomy, solar astronomy, and high energy astrophysics. Activities are conducted on both a domestic and an international cooperative basis. The current level of activity is about 60 rocket flights per year.

The specific objectives of the Sounding Rocket program are as follows:

1. To conduct a coordinated research program with flight requirements that cannot be met by vehicles with different performance characteristics. Sounding Rockets are uniquely suited for performing low altitude measurements (between balloon and spacecraft altitude) and for measuring vertical variations of many atmospheric parameters.

Specific areas of study include:

a. The nature, characteristics, and composition of the magnetosphere and near space.

b. The effects of incoming energetic particles and solar radiation on the magnetosphere, including the production of aurorae and the coupling of energy into the atmosphere.

c. The nature, characteristics, and spectra of radiation of the Sun, stars, and other celestial objects.

2. To support the basic objectives of the Physics and Astronomy program by providing the means for flight testing instruments and experiments being developed for later flight on satellites, Shuttle/Spacelab and space probes; and for calibrating or obtaining vertical profiles in concert with current orbiting spacecraft.

In 1979, 56 rockets were launched from eight locations in the United States, Canada, Sweden, Norway and Antarctica. These rockets supported the research activities of about 50 groups from universities, private industry, NASA field centers, other government agencies and foreign space organizations.

During the February 1979 solar eclipse over the northwestern United States and western Canada, seven launches were made from western Ontario, Canada, in support of Plasma Physics and Upper Atmospheric studies. A similar expedition is planned to support Plasma Physics and Solar Physics studies during the solar eclipse over East Africa in February 1980. Also, in support of Solar Terrestrial studies in FY 1980, chemical release experiments will continue to be launched on sounding rockets to measure winds, wind shears, temperatures, plasma motions, and electric fields.

In the astronomy and high energy astrophysics disciplines, continuing emphasis is being placed on development of instruments for studies of stars and extended sources in the ultraviolet (UV) and X-ray spectral regions. Of special interest during 1979 were several flights of an ultraviolet imaging telescope. The instrument obtained high quality photographs of nearby galaxies in both the far and mid-ultraviolet. These data help delineate hot young objects in these galaxies and will provide important new targets for the Space Telescope. During FY 1980, the first flight of an extreme ultraviolet spectrograph is planned.

BASIS OF FY 1981 ESTIMATE:

FY 1981 funds will provide for continuation of most of the efforts described above. Emphasis will be given to initiation of a concept called Experiments of Opportunity Payloads (EOP) which would make the capabilities of the Shuttle available to sounding rocket experimenters and potentially increase scientific

data acquisition periods from the present five minutes per flight up to 24 hours. The EOP concept calls for sounding rocket payloads, technology, and hardware to be launched by the Shuttle into a closeby orbit, operate in a free-flyer mode for up to 24 hours and then be retrieved and returned by the Shuttle. Payloads will be flown on a space available basis and have minimum interface with the Shuttle. An EOP development test flight is planned in the 1981-1982 time frame to provide a basis for evaluating the feasibility of the concept. Other efforts planned in FY 1981 include: (1) the first flight of an extremely high resolution, far ultraviolet spectrograph, which will provide a test of microchannel plates as space detectors and (2) the first test of new low cost technique using coated aluminum sheets for focusing X-rays.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Airborne research	4,600	4,000	4,000	4,500

OBJECTIVES AND STATUS:

Research with instrumented jet aircraft has been an integral part of the overall NASA program in Physics and Astronomy since 1965. The aircraft platform provides a large payload capacity and facilities for extending observations over any region of the Earth. It also may be transported readily to high operational altitude near 15 km (50,000 feet) in order to provide a cloud-free site for auroral geophysics experiments and astronomical observations. The possibility of conducting observations at this cloud-free altitude has been essential in opening to astronomy the infrared region of the electromagnetic spectrum from one micrometer to one millimeter. The airborne platform has the further advantage of enabling scientists to participate directly in space research.

The Airborne Research program has utilized two aircraft, the C-141 instrumented with the 91-cm infrared (IR) telescope and the Lear Jet instrumented for unique individual missions. The C-141A "Kuiper Airborne Observatory", which began operational flights in 1974, is a full-scale, manned facility. The 91-cm f/13.5 infrared telescope operates through an open port, with a pressure bulkhead giving the astronomers a comfortable, shirt-sleeve environment in which to work. The telescope floats on a large air bearing that permits hours of accurate stabilization within a few arc seconds. The weight of this observatory is about 16 tons (14.5 metric tons).

During the past year, support was provided for the February 1979 Solar Eclipse over the northwestern United States and Canada, and for an expedition to lower latitudes to observe the Galactic Center. In addition, a scheduled airframe inspection was accomplished on the C-141A. During FY 1980, support will

be provided for four airborne expeditions to areas in the Pacific to identify infrared sources not readily observable from the continental United States. Of special interest is the support planned for simulated Shuttle re-entry using an SR-71 aircraft (Project IRIS, Infrared Imagery Simulation). The main thrust of the FY 1980 program will be continued exploration of star forming regions as well as the development of more sensitive instrumentation for both photometry and spectroscopy.

BASIS OF FY 1981 ESTIMATE:

In FY 1981, airborne research funds will be used to continue operations of the Airborne Observatory and the Lear Jet, to provide support for astronomical groups, and to continue the development of improved instrumentation for conducting infrared astronomy.

	1979 Actual	Budget Estimate	Current Estimate	Budget Estimate
		(Thousands of Dollars)		
Balloon program	2,300	1,200	1,200	1,400

OBJECTIVES AND STATUS:

For the development of scientific experiments for space flight and for independent scientific missions, it is necessary to test the instrumentation in the space radiation environment and to make observations at altitudes which are above most of the obscuring effects of the atmosphere, particularly for observations in infrared and cosmic ray astronomy. In many instances, it is less expensive to fly these experiments on balloons. The funding for this program is utilized for balloons, helium, launch services, tracking and recovery, while funding for the experiments is provided from the Supporting Research and Technology program.

During 1979, 21 balloons were flown from five global sites to support the research activities of approximately 19 organizations. Of special interest was the successful resolution of problems affecting heavy-lift balloons, and a resumption of flights in the spring of 1979. One of these flights, carrying a 5,000-pound package of ultrasensitive instruments, has detected a stream of antimatter from interstellar space--the first such matter ever found outside a terrestrial laboratory. In the Infrared Astronomy area, about 40 percent of the galactic plane was surveyed resulting in the discovery of many new infrared sources.

FY 1980 funding provides support for about 20 flights including an expedition to Hawaii for carrying out scientific research in High Energy Astrophysics. In Infrared Astronomy, the survey of the galactic plane will be continued, which will provide additional information on the rate of star formation in our Milky Way system.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 funding provides for continuation of the Balloon program with approximately the same number of flights as in FY 1980. New techniques for understanding high energy nuclear interactions using cosmic rays will be tested in FY 1981 prior to being incorporated into Spacelab. In Infrared Astronomy, emphasis will be on continuing the survey of the galactic plane and using new techniques to better understand how stars are formed prior to designing instruments for Spacelab.

RESEARCH AND DEVELOPMENT
FISCAL YEAR 1981 ESTIMATES
BUDGET SUMMARY

OFFICE OF SPACE SCIENCE

PLANETARY EXPLORATION PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
		(Thousands of Dollars)			
Galileo Development	78,700	116,100	116,100	63,100	RD 5-5
Mission Operations and Data Analysis	59,300	59,000	58,800	64,800	RD 5-8
Research and Analysis	44,400	45,100	45,000	51,700	RD 5-10
TOTAL	182,400	220,200	219,900	179,600	
DISTRIBUTION OF PROGRAM AMOUNT BY INSTALLATION:					
Johnson Space Center	4,115	6,380	6,012	5,990	
Marshall Space Flight Center	824	10	45	75	
Goddard Space Flight Center	3,749	3,830	3,757	3,780	
Jet Propulsion Laboratory	107,899	136,330	140,067	101,877	
Ames Research Center	40,841	44,520	30,953	28,340	
Langley Research Center	---	---	7	---	
Headquarters	24,972	29,130	39,059	39,538	
TOTAL	182,400	220,200	219,900	179,600	

RESEARCH AND DEVELOPMENT
FISCAL YEAR 1981 ESTIMATES

OFFICE OF SPACE SCIENCE

PLANETARY EXPLORATION PROGRAM

LAUNCH SCHEDULE

PROJECT	MISSION	CALENDAR YEAR
Galileo:	Galileo:	
- Probe	- Probe	1984
- Orbiter	- Orbiter	1984

OFFICE OF SPACE SCIENCE

PLANETARY EXPLORATION PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The Planetary Program includes the scientific exploration of the planets, their satellites, the comets and asteroids, and the interplanetary medium. The program objectives are to understand the origin and evolution of the solar system, to better understand the Earth through comparative studies with the other planets, and to understand how the appearance of life in the solar system is related to the chemical history of the system. The projects undertaken have been highly successful. The strategy that has been adopted calls for equal emphasis on the terrestrial-like inner planets, the giant gaseous outer planets, and the small bodies (comets and asteroids). Missions to these planetary bodies start at the level of reconnaissance and exploration, to achieve the most fundamental characterization of the bodies, and proceed to a level of detailed study. The reconnaissance phase of inner planet exploration began in the 1960's, and has now been completed. Mars has provided a program focus because of its potential as a site of biological activity and the Viking landings in 1976 carried the exploration of this planet forward to a new, high level of scientific and technological achievement, setting the stage for the next step of detailed study. Analyses of the moon rock samples returned by Apollo continue to be highly productive as new insights into the early history of the inner solar system are achieved and as our theoretical concepts are revised accordingly. The continuing Pioneer Venus mission is taking the study of our nearest neighbor, and closest planetary analogue, beyond the reconnaissance stage to the point where we have made a basic characterization of the massive cloud-covered atmosphere of Venus. This characterization has also provided fundamental data about the formation of the planet. However, because of the opacity of the atmosphere, information about the Venus surface character remains sparse so that one of the more pressing goals of the Planetary Program is to fill this data gap.

The exploration of the giant outer planets began relatively recently with the Pioneer 10 and 11 flybys of Jupiter in 1973 and 1974. These simple reconnaissance spacecraft have returned excellent pathfinding data, contributing significantly to the success of the history-making flybys of two Voyager spacecraft through the Jovian system in the spring and summer of 1979. The Voyager data relating to Jupiter and its four largest moons constitutes a small analogue of the Sun and planets. The Voyager spacecraft are now enroute to Saturn where encounters will take place in November 1980 and August 1981. The first close-up examination of that planet occurred in September 1979 when Pioneer 11 reached Saturn after receiving a gravity-assist at Jupiter five years earlier. Numerous discoveries were made as a result of this encounter and it was demonstrated

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that a safe, close passage by Saturn's rings could be made. Voyager 2 must take a similar path if it is to proceed to Uranus for a 1986 flyby. Pioneer 10 has already crossed the orbit of Uranus on its way out of the solar system and is providing new information about a previously uncharted region of interplanetary space.

The Galileo mission is a cooperative effort between the United States and the Federal Republic of Germany. This mission, which will be launched by the Space Shuttle/IUS, has been rescheduled to early 1984 after it became clear that the Shuttle/IUS could not launch Galileo in 1982. A wide range of science experiments, chosen to make maximum progress beyond the Voyager findings has been selected. The Galileo development effort is proceeding on a schedule which will permit early 1984 launches of the Orbiter and Probe. FY 1981 funds will be used to continue this development effort.

The pre-eminence of the U.S. program of planetary exploration has been based on technology leadership and on a foundation of strong, coordinated research and analysis programs. These programs ensure that full advantage is taken of the spacecraft data and samples acquired on completed and ongoing missions, and that the necessary research is performed to maximize the return from ongoing and future missions. Included in the research and analysis programs are data analysis, lunar sample and meteorite analysis, telescopic observations, theoretical and laboratory studies, and instrument definition. The highest scientific standards are maintained in these programs and both new and old concepts are subject to intense scrutiny. The programs are also highly interdisciplinary with attention paid to establishing coordination among various research groups. The results of the research are widely and swiftly disseminated. The lunar sample analysis effort is mission-oriented and is coordinated with research efforts in this area supported by the National Science Foundation. A close coupling is maintained between the research programs and the planning activities that are undertaken to define the scientific rationale and technology needs for future missions.

One important class of solar system objects, comets and asteroids, has as yet not been subjected to investigation by spacecraft missions. Comet rendezvous and flyby missions are being defined as technology advances bring exploration of these small bodies within our grasp. Study of these primitive objects holds the promise of a breakthrough in our understanding of the nature of the early solar system.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

GALILEO DEVELOPMENT

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Spacecraft	54,083	83,260	90,875	42,184
Experiments	18,714	24,266	17,200	11,900
Ground operations	5,903	8,574	8,025	9,016
TOTAL	78,700	116,100	116,100	63,100
Space Transportations Systems Operations	(2,400)	(16,900)	(5,500)	(10,400)

OBJECTIVES AND STATUS:

The Galileo mission, which will conduct direct and long-duration studies of Jupiter, is a vital link in providing the continuity, balance and orderly progression of our program of exploration of the solar system.

The objectives of this program are to conduct a comprehensive exploration of Jupiter, its atmosphere, magnetosphere and satellites, utilizing a new deep space spacecraft concept which combines both remote sensing and direct measurements on an orbiter spacecraft with separate atmospheric probe.

The Galileo mission was originally scheduled to be launched as a single spacecraft in January 1982. The baseline 1982 mission plan called for the Galileo orbiter to carry the probe to Jupiter and relay its data back to Earth before starting a twenty-month orbital tour. During the twenty-month tour, the orbiter would have eleven encounters with the highly interesting Galilean satellites. The project was planned to be completed in July of 1987. However, when it became clear that the Space Shuttle/IUS could not provide the performance required for the launch of Galileo in 1982, several alternate plans for the mission were reviewed. The most economical and efficient alternative for the Galileo mission is to utilize separate Space Shuttle launches for the Galileo orbiter and probe, and to shift the launches to the earliest subsequent opportunity to utilize a Mars assist on the voyage of the orbiter to Jupiter in February and March 1984. Galileo is the only planetary program still under development and the 1984 mission will preserve the science content of the original mission as recommended by the National Academy of Sciences (Space Science Board) with the lowest increase in total cost.

The restructured mission makes maximum use of the development effort expended to date. The 1984 mission will result in a delay in science return of only one year although the launch is delayed by two years. This is a result of the shorter trip time available in the 1984 opportunity.

Although 1984 is not as favorable a Jupiter launch opportunity as 1982, the Mars powered swingby makes it an excellent opportunity. This trajectory, which will be employed by the Galileo 1984 orbiter mission, will reduce the performance required from the Shuttle and IUS. In order to accomplish the powered maneuver at Mars, the amount of fuel on board the orbiter must be doubled and there must be some redesign of the propulsion system. In the 1984 configuration, over 60% of the weight of the orbiter is in the propulsion system; therefore, the supporting structure must be strengthened. Those electronic subsystems and structural elements of the orbiter which were intended solely to support the probe will be deleted. Otherwise, the orbiter need not be changed. All of the design and development effort on science instruments and electrical subsystems is still valid. The current contracts for development of orbiter subsystems will remain in force. Delivery schedules will be slipped to avoid the use of overtime but will remain tight to minimize costs. Because of the increase in the spacecraft mass caused by the additional fuel, mass margins are still tight, but considered adequate.

The probe need not be modified. All science instruments can be retained. The delivery schedule on present contracts will be adjusted to achieve the most efficient application of funds.

The launch of the probe separately from the orbiter requires the development of a probe carrier spacecraft. For a planetary spacecraft, the probe carrier can be of a relatively light and simple design. The demands on electronic subsystems are not severe. It will simply fly past Jupiter and leave the solar system after delivering the probe. Therefore, no large propulsion system is required. Because the spacecraft is light we can use a direct trajectory to Jupiter. It may be possible to use, on the probe carrier, some of the electronic subsystems designed to support the probe which have been deleted from the orbiter. It is planned to procure the probe carrier through competitive proposals from industry. The cost of this spacecraft should be relatively low for a 1984 launch since there are existing spacecraft designs on which a carrier can be based. The development schedule appears to be reasonable.

The probe spacecraft trajectory will be designed so that the probe will enter the atmosphere of Jupiter when the orbiter is in a proper position to provide remote sensing of the probe entry site. Without this information, it will be significantly more difficult to understand the data from the probe. Likewise, without the simultaneous orbiter and probe measurements, the orbital data on the atmospheric dynamics of Jupiter will be less understood.

The Federal Republic of Germany has made a commitment to develop the retropropulsion element for the mission, and has agreed to sustain this endeavor for the 1984 mission. Design and development of the spacecraft and

probe elements as well as the science instruments are underway. This momentum can be efficiently redirected toward the 1984 launch opportunity.

In FY 1980, the design, development and fabrication activities will continue. Requirements imposed by the revised launch date are being translated into final designs for the major elements of Galileo--the probe and orbiter spacecraft, the mission operations, the spacecraft propulsion module, the on-board power systems, and the Space Transportation System interface. Competitive procurement of the probe carrier spacecraft will be initiated.

CHANGE FROM FY 1980 BUDGET ESTIMATE:

The FY 1980 Galileo estimate remains unchanged in total; however, adjustments have been made within the project elements to accommodate the 1984 launch dates. The 1984 launches require a modification of the spacecraft propulsion system to allow a powered Mars flyby and the orbiter structure will be modified as necessary. Orbiter hardware required solely to support delivery of the probe to Jupiter will be deleted. The probe will remain unchanged. A probe carrier spacecraft, which will deliver the probe to Jupiter and relay the probe data back to Earth, must be developed. Replanning of schedules is also required.

BASIS OF FY 1981 ESTIMATE:

FY 1981 funding requirements will provide for continued fabrication and test of the Galileo science instruments, the probe and the orbiter spacecraft. The award of a probe carrier contract in FY 1981 is planned, and will be followed by the orbiter critical design review.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

MISSION OPERATIONS AND DATA ANALYSIS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
Voyager basic mission	16,742	19,000	19,000	25,600
Voyager extended mission	---	---	---	3,000
Pioneer Venus basic and extended mission	9,000	9,800	9,400	7,700
Pioneer 6-11 extended mission	3,125	4,000	2,800	2,500
Helios extended mission	200	---	100	100
Viking extended mission	5,000	---	1,000	---
Planetary flight support	25,233	26,200	26,500	25,900
Total	59,300	59,000	58,800	64,800

OBJECTIVES AND STATUS:

The Mission Operations and Data Analysis Program funds the operations phase of planetary missions after development, launch, and initial in-flight checkout are complete. It also provides for multimission flight support. Currently, active planetary missions being supported within mission operations and data analysis are Voyager, Pioneer Venus, Pioneer 6-11, Helios and Viking.

The objective of the Voyager mission to the outer planets is to conduct scientific studies of the Jupiter and Saturn planetary systems, including their numerous satellites and the rings of Saturn. If conditions are favorable, Voyager 2 may also go on to Uranus to investigate that exciting planet. While the two spacecraft are cruising to the outer planets, they are also performing continuing investigations of the interplanetary medium. Since their launches in 1977, the two Voyager spacecraft have encountered Jupiter and investigated this system. Both spacecraft are in good condition and on cruise trajectories toward Saturn. The primary radio receiver of Voyager 2 has failed; however, the spacecraft is being operated successfully by using its backup receiver, even though that equipment is somewhat impaired by a component failure. Encounter operations for Voyager 1 will begin in mid-August 1980 and the closest approach to Saturn will occur in November 1980. Similar operations for Voyager 2 will occur in 1981 with closest approach at Saturn in August 1981. A wealth of new planetary data is expected from the investigations provided by the Voyager spacecraft as they traverse the Saturnian system. Subsequent to the Saturn encounters, the

spacecraft will continue to provide data on the interplanetary medium. Voyager 1 will investigate the outer limits of our solar system.

The objectives for Pioneer Venus are to obtain detailed information on the Venusian atmosphere, to investigate the planet's environment and to learn why the planet, so Earth-like in many respects, has an atmosphere so different. The mission is carried out by two spacecraft: an orbiter launched in May 1978 and a multiprobe launched in August 1978. The orbiter arrived at Venus on December 4, 1978, and was put into a highly elliptic orbit that approaches within 150 kilometers of the surface. On December 9, 1978, the four probes and multiprobe bus entered the atmosphere. The probes made measurements as they descended to the surface at widely separated points, and the bus also collected data. The mission has been, and continues to be, an outstanding success.

The objective of Pioneers 6-9 is to explore interplanetary space at radial distances from the Sun varying from 0.75 to 1.1 AU. (The Earth's distance from the Sun is 1 AU, an astronomical unit). The objectives of Pioneer 10 and 11 are to explore space beyond 1 AU, the Asteroid Belt, and the environment of Jupiter. Pioneers 6-9, with launches starting back in 1965, are still operational, but now generally data is acquired only when unusual solar activities or special alignment with other spacecraft occur. Pioneer 10, launched in 1972, reached Jupiter in December 1973, and the gravity of the massive planet provided the extra impetus to take the spacecraft out of the solar system. Pioneer 11, launched in 1973, passed Jupiter in December 1974, and the spacecraft trajectory was influenced by the planet's gravity field in such a way that it flew by Saturn in 1979. Both spacecraft have returned excellent data and continue successful operation.

During FY 1980, three Viking spacecraft are continuing to collect data at reduced levels. The two landers are in an automatic mission mode, in which they collect and store data for transmission to Earth upon interrogation. Orbiter-1 is expected to become depleted of attitude control gas by mid-1980. When this orbiter is shut down, the ability to obtain relays from Lander-2 will be ended, and Lander-2 will also be shut down. Lander-1, capable of transmitting directly to Earth on command, will continue to collect data.

Planetary Flight Support provides for mission control and other activities which support the tracking telemetry and command functions for all planetary spacecraft. The activities include general purpose scientific and engineering computing capabilities at the Jet Propulsion Laboratory (JPL), and the selected project functions such as computer analysis and preparation of data records. These functions are performed at the Mission Control and Computing Center at JPL.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The $200,000 decrease in the mission operations and data analysis budget is a result of a Congressional general reduction in the FY 1980 NASA Research and Development appropriation request. Minor adjustments were also made in several of the program elements. Viking operations were continued into FY 1980, as reflected by the increase of $1.0 million, to take advantage of the excellent data still being received.

BASIS OF FY 1981 ESTIMATE:

The successful encounters at Jupiter by the Voyager spacecraft have resulted in numerous discoveries, high demand for the image products, and a large data base for intense analysis by the scientific community. The Voyager FY 1981 funding will provide for mission operations during the Voyager 2 cruise period between the Jupiter and Saturn encounters, two Saturn encounters, and the start of the Voyager 2 cruise to Uranus. The project scientists will be engaged in analyzing and publishing the results from the two Jupiter encounters in 1979, and from the encounters with Saturn. The flight team will also be developing the sequences and software for the Voyager 2 Saturn encounter, which will occur in August 1981. Voyager 1's encounter period at Saturn will start with concentrated observations of the ringed planet and its many satellites in 1980. The FY 1981 funds will provide for processing and analysis of the data obtained during the first two years of the Pioneer Venus extended orbital operations. FY 1981 funds will also provide for Pioneer 6-11 mission operation and data analysis with emphasis on data from the Saturn encounter of Pioneer 11.

FY 1981 planetary flight support funds will provide mission control and computing support for all active deep space missions.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

RESEARCH AND ANALYSIS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
	(Thousands of Dollars)				
Supporting research and technology	29,500	33,300	33,600	37,500	RD 5-12
Advanced programs	5,400	5,800	5,400	7,800	RD 5-13
Mars data analysis	4,500	6,000	6,000	6,400	RD 5-13
Solar electric propulsion/comet studies	5,000	---	---	---	
Total	44,400	45,100	45,000	51,700	

OBJECTIVES AND STATUS:

The Research and Analysis program contains three supporting elements required to assure that data and samples returned from flight missions are fully exploited, to undertake complementary laboratory and theoretical efforts, and to define the science rationale and develop required technology to undertake

future planetary missions. The three elements are: (1) Supporting Research and Technology; (2) Advanced Programs; and (3) Mars Data Analysis.

Supporting Research and Technology -- The Supporting Research and Technology is made up of six areas of effort: (1) Planetary Astronomy; (2) Planetary Atmospheres; (3) Planetary Geochemistry and Geophysics; (4) Planetary Geology; (5) Planetary Materials and (6) Instrument Definition.

The Planetary Astronomy activity includes all planetary observations made by ground-based, airborne and Earth-orbital telescopes. Observations are made at a wide range of wavelengths from ultraviolet to radio. The rate of new discoveries continues to be high. The data acquired are used both for basic research in support of planetary program objectives and for direct support of specific flight missions.

In the Spring of 1979, the new Infrared Telescope Facility in Hawaii commenced planetary observations, and in October 1979 became fully operational. In addition to planetary observations, the Facility has provided support to the Voyager 2 encounter of Jupiter.

The Planetary Atmospheres activity includes data analysis and laboratory and theory efforts. The properties of other planetary atmospheres are amenable to measurement and can aid us in better understanding our own weather and climate. Observations of the atmospheres of Venus and of Jupiter, acquired by Pioneer Venus and by Voyager, will lay the basic groundwork for major advances in knowledge in atmospheric sciences.

The Planetary Geochemistry and Geophysics activity is broad in scope and includes studies of the composition and structure of all classes of solar system objects and the synthesis of data from all sources that relate to the origin and evolution of the solar system. The program supports the synthesis of planetary data already obtained, and the assembly of information needed to prepare for future missions. Both Voyager and Pioneer Venus are providing key data for the research efforts undertaken in this program.

To date, the Planetary Geology activity has focused on studies of the inner planets (including the Moon). Voyager data pertaining to the Galilean satellites of Jupiter have provided a new dimension for this effort. The geology program is a broadly based effort in which comparative studies of common processes affecting all the inner planets provide a powerful technique for unravelling individual planetary histories, including their early states. Imaging data, both from spacecraft and from ground-based radar, provide the basis for much of the data analysis.

The Planetary Materials activity supports an active scientific effort to determine directly the chemistry, mineral composition, age, physical properties, and other characteristics of returned lunar samples and of meteorites that fall to Earth. Recently, extraterrestrial dust grains have been collected for similar analysis. These studies continue to yield new and otherwise unobtainable information about the solar

system, particularly about its early history. NASA maintains a balanced program of work on extraterrestrial materials consistent with its mission. This program is coordinated with lunar sample research supported by the National Science Foundation.

The Instrument Definition activity is directed toward ensuring that the science return from future spacecraft missions is maximized by the availability of state-of-the-art scientific instrumentation. Most of the effort is currently directed toward the definition of instrumentation for an eventual mission to a comet.

Advanced Programs -- The objective of Advanced Programs is to provide planning and preparation for the systematic exploration of the solar system on a scientifically and technically sound basis. Prospective planetary missions are identified and defined through long-range studies; their technological and fiscal feasibility is evaluated, and their scientific merit is assessed through interaction with the scientific community. For near-term missions, detailed project planning and technology readiness studies are carried out so that these missions may be undertaken on schedule and within fiscal constraints.

Current studies and supporting activities cover such possible future missions as the Venus Orbiting Imaging Radar (VOIR), a comet mission, a Saturn orbiter mission with Saturn and Titan probes, and an asteroid multiple rendezvous mission.

Mars Data Analysis -- The Mars Data Analysis activity continues to assure that we fully capitalize on the wealth of data provided by Viking. The activity covers the broad scope of the returned data--biology, chemistry, geology, and meteorology.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase of $300 thousand from the budget estimate for the Supporting Research and Technology Program is a result of the transfer of instrument definition activities from the Advanced Programs area to the Supporting Research and Technology Program. The current estimate for Advanced Programs also reflects a reduction of $100 thousand as a result of a Congressional general reduction in the appropriation request.

BASIS OF FY 1981 ESTIMATE:

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Supporting Research and Technology.....	29,500	33,300	33,600	37,500

During FY 1981, research efforts will continue in the areas of Planetary Astronomy, Planetary Atmospheres, Planetary Geochemistry and Geophysics, Planetary Geology, Planetary Materials, and Instrument Definition. Infrared telescopic observations of Saturn will be undertaken in support of the Voyager missions, and radar telescopes will be used to continue the investigation of Venus and other solar system bodies. Other significant observations will be conducted both to increase our knowledge of the outer planets and the small bodies of the solar system, and to advance our readiness for future missions. A variety of efforts will be pursued to improve our understanding of planetary atmospheres, including laboratory studies of reactions in deep atmospheres and in tenuous cometary atmospheres. In the geochemistry-geophysics area, research efforts will be made to better understand the present state and evolution of individual bodies and of the solar system in general. Geology research will be directed at specific problems in understanding the various processes that have shaped planetary surfaces, and will also include geological analyses and a cartography effort based on the Galilean satellite imaging data acquired by Voyager. Analysis of lunar samples, meteorites, and cosmic particles will continue in order to determine their chemical and physical properties and thereby to derive their origin and evolutionary history. Instrument definition for future missions will be continued in FY 1981.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
Advanced Programs	5,400	5,800	5,400	7,800

In FY 1981, the major effort in Advanced Program will be devoted to continued prepartions for the Venus Orbiting Imaging Radar Mission, including more detailed mission definition studies and advanced technology development. Work will also proceed on advanced mission definition, and on instrument definition and development, in support of future cometary and other planetary science mission opportunities.

Mars Data Analysis	4,500	6,000	6,000	6,400

The Mars Data Analysis activity which began in FY 1979 has provided support for over 80 research efforts in a wide range of discipline areas such as biology, chemistry, geology, and meteorology. The FY 1981 funds will provide for the continuation and/or completion of these efforts and the initiation of new analyses.

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE SCIENCE

LIFE SCIENCES PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
		(Thousands of Dollars)			
Life sciences flight experiments	15,700	12,900	16,600	19,200	RD 6-3
Vestibular function research	---	3,700	---	---	---
Research and analysis	24,400	27,300	27,200	30,500	RD 6-5
Total	40,100	43,900	43,800	49,700	
Distribution of Program Amount by Installation:					
Johnson Space Center	19,716	16,650	19,423	22,210	
Kennedy Space Center	225	650	723	1,129	
Jet Propulsion Laboratory	1,770	2,050	1,677	1,746	
Ames Research Center	13,081	18,480	14,266	15,837	
Dryden Flight Research Center	185	200	164	288	
Langley Research Center	---	---	40	40	
Headquarters	5,123	5,870	7,507	8,450	
Total	40,100	43,900	43,800	49,700	

OFFICE OF SPACE SCIENCE

LIFE SCIENCES PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The objective of the Life Sciences program is to support NASA's overall goals and objectives in the exploration and utilization of space by conducting studies in the areas of space biology and medicine and by expanding scientific knowledge in the area of the origin and evolution of life. The realization of this objective, which is intimately linked to our understanding of the basic mechanisms of biological and medical processes, is achieved through a program of research conducted both on Earth and in space. The near-term activities will help us to discover and investigate the effects of the space environment on humans to facilitate their safe, useful participation in space activities. A continuum flows from the ground-based research activities to the flight experiments, and then from flight findings to laboratory work on the Earth. Thus, the Life Sciences program utilizes a composite of disciplines addressing all space-related problems in biology and medicine.

The Life Sciences program is composed of three major program thrusts. The first is a program consisting of flight and ground-based experiments, whereby the physiological effects of the space environment on humans are explored. The unique properties of space (e.g., micro-gravity, radiation, etc.) provide, for the first time in our history, an opportunity to explore significant problems in biology under a controlled set of conditions that cannot be adequately duplicated in laboratories on Earth. The second is the continous in-flight observation of crews venturing in space and the testing and refining of countermeasures and establishing requirements in space exploration. The third thrust is the studies in exobiology, with special emphasis on a problem of profound philosophical and scientific significance: the origins and the distribution of life in the universe.

The first major thrust is conducted through ground-based research, and through flight opportunities on the Shuttle as well as through the US/USSR Biological Satellite program. In preparation for the early Spacelab flights, and subsequent selection of Shuttle passengers, ground-based research is being conducted on the limits of physiological tolerance to space flight stresses. Seven life science experiments are being developed by NASA for the Spacelab-1 mission. These experiments emphasize the study of the effects of space flight on humans, such as changes in vestibular function and hematological indices and the impact of space radiation and the effect of gravity on plant growth and biological rhythms.

The first Spacelab flight, dedicated to Life Sciences experiments, is planned for 1983. Over 360 proposals in response to our first Announcement of Opportunity were received in 1978 and since then 82 of the most promising experiments were selected for a "definition phase". Final selections for the first dedicated flight will be made in 1981. Development of general purpose equipment for use on life science missions is in progress.

NASA continues its ongoing participation in the joint US/USSR Biological Satellite program, the latest of which was (Cosmos 1129) launched and successfully recovered in October 1979. Thirteen US experiments were flown on this flight; these experiments explored relevant medical and biological problems. In addition, experiments are being developed for US participation in a 1981 USSR biological satellite mission. In conjunction with the outlined flight program, complementary integrated ground-based research continues to enrich the Life Sciences data base and develops rationale for future flight experiments.

The second major thrust is in the area of operational medicine. The goals of this program are to assure astronaut and payload specialist health and ability to function effectively in the space environment, which in turn, will provide sound foundations for a broader segment of the population to participate in all aspects of future space missions. Particular emphasis is placed on the early detection and prevention of debilitating diseases, and on the testing of countermeasures designed to prevent untoward physiological responses associated with exposure to the space environment. It is essential that continuous long-term monitoring of Shuttle crew and complements is performed in a standard and organized fashion in order to establish the long-term clinical significance and development of risk factors which might be associated with repeated exposure to the space environment.

Exobiology is the third major program thrust. The goal is to understand the origins and distribution of life throughout the universe. Particular emphasis is placed on developing sound hypotheses which ultimately will lead to discovering the relationships which link the formation of the solar system to the beginnings of life. Ground-based research on model systems and analysis of extraterrestrial materials, coupled with planetary flight experiments, are clarifying the mechanisms of, and environments conducive to, the formation of essential biomolecules. The impact of the presence or absence of life on the subsequent evolution of a planet is just beginning to be realized.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

LIFE SCIENCES FLIGHT EXPERIMENTS

	1979	1980		1981
	Actual	Budget Estimate	Current Estimate	Budget Estimate
		(Thousands of Dollars)		
Life sciences flight experiments	15,700	12,900	16,600	19,200
Space transportation system operations	(2,500)	(2,800)	(7,500)	(12,000)

OBJECTIVES AND STATUS:

The objective of the Life Sciences Flight Experiments program is to expand our understanding of the operant basic mechanisms and time course of biological and medical processes as they occur from exposure to zero gravity. The program includes the whole processes of experimental design, development, inflight execution and data analysis and reporting. Advanced hypotheses which require the unique aspects of the space environment for adequate testing, form the basis for the experiments flown. The current plan is to provide as much general purpose flight hardware as is feasible for the flight experiments, thus avoiding unnecessary duplication of development costs.

During FY 1979, over 360 proposals for Life Sciences Flight Experiments were reviewed and evaluated for scientific merit, engineering, cost and mission compatibility considerations. In October 1979, 82 of these investigations, 78 from the US and four from the international science community, were selected as candidate flight experiments for Life Sciences Spacelab Missions. After a six to nine month experiment definition phase, the candidate group will be narrowed down to 50-60 investigations. From this group, payloads for the first and second dedicated Life Sciences Spacelabs will be selected. It is estimated that approximately 15 to 20 investigations can be accommodated on each mission. The first dedicated Life Science Spacelab mission is currently planned to be flown in 1983, and the second is planned to be launched approximately 18 months later. The final payload for each mission will be selected about two years prior to launch.

Flight experiments for the first joint NASA/European Space Agency mission (Spacelab-1), are now proceeding through their final phase of development. Once this activity is completed, the hardware will proceed through integration, test and checkout activities at Johnson Space Center prior to shipment to Kennedy Space Center for final Spacelab integration and tests in support of a 1982 launch.

Life Sciences Flight Experiment hardware which will be flown on two of the Shuttle orbital flight test (OFT) missions, and on Spacelab-2, is also in the final stage of development. Delivery of this flight hardware will be completed in 1980.

On the second Shuttle OFT mission, a single hardware verification test will be conducted in support of a plant experiment scheduled for flight on Spacelab-1. A plant growth experiment will be conducted on both OFT-5 and Spacelab-2. Spacelab-2 will also carry a blood experiment designed to investigate Vitamin-D metabolities and bone demineralization utilizing hardware developed for Spacelab-1.

Another element of the Life Sciences Flight Experiment program is our joint participation with the USSR which includes flying experiments aboard the Cosmos 1129 biological satellite which flew from September 25, 1979 to October 12, 1979. The flight specimens were received from the Soviets in November and the US scientists are now analyzing their material. Presentation of the results is planned in conjunction with a meeting of the International Congress of Physiological Sciences, July 1980, in Budapest, Hungary.

The next anticipated participation by the US in the Cosmos program will be a primate flight for 1981. The US has submitted six experiment proposals for consideration by the USSR.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase of $3.7 million in the FY 1980 current estimate for flight experiments reflects a restructuring of the Life Sciences program which involves the transfer of funds previously budgeted for the Vestibular Function Research to the Life Science Flight Experiments program where concept studies on a vestibular facility will be conducted.

BASIS OF FY 1981 ESTIMATE:

In early FY 1981, experiment selection for the first Life Sciences Spacelab Mission (LS-1) will be completed; subsequently, development phase contracts will be awarded to Principal Investigators who are selected for further definition. Experiment preliminary design reviews will be conducted followed by a payload synthesis exercise, after which final flight experiments selections for LS-1 will take place. Late in the year an integrated mission requirement review will be held.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

RESEARCH AND ANALYSIS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Life sciences supporting research and technology.....	24,400	27,300	27,200	30,500

OBJECTIVES AND STATUS:

The Research and Analysis activities of the Life Sciences program represent the ground-based research in space-related biological and biomedical problem areas that have been identified in previous flights or have been determined to be highly probable in future flights and comprises five elements: (1) operational medicine, (2) biomedical research, (3) space biology, (4) exobiology, and (5) life support.

The Life Sciences operational medicine program is the catalyst responsible for bringing the science, technology, and practice of medicine to bear on solving the problems of sustaining, supporting, and

protecting individuals working in the space environment. This includes assurances that physical welfare and performance is preserved and that adequate treatment of in-flight illnesses or injuries is provided. In addition, the Space Transportation System and future generations of space vehicles will allow for a complement of crews of varied background, age and sex, who will work for different lengths of time in the unique environment of space. Thus, a new dimension of frequent and repetitive exposure to zero-gravity will be introduced. Such manifestations as "space motion sickness", fluid shifts, endocrine shifts (which can result in decreased performance in flight), decreased post-flight cardiovascular tolerance, and possible aggravation of latent diseases, will be carefully documented and, where feasible, prevented. To this end, specific operational requirements such as careful medical selection, periodic evaluation of health status (including pre- and post-flight medical observations), in-flight monitoring of the time course of adaptation to and performance in the space environment will be continually reevaluated and updated. Significant emphasis is placed upon real-time testing of promising countermeasures developed by the research and analysis programs under controlled conditions.

The biomedical research program objective is to develop the basic medical knowledge needed to enable men and women to operate more effectively in space. The program is organized into discrete elements with each designed primarily to rectify a particular physiological problem expected to affect the human organism in prolonged or repetitive space flight. Thus, motion sickness, bone loss and hormonal disturbances are the subjects of a continued search for mechanisms and countermeasures. The program is largely dependent upon the use of ground-based analogues of space flight. Special regimens of bed rest, water immersion and centrifuge time are employed to evoke specific responses in both man and animals. New techniques such as tomography and radionuclide imaging are being perfected to study these changes in living organisms. Commencing in FY 1980, an integrated mathematical analysis of several physiological systems will receive major emphasis. The approach is expected not only to improve our capability to protect future space workers, but also to enhance our overall comprehension of physiology in health and in disease.

The space biology activity will explore the role of gravity in life processes and use gravity as an environmental tool to investigate fundamental biological questions. Specific objectives are to: (1) investigate and identify the role of gravity in plant and animal cellular processes, embryonic development, morphology and physiology; (2) identify the mechanisms of gravity sensing and transmission of gravity perception information within both plants and animals; (3) identify the interactive effects of gravity and other stimuli (e.g., light) and stresses (e.g., vibration) on the development of metabolism of organisms; (4) use gravity to study the normal nature and properties of living organisms; and (5) extend the limits of knowledge about plant and animal growth and metabolism to provide for long-term survival and multi-generation reproduction of life in space. This program provides basic ground-based information in support of future space flight experiments and life support systems.

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Exobiology is the study of the origin, evolution and distribution of life and life-related molecules on Earth and beyond. Sophisticated analyses of life as we know it, its chemical precursors and its origin, coupled with extrapolation to extraterrestrial environments, affords a unique opportunity to address a most fundamental question regarding the existence of such processes beyond the Earth. Theories about chemical evolution and the origin of life are being refined to reflect results from the most recent planetary and astronomical explorations. The current research program also is uncovering an initmate association between the origin and evolution of life on Earth and the processes which shaped the evolution of the solar system itself. These discoveries have highlighted gaps in our knowledge which, when completed as the program expands, will ultimately allow tests of the concept of universality of biological processes.

The life support systems activity will focus on the continuing research and developmental efforts aimed at increasing and enhancing our ability to support long-duration manned space occupancy and maximizing astronaut and passenger-scientist productivity. Achievement of these goals is sought through improved habitability, man-machine relationships, as well as provision of direct supportive needs such as food, water, and a habitable atmosphere. For longer duration missions, the program will continue to study the capability for regeneration and reuse of water and air, as contrasted to the expendable-type life support currently available.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The decrease of $100 thousand in the FY 1980 estimate is the result of a Congressional general reduction in the NASA FY 1980 R&D appropriation request.

BASIS OF FY 1981 ESTIMATE:

The operational medicine program will continue to investigate the possible occupational exposures in zero-gravity, and the development of training and remedial preventative measures, together with modification of medical care procedures utilized on Earth to meet the unique requirements of the space environment.

The biomedical research program will continue to focus primarily on the motion sickness problem because of its relevance to Space Shuttle operations. Cardiovascular and musculoskeletal studies will also be pursued in recognition of the considerable fundamental knowledge that must be acquired in these areas before effective countermeasures can be devised. Increased awareness and understanding of the radiation hazard has resulted in more emphasis being placed on the biological effects of high energy radiation and upon radiation protection. Major new avenues of research will deal with the psychological accompaniments of space flight and with mathematical modeling procedures.

The space biology program will continue to research the stress responses to hypo- and hyper-gravity and the relationship of these responses to those provoked by other stresses and stimuli. The use of gravity

as a tool to investigate fundamental endocrine responses and basic biological control mechanisms will be expanded. The space biology program will continue to provide ground-based support data for future Shuttle/Spacelab flight experiments.

Exobiology research has identified a need to expand our understanding of events preceding what is classically called chemical evolution and following what is referred to as the origin of primitive life forms. Studies of the history of biogenic elements, the effect of extraplanetary and astrophysical events on evolution of complex life, and the distribution of life in the universe will be conducted to make the unifying scenario of life in the universe complete.

The life support systems program will continue to investigate basic biological processes and physical-chemical methods which can provide the capability to recycle waste, food, atmosphere and water.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES

RESEARCH AND DEVELOPMENT BUDGET PLAN FOR SPACE AND TERRESTRIAL APPLICATIONS

Programs	Budget Plan 1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Space applications	274,800	332,300	331,800	381,700
Technology utilization	9,100	12,100	12,100	13,100
Total	283,900	344,400	343,900	394,800

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE AND TERRESTRIAL APPLICATIONS

SPACE APPLICATIONS PROGRAMS

SUMMARY OF RESOURCES REQUIREMENTS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
	(Thousands of Dollars)				
Resource Observations	139,400	141,400	145,203	162,300	RD 7-9
Environmental Observations	67,750	117,200	109,470	137,600	RD 7-29
Applications Systems	13,950	20,300	24,547	18,100	RD 7-49
Technology Transfer	10,700	10,300	10,087	12,500	RD 7-50
Materials Processing in Space	20,400	19,800	19,768	22,200	RD 7-53
Space Communications	22,600	23,300	22,725	29,000	RD 7-58
Total	274,800	332,300	331,800	381,700	
Distribution of Program Amount by Installation:					
Johnson Space Center	24,146	31,150	25,330	41,990	
Kennedy Space Center	520	825	1,428	195	
Marshall Space Flight Center	26,412	29,525	28,705	23,950	
National Space Technology Laboratories	3,199	3,750	2,940	3,720	
Goddard Space Flight Center	159,076	184,100	182,320	198,770	
Jet Propulsion Laboratory	22,951	22,300	18,463	21,570	
Wallops Flight Center	3,114	4,125	3,915	4,390	
Ames Research Center	7,983	10,550	16,010	18,295	
Langley Research Center	9,789	19,125	14,548	12,805	
Lewis Research Center	5,294	5,125	10,368	17,000	
Headquarters	12,316	21,725	27,773	39,015	
Total	274,800	332,300	331,800	381,700	

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

OFFICE OF SPACE AND TERRESTRIAL APPLICATIONS — SPACE APPLICATIONS PROGRAM

FLIGHT SCHEDULE

Project	Mission	Calendar Year
Resource Observation:		
Earth Resources Tech. Satellites	Launch of LANDSAT-D	1981
Shuttle/Spacelab Payload Development	Orbital Flight Test Missions	1980
	Spacelab Payloads	Beginning in 1981
Environmental Observation:		
Shuttle/Spacelab Payload Development	Orbital Flight Test Missions	1980
	Spacelab Payloads	Beginning in 1982
Earth Radiation Budget Experiment	Launch of ERBS	1983
	ERBE instrument to be launched on NOAA F&G (Subject to NOAA call-up)	1984-1985
Halogen Occultation Experiment	HALOE instrument to be launched on Spacelab mission and ERBS	1982-1983
National Oceanic Satellite System	Launch of first spacecraft	1986
Materials Processing in Space:		
Sounding Rocket Missions	Launch 2 in 1980, 1 in 1981	1980-1981
	Flight of Materials Experiment Assembly	Beginning in 1982
Shuttle/Spacelab Payload Development	Spacelab Payloads	Beginning in 1982
Space Communications:		
Search and Rescue Mission	Instruments to be launched on NOAA (TIROS-N series) spacecraft	1982

FLIGHT SCHEDULE

Project	Mission	Calendar Year
Reimbursable Missions:		
GOES*	Launch of GOES D through F	1980-1983 (Subject to call-up by NOAA)
NOAA*	Launch of NOAA A-G	1979-1985 (Subject to call-up by NOAA)

*National Oceanic and Atmospheric Administration (NOAA) funded.

OFFICE OF SPACE AND TERRESTRIAL APPLICATIONS — SPACE APPLICATIONS PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The objective of the Space Applications program is to conduct research and development activities that demonstrate and transfer space-related technology, systems and other capabilities which can be effectively used for down-to-Earth practical benefits. These activities are grouped in the following general areas: Resource Observations, Environmental Observations, Applications Systems, Technology Transfer, Materials Processing in Space, and Space Communications.

In each of these areas, programs are being planned and conducted to contribute to the solution of pressing national, as well as international, problems and needs.

Resource Observations - This program addresses the needs for information of vital economic value to the U.S. and of worldwide humanitarian concern required for management of the world's limited food, water, and energy supplies and for the identification of potential geodetic hazards. The principal objectives are to develop and demonstrate the use of space and space technology to provide the U.S. with a global capability for monitoring and forecasting major agricultural commodities, for water resources management, for land use assessment, for improving the exploration for mineral and energy resources, and for understanding the dynamic characteristics of the solid earth and its crust, including tectonic plate motion, stability and crustal deformation. Inherent in the pursuit of these objectives is the involvement of the users of space-derived information in the total program activities, from the planning to the development, test, verification, and application of the techniques.

Principal activities include the identification of user information needs, the development of remote sensing and information extraction techniques, provision for the acquisition of space data, and joint research, development and test projects with users, leading eventually to the establishment and routine use of global data collection systems. Currently, Landsat-3 is providing a wide variety of useful data. Landsat-D, with improved sensing capabilities, is under development and will be launched in late 1981 or early 1982. NASA will support the National Oceanic and Atmospheric Administration with its new responsibility for management of the operational land observing system. Magsat and the Heat Capacity Mapping Mission continue to provide valuable information for geophysical and geologic studies. Experiments designed to test the applicability of active microwave measurements, and of high resolution imagery for mapping investigations, are planned for flight on early Shuttle missions. Studies are also underway to define the appropriate space

systems for gravimetric measurements for solid earth studies, for global stereoscopic imagery for resource exploration, and for improved remote sensors for multiple applications. Joint research, development, and testing activities with other Federal agencies are underway to advance our understanding of how to apply multiple data sources in improving agricultural early warning and crop commodity forecasting; joint research activities are planned with other Federal agencies and coordinated with international organizations for advancing the scientific knowledge of the solid earth.

Environmental Observations - Understanding the dynamics and limitations of our environment is essential to our long-term survival and to many of our day-to-day activities. Prediction of the weather, control of pollution, ship routing, storm warnings, and modeling of long-term trends in climate and the stratosphere, are all areas where such understanding is put to day-to-day or strategic planning uses. NASA's Environmental Observations program aims at improving the understanding of processes in the atmosphere and the oceans, providing space observations of parameters involved in these processes and extending the national capabilities to predict environmental phenomena and their interaction with human activities. Because many of these phenomena are global or regional in extent, they can be studied effectively (and sometimes solely) from space. NASA's program includes research efforts plus the development, demonstration and transfer of new technology for global and synoptic measurements. NASA's research satellites give a special view of the radiative, chemical and dynamics processes occuring in the atmosphere and oceans.

The Environmental Observations Program includes studies and flight missions directed at all of the layers of the atmosphere from the highest layer of the upper atmosphere down to and including the upper layers of the oceans. The program areas include: (1) upper atmospheric research, (2) tropospheric air quality, (3) global weather, (4) severe storms, (5) oceanic processes (including ocean circulation, sea and glacier ice, coastal and inland waters, air-sea interaction and marine boundary layer), and (6) climate. This integrated approach encompasses the diverse fields of meteorology, climatology, atmospheric chemistry, atmospheric physics, and oceanography, and focuses on the special contributions of space-derived data.

Research into the chemistry of the stratosphere as it relates to ozone is beginning to pay dividends with the production of global ozone maps from NIMBUS data and a large collection of measurements of chemical constituents. These now make possible testing of mathematical models of the complex chemical system of the stratosphere. Advanced studies of the next remote sensing contributions to understanding the upper atmosphere and to observing tropospheric pollution are now underway.

In support of operational services the NOAA series and GOES series of satellites are well established. TIROS-N, NOAA-A and GOES-D, launched in 1978 and 1979, continue to provide National Oceanic and Atmospheric Administration with excellent data for incorporation into their forecasts. SEASAT, NIMBUS-7, and SAGE have provided and continue to provide important research information. Several other flight programs, such as the Earth Radiation Budget Experiment, the Halogen Occultation Experiment and a number of Shuttle/Spacelab

payloads, are being prepared for launch in the early 80's. Information from these experiments should provide a significant contribution to achieving a better understanding of climatological processes.

Programs of research and transfer of technology are well established in the area of weather and storms. Research and analysis of data from the flight demonstrations (such as SEASAT) of remote sensing of the oceans have been a major thrust in recent years within the Applied Research and Data Analysis program. Based on experience gained through the SEASAT mission and as part of the ongoing program in remote sensing of the oceans, NASA, DOD, and NOAA are jointly proposing a new initiative called the National Oceanic Satellite System (NOSS). NOSS is a limited operational demonstration consisting of two ocean-viewing satellites with a full ground data system that provides near real-time information to the operating agencies. NOSS will provide valuable information on global wind fields, wave height and spectrum, sea surface temperature, ice coverage, and ocean color.

Applications Systems - This program supports Space Applications requirements for use of airborne facilities and provides flight support to major segments of the Space Applications program as well as to other NASA programs.

Technology Transfer - The objective of the Technology Transfer program is to ensure that the maximum possible benefits are derived from the technology developed by NASA. There is a growing demand by an increasing number of public and private organizations to use space-based remote sensing technology as a tool to derive much of the resource information required for a variety of needs: to meet Federal, state and local requirements; to assist in the search for and development of critical energy resources; and, to meet numerous other requirements for synoptic, geobased information. The Technology Transfer program assesses national priorities and user needs which can benefit from remote sensing technology, informs users of existing and planned technological capabilities, and conducts cooperative projects with user organizations to verify and transfer remote sensing technology to operational use. Due to the extensive interfaces maintained with a wide variety of individual users as well as user representative groups such as the National Conference of State Legislatures, the Technology Transfer Program also serves as a valuable communication channel for the widespread dissemination of transfer project results and user experience which is synthesized and focused for planning of new technology programs.

Materials Processing in Space - The Materials Processing in Space (MPS) program emphasizes the fundamental science and technology of processing materials under conditions that allow detailed examination of the constraints imposed by gravitational forces. Its goal is to test and demonstrate the capabilities of space-borne facilities in space environment for materials processing, and to provide opportunities for independently funded users to exploit space flight for processing activities related to their own needs.

In accordance with guidelines formulated and published in 1979, negotiations on several joint endeavors with private companies will be conducted in 1980. These activities are intended to encourage early transfer of space activity in materials science to private sponsorship. Ground-based research in FY 1981 will continue the expanded effort initiated in 1980 and will be increased to accommodate an augmented effort in advanced technology development to meet needs identified in the ground-based research program, and definition studies on space experiment systems to perform investigations arising from MPS materials research. The program's initial STS payload equipment will be fabricated in FY 1981, leading to delivery for integration early in FY 1982. Principal Investigators will complete development of experiment plans and samples for the first flights of the several apparatus systems.

Space Communications - A new industry was built upon NASA's early pioneering work in satellite communications. Industry now offers strong support for a renewed NASA effort in satellite communications R&D in order to assure a large U.S. participation in a rapidly growing worldwide telecommunications market. In FY 1980, NASA is focusing on the development of technology to increase the usable capacity of the radio frequency spectrum. In particular, NASA is developing hardware and techniques for a new higher frequency satellite communications band, including multi-beam antennas and on-board switching. In FY 1981, user experiments and demonstrations on NASA's Applications Technology Satellites, ATS-1 and ATS-3 experimental satellites will continue. Although public service user experiments on ATS-6 and Communications Technology Satellite have been completed, the review, analysis and reporting on the four hundred experiments conducted will be supported in FY 1981. Significant effort is being undertaken to provide technical consultation and support to U.S. Government agencies that have participated in the 1979 General World Administrative Radio Conference to assess the impact of changes made in the Radio Regulations.

Work is continuing on the development of an experimental Search and Rescue Mission. This system will employ sensitive receivers and high gain antennas, carried on a spacecraft, to demonstrate the feasibility of obtaining a significant increase in the capability to detect and locate distress signals from general aviation aircraft and certain marine vessels. This program is being conducted with the Departments of Defense, Transportation and Commerce as well as jointly with Canada and France; and negotiations have been completed for participation by the Soviet Union. The launch of the first operational meteorological satellite equipped with the search and rescue instrumentation is planned for 1982.

Changes from FY 1980 Budget Estimate:

The FY 1980 estimate for the Space Applications program has changed only slightly in total - a reduction of $500 thousand as a result of a general congressional reduction in the NASA budget request. A number of adjustments have been made among the individual subprogram elements, however, in order to respond to technical

problems and other unforeseen circumstances, and to refine the budget structure in order to improve the budget presentation or to reflect internal organizational assignments. All of these adjustments have been accommodated within the total budget for the program, and in the context of balanced priorities.

There have been no major redirections in the FY 1980 Space Applications program budget. However, relatively significant funding adjustments have been required in three projects:

- Landsat-D resources were increased by $8.9 million to provide spacecraft telemetry tape recorders, additional ground equipment to permit dual (Landsat-D and D') spacecraft operations, and an improved spacecraft propulsion system for compatibility with Shuttle retrieval mission requirements.

- In response to a USAF offer to enter into a joint procurement with NASA for advanced high altitude aircraft, the TR-1 (NASA ER-2), it was decided to proceed with the procurement. The aircraft is a significantly improved version of the U-2 aircraft, with improved range, payload capacity, and flight handling characteristics. In FY 1980, $5.24 million has been reallocated from other projects to the Airborne Instrumentation Research Program for this purpose.

- The FY 1980 Budget Estimate for the Earth Radiation Budget Experiment (ERBE) of $23.0 million has been reduced to $17.0 million. The ERBE funding requirements for FY 1980 have changed due to a recent NASA/NOAA evaluation of the probable launch dates for the NOAA polar-orbiting, operational meteorological spacecraft. The launch dates for NOAA-F and NOAA-G, the spacecraft equipped with ERBE instruments, have been reassessed for 1984 and 1985. As a consequence, the launch date for the NASA ERBE spacecraft has been adjusted to late 1983; initiation of the spacecraft procurement has accordingly been delayed to the end of FY 1980. The reduction in ERBE requirements made it possible to meet the increased requirement for Landsat-D.

In addition to these project-level changes, some internal project adjustments have been necessary. Notably, as definition/development efforts have progressed and as STS flight schedules have changed, funding requirements for individual Spacelab payload instruments have tended to change from the original budget estimate. In particular, FY 1980 estimates for the Shuttle Imaging Radar, Atmospheric Cloud Physics Laboratory, and Atmospheric Trace Molecules observed by Spectroscopy experiments have increased, principally due to technical problems.

Several structural changes have been made in the Space Applications budget to aid in its presentation. These include:

- A separate breakout within Resource Observations of the interagency program, AgRISTARS, to highlight its importance. In the FY 1980 Budget, this agriculture research program was included within several subelements of the Applied Research and Data Analysis (Resource Observations) activity.

- The Data Management and Applications Data Service definition activities, carried as subelements in Applications Systems for the FY 1980 Budget, are included in the Space Communications request for FY 1981. Management of these activities was transferred to the Communications Division in 1979.

For comparability purposes, these structural changes have been incorporated in the FY 1980 Budget Estimate column of the funding tables for each program area.

In summary, there have been both programmatic and budget structure changes in the FY 1980 estimates as detailed operating plan requirements have become firm. These changes are discussed in the appropriate sections of the individual program justifications which follow.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

RESOURCE OBSERVATIONS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
	(Thousands of Dollars)				
LANDSAT-D	97,500	89,800	98,663	64,300	RD 7-12
Operational land observing system	---	---	---	16,000	RD 7-14
Magnetic field satellite	3,900	1,600	1,600	500	RD 7-16
Shuttle/Spacelab payload development	6,200	1,600	1,850	2,000	RD 7-17
Extended mission operations	358	1,500	1,582	2,700	RD 7-19
Geodynamics	8,200	13,100	12,600	24,800	RD 7-20
Applied research and data analysis	22,242	17,800	12,908	18,800	RD 7-23
AgRISTARS	---	16,000	16,000	33,200	RD 7-26
LANDSAT-3	700	---	---	---	
Heat capacity mapping mission	300	---	---	---	
Total	139,400	141,400	145,203	162,300	

OBJECTIVES AND STATUS:

The goal of the Resource Observations Program is to develop and demonstrate the application of space observations and space techniques to the acquisition of important information to assist in the management of the Earth's agricultural, water, land, mineral, and energy resources, and to acquire information on the dynamic characteristics and interior structure of the Earth to improve our understanding of the solid Earth and to enable the development of a more precise physical description of the planet. To achieve this goal, the program is focused towards: (1) the development of basic techniques for sensing the characteristics of the Earth's surface and for extracting useful information from the remotely-sensed data from space; (2) the development of techniques for the precise measurements of the movements of the Earth, its crust, and its potential fields to support research in crustal movement and deformation, rotational dynamics, and interior structure; (3) the conduct of joint research and development programs with elements of the Federal, public and private sectors that have major responsibilities and information needs in managing resources and are interested in the use of space-derived data to augment other information sources; (4) the provision of remotely-sensed data from space to a variety of users; and (5) the transfer of technology to the responsible organizations leading to an evolutionary development of the global space sensing capability for the routine dissemination and use of timely and comprehensive resource information.

Principal elements of the program include the development of space and supporting ground systems; improved data processing and analysis techniques; Shuttle and aircraft support for sensor and technique development; and basic and applied research for monitoring, analyzing, and modeling vegetated and structural features of the Earth.

Landsat-3 is operating and providing data routinely. LANDSAT-D development is proceeding with launch planned in late 1981 or early 1982. In addition to continuing the availability of Multispectral Scanner (MSS) data, LANDSAT-D will provide imagery with the improved spectral and spatial resolution of the thematic mapper needed to expand the use of space data for agricultural, water resources, land use, and other applications.

Improvements in the effectiveness of exploration for new mineral and energy deposits require the development of a global capability for efficiently determining the composition and geometry of crustal materials, and improvement of our understanding of the structure, composition and evolution of the Earth's crust. Remotely-sensed data in the visible, infrared, and microwave portions of the spectrum are useful for these purposes, but currently performing systems are somewhat limited in their contributions. New instruments, such as the Shuttle Multispectral Infrared Radiometer (SMIRR), the Shuttle Imaging Radar (SIR-A), and the Large Format Camera, are being developed to obtain, on an experimental basis, additional narrow band IR and microwave data which will be assessed for its applicability in aiding in resource exploration. Although there have been delays in the processing and distribution of data from the Heat Capacity Mapping Mission

(launched in 1978), those data are now being analyzed to determine their utility in discriminating the composition of crustal materials. Data processing delays appear to be solved and investigations are in process. Initial studies indicate that HCMM imagery may be used to map structural features that are partially obscured by overlying soils. The Magnetic Field Satellite (Magsat), launched on October 30, 1979, is now providing detailed scalar and vector magnetic field information for updates of maps and charts for public use, as well as for studies of crustal inhomogenieties that may be related to mineral and petroleum emplacements. Development of the SIR-A, the SMIRR, and the Ocean Color Experiment have been completed, and the instruments are now being integrated with the Shuttle Pallet for flight in late 1980. These instruments will provide new and unique data for studying terrain features and discriminating among rock types. Development of the Large Format Camera is proceeding on schedule with delivery expected in June 1980. It will be flown on a later Shuttle flight to obtain mapping quality imagery.

A major aspect of the Resource Observations Program is research associated with understanding and extracting the physical relationship of emitted and reflected radiation with vegetated and other surface features from remotely-sensed data; with the development of models appropriate to the management of resources; and the evaluation of the use of space-derived data along with other data sources in meeting user needs. The scope of these activities ranges from individual scientific studies to projects such as Agricultural and Resources Inventory Survey Through Aerospace Remote Sensing (AgRISTARS).

When the results of the research indicate, Application Pilot Tests are used to test and expand the research concepts in the realism of the users' environment. AgRISTARS was initiated in FY 1980 with the Department of Agriculture, the Department of Commerce (National Oceanic and Atmospheric Administration), Department of the Interior, and the Agency for International Development to address priority information needs identified by the USDA. The Department of Agriculture information requirements cover a select group of crops and producing countries of significance to world trade and world nutrition.

In FY 1981, two Application Pilot Tests will be completed: an Urban Area Information System with the Bureau of the Census; and an Automated Crop Area Information System with Cotton, Inc. Four Application Pilot Tests will continue: with the California Department of Water Resources, the Pennsylvania Department of Environmental Resources, the Missouri Farm Association, and, the U.S. Geological Survey. Two or three new projects will be selected for initiation in FY 1981. Candidates include projects with applications such as range information, wetlands mapping, and soil mapping.

Studies to define the requirements for stereoscopic data for resource exploration and to develop technical and management implementation approaches will be carried out in concert with NOAA in FY 1980. Future funding and implementation decisions will be the responsibility of NOAA as part of their responsibility for operational terrestrial remote sensing systems.

Studies of the physical character and dynamic motions of the solid Earth are needed to address fundamental problems in geophysics and geodesy and to better understand the mechanisms associated with the accumulation and release of crustal strain. In the past, these studies have been severely limited by the accuracy and extent of measurement methods. The demonstration in the Geodynamics program of precise measurements of the locations of monitoring sites, separated by hundreds to thousands of kilometers, now makes it possible to acquire global, regional and local scale data to verify and extend models of tectonic processes. In FY 1980, under the Geodynamics program, and as part of a joint program with NOAA, the USGS, National Science Foundation, and Defense Mapping Agency, satellite laser ranging systems are being deployed in the U.S., the Pacific, and Australia. These lasers form part of a global network of U.S. and international laser systems for measurement of polar motion, Earth rotation changes, and plate motion. Regional measurements were initiated in California using mobile laser and microwave systems. Twenty-five investigations, including seven from Europe, were selected to begin studies using the laser data. Agreements for joint programs were implemented with Japan and discussed with Canada, Australia, New Zealand, Germany, and others. In FY 1981, these measurements will be continued and expanded to cover North and Central America, portions of the Caribbean, and Alaska. Modeling of Earth processes and methods for improved measurement of the Earth's gravity field will be studied.

Earth Resources Technology Satellite (Landsat-D)

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Spacecraft systems and sensors	82,851	68,800	73,263	44,300
Ground system	14,400	20,500	24,900	14,100
Ground operations	---	---	---	4,800
Investigations	249	500	500	1,100
Total	97,500	89,800	98,663	64,300
Delta (Expendable Launch Vehicles Program)	(10,000)	(---)	(---)	(6,000)

OBJECTIVES AND STATUS:

The objective of the LANDSAT-D project is to continue the exploration of advanced techniques to understand and demonstrate the utility of satellite-based Earth resources remote sensing systems with the experimental Thematic Mapper (TM) and the flight-proven Multispectral Scanner (MSS). The initial LANDSAT-D launch is planned for late 1981 or early 1982; the backup spacecraft will be available for launch six months after the initial launch. The major technical focus of the LANDSAT-D project involves a test of both the Thematic Mapper instrument's capabilities and an improved ground data handling system. The Thematic Mapper - on which development was initiated in FY 1977 - will offer higher resolving power and greater spectral coverage than existing instruments. These advantages promise to open up a significant number of new uses of Landsat data and to enhance many current uses.

The MSS contract was awarded in March 1978, and the design changes necessary for the LANDSAT-D mission have been verified by ground tests during FY 1979. Activities on the protoflight and flight model are on schedule for delivery to the mission contractor in January and July 1981, respectively.

Thematic Mapper development is behind the scheduled delivery date largely due to a series of technical and management problems. The present adjusted schedule points to a February 1981 delivery to the mission contractor for spacecraft integration, which is consistent with a late-1981 or early-1982 launch of LANDSAT-D.

Work is continuing on schedule for the Multimission Modular Spacecraft (MMS). The integrated spacecraft bus is scheduled to be delivered to the LANDSAT-D mission contractor in May 1980. The mission-unique flight segment design is nearing completion, and the mechanical test model of the spacecraft will undergo vibration tests early in 1980. The various mission communication antennas have already satisfactorily completed testing to assure their design adequacy.

Ground segment design is proceeding, although some schedule change has occurred due to late computer deliveries and a more complex geometric correction software development than originally anticipated. However, the present schedule outlook still supports a ground system readiness date compatible with a late 1981 Landsat-D launch.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The FY 1980 funding for LANDSAT-D has been increased by $8.9 million. Technical changes include the installation of telemetry tape recorders which are required to operate LANDSAT-D in the absence of full operational readiness of the TDRSS, which, in turn, results from delays in the Shuttle schedule. Also included is FY 1980 funding for additional ground equipment to permit dual (LANDSAT-D and -D') spacecraft

operations. Provision has been made for increasing the performance capability of the LANDSAT-D propulsion system to be compatible with Shuttle retrieval mission requirements. The planned upgrading of the Delta launch vehicle capability permits incorporation of this change.

BASIS OF FY 1981 ESTIMATE:

FY 1981 funds will permit the completion and acceptance testing of the LANDSAT-D and -D' TM and MSS. Integration and checkout of all elements of the LANDSAT-D flight segment will be conducted during FY 1981. This includes the MMS, mission uniques (such as the solar array and wideband communication systems), and the instruments. The major integration activities associated with LANDSAT-D' will also take place during FY 1981. The LANDSAT-D ground system, including the operations control center and data processing system, will be completed and checked out during FY 1981.

Operational Land Observing System

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Ground data handling system modifications	---	---	---	10,000
Sensor parts procurement	---	---	---	6,000
Total	---	---	---	16,000

OBJECTIVES AND STATUS:

An extensive review was conducted during 1979 of the technical and institutional aspects of operational remote sensing systems. An outcome of that review was the assignment to the National Oceanic and Atmospheric Administration (NOAA) of the management responsibility for land observing operational remote sensing systems. It was also decided that NASA should continue in its role of carrying out the research and development activities which advance the technological capabilities of these systems. NOAA has initiated the development of an implementation plan in concert with NASA and other Federal agencies to establish the performance objectives and programmatic requirements for the operational systems. Although this plan will not be completed prior to mid-1980, in readiness for the FY 1982 budget formulation process, NASA and NOAA identified several issues for consideration in the FY 1981 budget recommendations to the

President; specifically, the Administration agreed that provision should be made in the NASA and NOAA budget requests for both hardware procurement and study activities supporting the operational system development and formulation.

The NASA request in FY 1981 provides for funding to modify the ground data handling system for LANDSAT and to initiate procurement of long-lead-time parts for the Thematic Mapper and Multispectral Scanner sensors. The ground system modifications will enhance the reliability and operational characteristics of the LANDSAT ground data handling system. The LANDSAT-D system, currently under development, has been designed to meet the requirements of a research and development system and consequently lacks the redundancy and timeliness provisions which are required of operational systems. Modifications to the system are necessary in order to meet the operational requirements of 95% reliability and 48 hour throughput time. In addition, the long-lead-time parts procurement for the two sensors has been identified as a means of reducing the time span from initiation of development of follow-on spacecraft of the LANDSAT type to actual flight readiness. Sensor parts procurement undertaken in FY 1981 concurrently with the timing of a decision on the configuration of the operational system in the FY 1982 budget recommendations, ensures a flight readiness date for a transitional third LANDSAT-D type spacecraft which is compatible with the projected need in 1985.

BASIS OF FY 1981 ESTIMATE:

FY 1981 funds will be used to initiate modifications to the LANDSAT-D ground handling system and to initiate procurement of long-lead-time hardware for the Thematic Mapper and Multispectral Scanner. The Landsat-D ground system currently under development is of a serial, nonredundant design well suited to research and development, but vulnerable to any one of numerous single point failures. The requested funds will be used for the initial modifications required to partially upgrade the data handling system to meet operational requirements. Consideration of additional improvements to the system is an integral part of the implementation planning studies currently underway. Initiation of procurement of long-lead-time hardware for the Thematic Mapper and Multispectral Scanner in FY 1981 will enable a launch readiness date of 1985 for a follow-on spacecraft program to be initiated in FY 1982. Items to be procured include: Thematic Mapper elements - scan mirror blank, detectors, and high reliability electronic parts; Multispectral Scanner - photomultiplier tubes, scan mirror blank, and high reliability electronic parts.

Magnetic Field Satellite (Magsat)

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Spacecraft	2,538	460	286	---
Experiments	1,009	840	863	500
Ground operations	353	300	451	---
Total	3,900	1,600	1,600	500
Scout (expendable launch vehicle program)	(1,400)	(---)	(---)	(---)

OBJECTIVES AND STATUS:

The Magnetic Field Satellite (Magsat) Mission was designed to measure near-Earth magnetic fields on a global basis. The objectives are to obtain an accurate description of the Earth's magnetic field; to obtain data for use in the update and refinement of world and regional magnetic charts; to compile global crustal magnetic anomaly maps and to interpret those maps in terms of geologic/geophysical models of the Earth's crust. The United States Geological Survey (USGS) plans to utilize the field models to update regional and global magnetic charts it will issue in 1980. The USGS also plans to use the field models and the basic magnetometer measurements to derive magnetic anomaly maps for use in Natural Resource Assessment Studies.

The Magsat was successfully launched on October 30, 1979 into a low Earth, nearly polar, orbit by the Scout launch vehicle. Deployment of the sensor boom and platform on which the scalar and vector magnetometers are mounted was completed on November 1, 1979. Data acquisition was initiated on November 3, 1979. Two anomalous conditions have been experienced. These are: 1) higher than expected temperatures in portions of the spacecraft; and 2) an interference with one of the cesium vapor lamps in the scalar magnetometer. Neither anomaly has impacted the Magsat mission objectives or scientific investigations. The Magsat mission duration, based on the actual orbit and solar conditions, is estimated at five months.

In 1979, 32 Magsat investigations were selected. Scientists from the United States and eight foreign countries - Australia, Brazil, Canada, France, India, Italy, Japan, and the United Kingdom will carry out investigations in six general categories: geophysics, geology, field modeling, marine studies, magnetosphere/ionosphere, and core/mantle studies. The first magnetic field model using Magsat data has been obtained

using measurements taken during the initial three weeks of operations. The model will be updated periodically as more data are acquired. The initial field model was delivered to the U.S. Geological Survey in mid-December.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The current FY 1980 funding requirements for Magsat remain unchanged from the budget estimate. Minor adjustments between project elements were based on up-to-date detailed schedule and contract requirements.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 funds provide for data analysis. This will include the processing and distribution of data, final spacecraft orbit and precision attitude determination, and computation of the definitive field model. Support will also be provided for using the precision attitude determination and the vector data to generate magnetic anomaly maps and conduct studies, and for completion of the Magsat investigations.

Shuttle/Spacelab Payload Development (Resource Observations)

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
Orbital flight test payload development	1,905	600	854	800
Large format camera	4,295	1,000	996	1,200
Total	6,200	1,600	1,850	2,000

OBJECTIVES AND STATUS:

The objective of this project is to develop, test, demonstrate, and evaluate Earth-viewing remote sensing instruments and systems to obtain data for resource observations research. Three instruments are completing the development and test phase for flight on the second Shuttle orbital test flight mission, and one instrument is being developed for a subsequent Shuttle operational flight.

The Shuttle test flight instruments are: the Shuttle Imaging Radar (SIR-A) for evaluation of the applicability of spaceborne imagery radar for geologic exploration; a Shuttle Multispectral Infrared Radiometer (SMIRR) to conduct research for optimum spectral bands for geologic mapping; and an Ocean Color Scanner to assess the applicability of improved passive, color sensing techniques for mapping biologically-rich

(phytoplankton) areas in the ocean. The SIR-A is an adaptation of the Seasat Synthetic Aperture Radar and will be the first use of spaceborne radar specifically for landform analysis. These instruments are presently being integrated into the payload pallet for the second Shuttle test flight. The Large Format Camera (LFC) is under development for flight on a Shuttle operational mission. The LFC is a high resolution mapping camera with direct application to the mapping of large geographic areas for mineral and energy resources exploration. The camera unit will be completed in the summer of 1980 and is excepted to be flown in 1983. The Large Format Camera Interagency Working Group meets periodically to review camera design, evaluate pre-mission camera performance data, and determine initial mission coverage requirements; it will also prepare a post-flight data usefulness and system performance report.

Included in the overall project plan are efforts on a Synthetic Aperture Radar (SAR) fold and tilt antenna and a study of an attitude reference package for instruments such as the Large Format Camera. A SAR antenna with fold and tilt capability is fundamental to reducing the payload volume required for future spaceborne radar flights. This antenna would eventually support multifrequency, multipolarization radar research.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The change in Shuttle/Spacelab payload development activities in FY 1980 reflects increases in the payload development costs for the second Shuttle orbiter test flight.

BASIS OF FY 1981 ESTIMATE:

During FY 1981, the Resource Observations payload will be flown on the second Shuttle orbital test flight. Following flight, the SMIRR, SIR-A, and Ocean Color Scanner will be recalibrated and refurbished where appropriate. The data will be processed, evaluated by the science teams, and research results published. The Large Format Camera operational control center software and hardware will be developed, and field support activities will be sustained in preparation for a Shuttle flight.

Extended Mission Operations (Resource Observations)

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Heat capacity mapping mission (HCMM)	200	600	600	300
LANDSAT-2 and -3	158	900	982	2,400
Total	358	1,500	1,582	2,700

OBJECTIVES AND STATUS:

The objective of extended mission operations is to capitalize on the expected continued performance of the LANDSAT-3 and HCMM satellites beyond the initially planned mission duration. Data products from these missions are being used to support research activities in agriculture, water resources, geology and land use. In the case of LANDSAT, some operational requirements of federal and state agencies, plus many private interests are now being satisfied.

LANDSAT-3 is a major source of space data for domestic and international users and an essential element of planned and continuing experimental demonstration activities. Some continuing needs of users (federal, state, and local government agencies; foreign users; and private industry) for LANDSAT data can be met by extending spacecraft operations and data processing activities for an additional year. LANDSAT-2, while still functioning, is experiencing attitude control problems and is not being used for data acquisition while possible corrective procedures are being tested. LANDSAT-3 continues to operate nominally.

The HCMM was launched in April 1978 and was initially planned for one year of operations; in FY 1980, funds were provided to extend spacecraft operations from April 1979 to October 1980. The mission provides thermal imagery which is being analyzed to assess the feasibility of using the thermal inertial characteristics of surface material to discriminate rock and soil types and for soil moisture studies. Recent electrical power problems have reduced the data acquisition rate from the planned seven daytime and seven night passes to seven daytime and one night pass.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

An increase of $82 thousand is needed to support continuation of services provided to LANDSAT users from March 1980 to October 1980.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 funds provide for continuation of the LANDSAT-3 spacecraft operations, and data processing requirements for a full year. The HCMM funds provide for data processing and completion of approved principal investigators' studies.

Geodynamics

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Crustal dynamics project	5,400	10,100	9,600	12,600
Modeling and technique development	2,800	3,000	3,000	3,200
Laser network operations	(7,200)*	(8,400)*	(8,400)*	9,000
Total	8,200	13,100	12,600	24,800

*Funding responsibility transferred from Space Tracking and Data Systems to Space Applications in FY 1981; FY 1980 and prior funding not included in totals.

OBJECTIVES AND STATUS:

The objectives of the Geodynamics Program are to improve our understanding of the motion and deformation of the Earth's crust, the rotational dynamics of the Earth, the geopotential fields, and the Earth's interior structure. Understanding these processes has important implications in the study of earthquake and exploration for resources. Studies of the motion of the Earth's pole and variations in its rotational rate are important because of suspected causative relationships between these variations and weather and climate. The global gravity field provides information needed for understanding the mechanism that drive the motion of the Earth's crust, crustal processes associated with the formation of mineral and petroleum deposits, and for studies of oceanic circulation and current systems.

The objectives of the Crustal Dynamics project are to detect and monitor the global motion of the tectonic plates that make up the Earth's crust; to understand how and why the plates are moving and to determine if deformation internal to the plates is related to the unusual occurence of major earthquakes away from plate boundaries; to map the accumulation of crustal strain in the vicinity of seismically active faults and plate boundaries; to understand how and where this strain energy is stored; and to observe the crustal motion prior to and after major earthquakes to understand how the accumulated energy is distributed and released. The results of this project are expected to contribute to the understanding of earthquake mechanisms and hence to the eventual development by other agencies of predictive techniques. The project is conducted jointly with USGS, NOAA, NSF, and Defense Mapping Agency. Joint programs have been discussed with scientists in about 30 countries, and an agreement has been formalized with Japan. In 1979, twenty-five investigators, including seven from Europe, were selected to analyze laser data for studies of polar motion, Earth rotation, solid Earth tides and plate motion.

NASA is collaborating with the National Geodetic Survey of NOAA in project Polaris which is intended to establish a three-station Very Long Baseline Interferometer polar motion network which will be operational in 1983. Also, under the auspices of the International Astronomical Union, NASA and other Federal agencies will be participating in an international project for Monitoring Earth Rotation and Intercomparison of Techniques (MERIT). A preliminary MERIT observation campaign is planned for August-October 1980.

The laser network now operational and acquiring data for geodynamics study includes nine mobile lasers and five fixed laser observatories in the U.S. and several other countries. Several radio observatories have been equipped with advanced electronic equipment to use radio signals from quasars to measure continental distances to a very precise accuracy (the very long baseline interferometry or VLBI technique). Two mobile VLBI facilities have been developed. The two types of observing systems are now being intercompared and validated. Earlier satellite laser ranging observations were made from opposite sides of the San Andreas Fault in California and in Bear Lake, Utah as a continuation of the San Andreas Fault Experiment (SAFE). This experiment, initiated in 1972 to measure the relative motion of the Pacific and North American plates, is the first long-term monitoring of plate motion, and is showing the plates to be moving at a rate of about nine centimeters per year relative to each other.

The Geodynamics Modeling and Technique Development Program supports studies of physical processes associated with crustal deformation mechanisms, polar motion and Earth rotation, and new system concepts. In FY 1980 studies are being conducted of regional deformation in selected areas and of methods for improved gravity field surveying and global time transfer. Engineering prototypes will be constructed of small antenna systems which use Global Positioning System (GPS) signals in place of radio stars for geodetic surveying over distances of a few hundred kilometers.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The decrease of $500 thousand in the crustal dynamics project in FY 1980 is the result of delays in the initiation of some of the planned activities.

BASIS OF FY 1981 ESTIMATE:

In FY 1981, crustal dynamics measurement of regional deformation in Western North America will be continued. The motion of the Pacific, North American, Australian and European plates will be monitored and the internal deformation measured. Cooperative programs will be initiated with countries in Central America and South America. In support of these studies, laser operations at the U.S., Pacific and Australia sites will be continued and other sites will be used as dictated by program needs. In the modeling and technique development activity, FY 1981 funds will provide for completion of the present gravity field and geoid modeling. Emphasis will be placed on derivation of models of crustal deformation and fault mechanisms, and of plate mechanisms. Work will continue on formulating the basis for the eventual evolution of a global model of the dynamic Earth which will have broad application to basic science and to our understanding of geophysical processes. Responsibility for funding of the laser network operations has been assumed by Space Applications in FY 1981 to facilitate management and integration of the overall Geodynamics program requirements.

Applied Research and Data Analysis (Resource Observations)

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Renewable resources	19,192	7,000	5,873	7,800
Non-renewable resources	1,500	3,600	3,300	3,900
Applications pilot tests	1,550	2,700	1,160	2,700
Operational earth resources system (OERS) definition	--	3,000	1,100	2,800
Advanced studies	--	1,500	1,475	1,600
Total	22,242	17,800	12,908	18,800

OBJECTIVES AND STATUS:

The goal of the AR&DA activities is to develop remote sensing capabilities through theoretical studies, ground-based research and flight instrument development that can aid in the management of renewable and non-renewable resources and can monitor the impact of man and his works on the natural environment. Observables include surface characteristics such as type and extent of vegetation; characteristics of exposed soil and rocks; snow and ice cover, water impoundments and soil moisture; geological structure and landforms; and the works of man such as urban and suburban developments, major facilities and surface mines. The program is closely coordinated with, and in many instances, developed in collaboration with other Federal agencies (such as the Department of Agriculture (USDA), Department of Interior (DOI), Department of Commerce (DOC), Department of Defense (DOD), Department of Energy (DOE), Agency for International Development (AID), state and local governments, and the private sector (e.g., the Geosat Committee)). This program supports the ground-based and aircraft-based activities for renewable and non-renewable resource observations research. The objectives of this effort are as follows: to improve machine-aided interpretation and classification techniques, and data handling techniques, which are needed to increase efficiency in the transformation of space-derived data into information for utilization by the user community; to test this capability with the users through Applications Pilot Tests; to develop new sensors operating in the visible, infrared, and microwave regions of the spectrum, with emphasis on the latter two, to analyse user requirements for new types of space-acquired data; to develop and demonstrate ground-based or airborne systems that are derived from space technology, processes, management techniques or operations that contribute to the timely solution of natural resources problems. Through FY 1981, emphasis will continue to be placed on developing techniques to interpret and use the visible and infrared data from Landsat-3, the active microwave data obtained from Seasat, the thermal data from HCMM, and aircraft data from visible, infrared, and microwave sensors. Studies

are underway to develop capabilities to analyze and interpret the data which will be obtained by future systems, such as the seven-channel, higher resolution data expected from Landsat-D, the multichannel data to be provided by the Shuttle Multispectral Infrared Radiometer (SMIRR), and the optimized look-angle radar data expected from the Spaceborne Imaging Radar (SIR-A).

Renewable Resources: The principal objectives are to develop remote sensing techniques; to monitor the spatial variability of soil and snow moisture and to perform associated hydrologic modeling; to improve land resources classification, modeling, change detection, and geobased information system interfaces; to develop improved remote sensing techniques and machine-aided interpretation; and to test the utilization of these information extraction techniques with user agencies.

Non-Renewable Resources: The principal objectives are to develop optimal spaceborne remote sensing techniques to discriminate geologic materials at the Earth's surface and for analysis of surface morphology and composition; to develop optimal spaceborne potential field techniques for analysis of subsurface crustal structure; and to develop geologic models for use with space-acquired data in mineral and energy assessment, exploration development, and management.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The decrease of $4.9 million in the Resource Observations AR&DA FY 1980 estimate reflects deferrals of effort in the various activities, based on an assessment of priorities within available funding. The initiation of a small number of Applications Pilot Test projects, and certain research tasks, will be delayed until FY 1981.

Reallocation of Operational Earth Resources Satellite (OERS) definition and Non-Renewable Resources AR&DA funds was also required in FY 1980 to cover increased costs for development of Shuttle/Spacelab instruments and to support acquisition of the ER-2 aircraft. The decrease in the OERS definition activity is a result of a less extensive scope of work than anticipated.

BASIS OF FY 1981 ESTIMATE:

Renewable Resources: Principal efforts will be directed at continuation of on-going remote sensing technique development with the Federal, university and private research communities in the areas of water resources, land resources, and interpretive techniques and sensor development. These efforts include theoretical modeling, ground-based studies, and aircraft and spacecraft data analysis. Specific activities planned for FY 1981 include projects in coastal resource monitoring, radar land cover interpretation, interpretive techniques, and sensor development.

Non-Renewable Resources: Principal efforts will be directed toward improving our ability to detect geological structures and chemical composition and to understand geological processes, thereby enhancing exploration strategies for non-renewable resources. Included are: continuation of broadband spectral reflectance/thermal emittance measurements of rock types found in arid environments; continuation of NASA/Geosat Test Case studies to evaluate remote sensing techniques for geological mapping in different environments; continued development of methods to extract geological information from existing remote sensing data; a geobotanical research program to develop methods of determining rock/soil composition on the basis of the distribution and spectral properties of surface vegetation; development of geologic models for use with space-acquired data in mineral and petroleum exploration and in non-renewable resources assessment investigations; and expansion of the NASA radar program including reflights of the SIR-A, ground-based research and aircraft testing of sensors to obtain an understanding of the technology needed to develop a Shuttle payload for acquisition of landform data in cloud-covered areas.

Application Pilot Tests: FY 1981 funds will support eight to nine Application Pilot Tests (APT's); six on-going with the Bureau of the Census, California Department of Water Resources, Cotton, Inc., USGS, Pennsylvania Department of Environmental Resources, and the Missouri Farm Association; and two to three new APT's which will be initiated in the areas of range information, wetlands mapping, and soil mapping.

Operational Earth Resources System Definition: Support to the National Oceanic and Atmospheric Administration for definition of the OERS system, initiated in FY 1980, will be continued in FY 1981. The definition tasks include an analysis of data acquisition requirements and the subsequent derivation of system engineering parameters, conceptual designs of space and ground segments and identification of implementation options for both segments.

Advanced Studies: In FY 1981, definition studies will be performed for potential new initiatives--Gravsat, Soil Moisture Mission, Multispectral Resources Sampler, and Spacelab payloads. In addition, preliminary mission definition studies will be performed on promising future missions and sensors.

Agriculture and Resource Inventory Surveys Through Aerospace Remote Sensing (AgRISTARS)

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Foreign commodity production forecasting.....	--	7,300	6,291	13,200
Supporting research.....	--	7,300	7,559	13,800
Early warning, soil moisture, domestic crop and land use, conservation pollution, and renewable resources.....	--	1,400	2,150	6,200
Total.....	--	16,000	16,000	33,200

OBJECTIVES AND STATUS:

Agriculture and Resource Inventory Surveys Through Aerospace Remote Sensing (AgRISTARS) is a joint research, development, and testing activity undertaken with the Department of Agriculture (USDA), the Department of Commerce (USDC), and NASA. FY 1981 is the second year of a six-year program to develop and test techniques using satellite-acquired remote sensing data to augment existing data sources and to provide information not presently available. Primary emphasis will be placed on the two highest priority USDA items, early warning and commodity production forecasting.

The FY 1980 focus within the elements of the AgRISTARS program are:

- Early Warning/Commodity Condition Assessment Project: conduct data collection and analysis for soybeans, corn, small grains, rice and cotton; and, conduct research on selected early warning alarms for wheat such an winterkill.

- Foreign Commodity Production Forecasts Project: conduct an exploratory test of wheat/barley separation procedures in the United States and Canada and corn/soybeans in the United States in preparation for an FY 1981 Pilot Test. In the USSR, a barley production forecasting agronomic data base will be developed and pilot test areas selected. Data acquisition will be initiated in Brazil for separation and production estimation of corn and soybeans. Data collection will be conducted and research initiated for wheat in Australia.

- Supporting Research Project: complete installation of supporting research data system and conduct technique development for crop development stage and area estimation. Initiate development of crop spectral inputs for yield model development.

- Soil Moisture Project: continue field measurements with ground sensors to obtain a better understanding of the basic measurement capabilities. Continue analysis of 1978 Colby, Kansas, aircraft data sets, and continue profile modeling of root zone soil moisture.

- Domestic Crop/Land Cover, Renewable Resources Inventory, and Conservation/Pollution Projects: conduct limited start-up activities in these areas to prepare for conduct of pilot tests in FY 1981.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The FY 1980 estimate for AgRISTARS has not changed in total, but some adjustments have been made in the estimates for Foreign Commodity Production Forecasting, Supporting Research, and other research tasks to provide necessary support to the interagency research in the Conservation/Pollution, Domestic Crops/ Land Cover, and Renewable Resources Inventory Projects.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 focus within the elements of the AgRISTARS program are:

- Early Warning/Commodity Condition Assessment Project: expand FY 1980 activities to develop and test techniques to quantify the damage to spring wheat caused by wind and/or excessive water; and, initiate R&D for rice, cotton, soybeans, corn and small grains. Initiate pilot tests in water stress assessment, adverse temperature/wind alarms for small grains and snow cover estimates.

- Foreign Commodity Production Forecasts Project: expand FY 1980 activities to conduct and evaluate pilot tests of techniques to forecast corn and soybean production in Indiana, Illinois and Iowa and to test and evaluate spring wheat/barley technology in the Northern United States Great Plains and Canadian test sites; and, to design experiments for corn/soybeans in Brazil; wheat, corn and soybeans in Argentina, and barley in USSR. Conduct problem solving for Australian wheat area determination.

- Supporting Research Project: develop research geocoded data base for historic, agronomic and remotely-sensed data. Conduct initial technique development for crop stage and area determination and test in the United States for rice/corn/soybeans; in Argentina for wheat/corn/soybeans; in Brazil for corn/soybeans; and in the USSR for barley. Continue development of spectral inputs for yield models for wheat, barley, corn and soybeans.

- Soil Moisture Project: conduct a major aircraft test to evaluate remote sensing determination of soil moisture in other climate conditions such as the humid east coast environment; and, continue root zone soil moisture profile modeling and conduct analysis of measurement effects such as vegetation cover, surface roughness, and soil type, etc., on remotely-sensed soil moisture measurements.

- Domestic Crop/Land Cover Project: provide major crop area determination in Iowa and Kansas and expand to two additional states to reduce variance of commodity forecasts in those states; and, develop techniques to improve efficiencies for full Landsat frame analysis.

- Renewable Resources Inventory Project: continue multi-resources inventory pilot tests and initiate new areas of research to conduct inventories and monitoring activities required by the Resources Protection Act.

- Conservation/Pollution Project: complete research and development activities required prior to FY 1982 pilot test of hydrologic watershed model and snowpack assessment model; and, continue development of water basin scale pollution model using remote sensing inputs. Initiate air pollution studies to determine effects on crops.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

ENVIRONMENTAL OBSERVATIONS PROGRAM

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
		(Thousands of dollars)			
Upper atmospheric research program.....	(14,500)*	13,000	12,500	13,500	RD 7-32
Applied research and data analysis.....	33,726	49,900	48,670	56,400	RD 7-34
Shuttle/Spacelab payload development....	7,750	9,600	9,600	8,200	RD 7-39
Operational satellite improvement program.....	6,100	7,400	7,400	10,700	RD 7-42
Earth radiation budget experiment.....	7,000	23,000	17,000	29,000	RD 7-43
Halogen occulation experiment.....	3,600	8,000	8,000	6,000	RD 7-44
Extended mission operations.....	1,250	5,800	5,800	8,000	RD 7-45
National oceanic satellite system.....	---	---	---	5,800	RD 7-46
Tiros-N.....	1,200	---	---	---	
Nimbus-7.....	3,624	500	500	---	
SEASAT.....	3,500	---	---	---	
Total.....	67,750	117,200	109,470	137,600	

*Program transferred from Space Science to Space Applications, January 1979; FY 1979 funding not included in total.

OBJECTIVES AND STATUS:

Understanding the dynamics and limitations of our environment is essential to long-term survival and important to many day-to-day activities. The objectives of NASA's Environmental Observations program are to improve the understanding of processes at work in the atmosphere and oceans, to provide space observation of parameters involved in these processes, to extend the capabilities to predict environmental phenomena and to assess their interaction with human activities. The interactions among the processes and the interrelationship of the atmosphere, ocean, land and space environments can only be fully studied on a global basis from space. The application of remote sensing from space to environmental studies and services is the focus of the program.

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To meet the objectives, a number of program elements are pursued in reasonable balance. They include: (1) research and development efforts; (2) the development and demonstration of new techniques; (3) research and demonstration flight missions; and, (4) operational prototypes and demonstrations in support of other agencies.

A number of significant events have occurred in the past two years and others are planned in the on-going program. Three research/demonstration satellites were launched in 1978 and 1979 (SEASAT, Nimbus-7, and SAGE). Nimbus-7 and SAGE continue to operate, and the SEASAT data is providing the basis for a number of new efforts, including a major new initiative, the National Oceanic Satellite System (NOSS). Three operational satellites were placed in orbit for the National Oceanic and Atmospheric Administration (NOAA) in 1978 and 1979 (Tiros-N, NOAA-A, and GOES-3). These continue to provide excellent service to the NOAA weather forecasters. The Halogen Occultation Experiment (HALOE) will be launched in 1982 and 1983, and the Earth Radiation Budget Experiment (ERBE) instrument will fly on two NOAA meteorological satellites and a NASA dedicated spacecraft over the 1983-1985 timeframe.

NASA continues to study the upper atmosphere and stratospheric air quality with the objective of expanding our understanding of the upper atmosphere and developing our ability to assess potential threats to the ozone layer. The program combines field measurements from ground, aircraft, balloon and rocket platforms; laboratory studies; theoretical studies; and data analysis. In the past few years, NASA and others have measured key species involved in ozone photochemistry and now have adequate information to begin comparisons of field data with mathematical models. These comparisons will be a major advancement in understanding the chemistry of the stratosphere. Advanced planning includes the use of research satellites for the simultaneous and global study of the radiative, chemical, and dynamics processes occurring in the upper atmosphere.

It is now clear that air pollution problems must be solved on a regional basis, and that global chemical budgets (such as carbon monoxide) act both as tracers of transport processes and as a background for regional events. Because remote sensing offers the requisite large spatial perspective, the NASA R&D efforts in air quality and chemistry include joint support of field investigations with the Environmental Protection Agency and the National Science Foundation to focus on these two areas. Field analytical and laboratory studies will continue to emphasize the global carbon-nitrogen-ozone and sulfur-ammonia-aerosol chemical systems. NASA and the Environmental Protection Agency (EPA) have developed a cooperative plan to demonstrate synoptic coverage of regional air pollution using satellite data.

To provide improved systems for future operational satellite missions, NASA's global weather activities include both the analysis of intensive meterological observations and the development of improved sensors and calculation techniques. The Global Atmospheric Research Program (GARP) Global Weather Experiment conducted in 1979 provides a unique set of data that has never before existed for research purposes. NASA's numerical forecast models are now able to utilize satellite data, and some of the results show marked improvements (up to 20% improvement with SEASAT wind fields). Improved models are being investigated, and research is being conducted on improved temperature sounders, surface pressure instruments, passive and active microwave moisture sensors, wind sensors, and rainfall measurement techniques.

Severe storms, tornadoes, damaging downdrafts, and destructive cloud-to-ground lightning are the focus of a group of activities in the Severe Storms program aimed at improving both observation and forecasting of such events. Such studies will use the remotely sensed data from the Severe Environmental Storms and Mesoscale Experiment (SESAME) program conducted in 1979 - another unique set of data for research. Ongoing mesoscale modelling efforts for forecast improvement with machine interactive systems will lead to a joint project with NOAA at their National Severe Storm Forecast Center. This is similar to the successful NOAA/NASA frost-freeze warning system demonstration in Florida. The performances of an aircraft Doppler lidar system now under development for improved wind measurement and an improved meteorological temperature and moisture sounder now being installed on GOES-D will be evaluated in FY 1981.

NASA, DOD, NOAA and the oceanographic science community have realized the tremendous potential that satellites may bring to the study of the world's oceans. The observations collected during 99 days of SEASAT operation are currently being used in many oceanic and ice studies and provide the basis for a major new initiative (NOSS). The SEASAT, Nimbus and Geodynamic Experimental Ocean Satellite (GEOS) data have also pointed toward opportunities for future missions. NASA is beginning to investigate methods to obtain global ocean surface topography and measurements of the polar ice caps, the ice sheets and snow - the largest single yearly environmental variables on Earth.

The SEASAT sensors performed so well (winds to $\pm$ 2m/sec., significant wave height to $\pm$ 10%, and local sea surface elevation to $\pm$ 10 cm. or better) that NOAA, DOD and NASA are jointly proposing a major new initiative in FY 1981 - the National Oceanic Satellite System (NOSS). NOSS is a limited operational demonstration consisting of two ocean-viewing satellites with a full ground data system that provides near real-time information to the operational agencies. NOSS will provide valuable information on global wind fields, sea state (wave height and spectrum), sea surface temperature, ice coverage, and ocean color. By retrospective analysis, the SEASAT data now shows that such information will materially aid shipping, fleet operations, marine resource management and extraction and numerous commercial ventures.

In support of the National Climate Program, NASA is involved in those long-term global measurements and research areas where space systems can provide a significant contribution to achieving a better understanding of climatological processes. The earth's radiation budget was established early as one such area, and the Earth Radiation Budget Experiment (ERBE) is an on-going flight program aimed at studying the global dynamics of this portion of the atmosphere. Special studies are underway regarding air-sea interactions, hydrological processes, cryospheric processes, and aerosol effects. Climate sensitivity models now under development and the on-going pilot data base management study for precipitation and sea ice will be evaluated in FY 1981.

Building on this research base, the major thrusts in FY 1981 in NASA's Environmental Observations program are to: (1) initiate a joint NOAA, NASA and DOD program for demonstration of an operational system for ocean monitoring; (2) improve the understanding of the physics and chemistry of the stmosphere and detect any global

changes in stratospheric ozone; (3) improve operational measurements of atmospheric temperature, moisture, pressures, winds, and precipitation; (4) determine the dynamic behavior of water and ice (costal zone and deep ocean); and, (5) validate severe storm indicators and precursors.

Upper Atmospheric Research

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Research support	(12,900)	11,400	10,900	12,400
Upper atmospheric research balloon program	(1,000)	1,100	1,100	1,100
Spacelab payload definition	(600)	500	500	---
Total	(14,500)*	13,000	12,500	13,500

*Program transferred from Space Science to Space Applications, January 1979

OBJECTIVES AND STATUS:

The Upper Atmospheric Research Program was formulated in compliance with a Congressional mandate to NASA to develop and implement a comprehensive program of research, technology and monitoring of the phenomena of the upper atmosphere. The resulting program is aimed at improving basic scientific understanding of the upper atmosphere and the methods needed to maintain its chemical and physical integrity.

In particular, the goal of the program is the improved prediction of man's impact upon the ozone layer and the effects of changes in the upper atmosphere upon our environment. In order to accomplish this, efforts are underway: (1) to improve upper atmospheric models, validate them and assess their uncertainties; (2) to measure minor chemical constituents, temperature, and radiation fields; (3) to develop sensors capable of remotely sensing all aspects of the upper atmosphere from space; (4) to assemble and maintain the existing long-term data base of stratospheric ozone measurements and long-time scale natural variations in order to detect man-made ozone changes; and (5) to carry out laboratory kinetics and spectroscopy studies to support these activities.

Significant simultaneous measurements of numerous stratospheric species and several coordinated balloon flights have been completed which provide validation for some of the predicted 1-dimensional model results. Results from theoretical studies have emphasized the close coupling of the nitrogen, hydrogen and chlorine compounds. New laboratory results have provided improved data required for models and the interpretation

from our field measurements program. New measurement techniques have been demonstrated. A reaction rate panel has been established. An extensive workshop has assessed the status of the ozone depletion problem (current steady state CFM ozone depletion will be about 18%) and planning is underway for an Upper Atmospheric Research Satellites (UARS) program to provide a comprehensive investigation of the energetics, composition, and dynamics of the stratosphere and mesosphere.

The balloon support program supports instrument development and testing, and provides for a large number of direct and remote atmospheric measurements in the altitude range up to about 45 kilometers.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The decrease of $500 thousand in the Upper Atmospheric Research Program reflects an internal adjustment of funds for the procurement of the ER-2 aircraft. The increased range and payload capability of the ER-2 as compared to the U-2 aircraft is especially important to studies in the upper atmosphere. It will enhance the ability to acquire data concerned with stratosphere-troposphere exchange and aerosol processes. This adjustment of Upper Atmospheric Research resources recognizes that the ER-2 will provide needed capability for study of potentially important exchange regions such as the Southeast Asia monsoon area and the Antarctic, and for study of the effect of tropical cloud processes on stratosphere-troposphere exchange.

BASIS FOR FY 1981 ESTIMATE:

During FY 1981, NASA will continue the assessment and evaluation of man-made and natural perturbations of the stratospheric ozone layer. The development of models which couple radiative, dynamic, and chemical processes will continue; the confirmation of chemical mechanisms by simultaneous measurements of stratospheric trace species will be extended; improvements in the laboratory kinetics and spectroscopy data base will be sought; and new and improved techniques will be developed for detecting additional trace species and remotely measuring winds. The research program will be extended into the mesosphere because knowledge of the coupling between the mesosphere and the stratosphere is necessary for understanding the complex interactions between radiation, chemistry, and dynamics in the upper atmosphere, and the relationship between solar variations and terrestrial weather and climate. Feasibility and definition studies for a future Upper Atmosphere Research Satellites (UARS) program will be continued.

The balloon program will be continued at a level of approximately 45 flights per year and will provide key measurements of the photochemically active trace species important in the stratospheric ozone balance. Evaluation and selection of atmospheric experiments for follow-on Spacelab missions will be completed. Definition studies for a Spacelab Light Intensification Detection and Ranging (LIDAR) system and a cryogenically-cooled, limb-scanning interferometer radiometer (CLIR) will be continued. These studies will continue our progress towards developing the spaceborne active and passive measurement capability to provide the global data on trace species, dynamic processes, and meteorological parameters needed in understanding the atmosphere.

Applied Research and Data Analysis (Environmental Observations)

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Applied research and data analysis in:				
Stratospheric air quality	---	4,800	4,800	5,800
Tropospheric air quality	6,636*	4,400	4,400	5,400
Global weather (including GARP)	8,239	10,700	10,600	11,600
Severe storms	3,382	5,200	5,200	6,600
Ocean processes (including water quality for FY 1980 and beyond)	9,895	13,300	13,140	17,600
Climate	4,489	8,500	8,400	9,400
System '85 definition	---	1,500	---	---
National oceanic satellite system (NOSS) definition	1,085	1,500	2,130	---
Total	33,726	49,900	48,670	56,400

*Includes all environmental quality: tropospheric, stratospheric and water.

OBJECTIVES AND STATUS:

The Applied Research and Data Analysis (AR&DA) program is the foundation for NASA's activities in Environmental Observation. It supports the basic studies that result in the understanding of the phenomena and processes of the atmosphere and oceans and their interactions. In the AR&DA program, hardware concepts are developed to produce sensors and instruments for demonstration; advanced studies are conducted for the definition of new systems and missions; and support is provided for the transfer of new technology to the user community. An integrated program, it focuses on the interrelationship among the classically diverse fields of meteorology, climatology, atmospheric chemistry, atmospheric physics and oceanography.

Capitalizing on the global perspective of space, the AR&DA program objectives are to study tropospheric and stratospheric chemical composition and pollution; to model the radiative budget of our planet; to improve numerical weather prediction; to determine the morphology of lightning and severe storm occurrence; and to develop and demonstrate a capability for remotely sensing near-surface properties of the ocean and to relate these properties to characteristics in both the atmosphere above and ocean below the air-sea interface. To study the climate, NASA takes a long-term perspective of the phenomena of the atmosphere and oceans with the objective of defining the data requirements, and interpreting the global data sets obtained from spaceborne platforms. Such data will be important in developing a long-term predictive capability.

To a varying extent, each of the elements of the program supports the development and demonstrations of remote sensing technology; the development of algorithms to extract geophysical parameters from remotely acquired data; suborbital and ground-based experiments to measure fundamental properites and processes of the environment and provide a base for remote sensor development; fundamental research into the processes at work in the environment; and the development of models which express the current understanding of all or part of this system and provide a predictive capability.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

Funding in FY 1980 has been reduced by $1,230 thousand, largely by deferring studies of the next generation meteorological satellite system (System 85) for two years following NOAA's decision to extend the present operational weather satellite system for the near future. These funds were applied to the Airborne Instrumentation Research Program to support the North Sea Experiment (NORSEX) which is part of the SEASAT data utilization activities ($200 thousand); to purchase an ER-2 aircraft to enhance data collection capabilities required by Environmental Observations programs ($900 thousand); and to the general reduction to the R&D budget request by the Congress ($130 thousand). Internal reallocations provided for an increase in the planned funding for National Oceanic Satellite System (NOSS) definition activities to support earlier studies of instruments and algorithms where some extra development is required.

BASIS FOR THE FY 1981 ESTIMATE:

The FY 1981 AR&DA program will include both the continuation of and the logical extensions from present activities. Particular emphasis is being placed on ocean processes AR&DA because remote sensing of the oceans represents a major new area of application of space technology. All of the program areas will continue laboratory research, numerical modelling, field research, instrument development and studies of flight missions.

The stratospheric air quality program will continue to focus on the impact of ozone perturbation on stratospheric chemistry. In FY 1981, emphasis will be on support of satellite missions and measurements and analyses focused specifically on ozone. This work will complement the efforts on ozone study being conducted in the Upper Atmospheric Research program. Ground truth for analysis of the Nimbus-7 and SAGE observations and for the NOAA temperature soundings will be supported. Satellite ozone data will be analyzed for trends, variability, transport and model verification. New developments include an ozone calibration facility and an improved ground-based ozone measurement system. An advanced laser heterodyne spectrometer, CLIR, and LIDAR instruments will be studied for future flights on Shuttle.

In tropospheric air quality research, emphasis will be placed on Environmental Protection Agency (EPA) interests in regional pollution problems and on global chemical cycles. The latter will include a joint field experiment to be performed with the National Science Foundation (NSF). Airborne laser sensors and imagery from satellite systems will be used in the joint EPA study of Persistent Elevated Pollution Episodes (PEPE) in the northeastern United States. NASA in-situ and remote sensors will be utilized for the first time in the NSF's Global Atmospheric Measurement Experiment of Tropospheric Aerosols and Gases. Analytical laboratory and field studies will be conducted to improve our understanding of man's impace on the atmosphere, with emphasis on the global carbon-nitrogen-ozone and sulfur-ammonia-aerosol geochemical cycles.

During the past year, NASA, NSF, NOAA and others participated in the successful GARP Global Weather Experiment which was completed in December 1979. In FY 1981, emphasis in global weather will be on completing studies on the data sets collected, and assessing requirements for improved operational forecasting. Simulation and sensitivity studies will be performed to define future remote measurement requirements. NASA will pursue the development of a number of improved remote meteorological sounders, including (1) advanced passive temperature and pressure concepts in the infrared and microwave regions, (2) advanced techniques to derive rainfall over land, and (3) assessment of microwave moisture sounders and lidar techniques to measure temperature and pressure profiles. Support will be provided for an advanced array processor to investigate and assess the impact on forecast accuracy of both polar orbiter and geostationary satellite observations. Experiments will be conducted to examine instability development and wave propagation in a spherical, stratified atmospheric model.

In FY 1981, the NASA severe storms research will support studies to measure convective storm intensity, tropical cyclone motion and intensification, flash flood potential, and the relationship of lightning to

thunderstorm development. Other severe storm research will include efforts to improve the basic understanding of storm development and the specific conditions which initiate storms, tornadoes, and damaging downdrafts, and produce destructive cloud-to-ground lightning. Efforts in the numerical modelling of storms and their environments will be supported in order to enhance capabilities in computerized forecasting. The program will support forecast improvement on both NASA and NOAA man-interactive systems including installation of a Centralized Storm Information System (CSIS) at NOAA's Kansas City facility. Two new measurement techniques will be assessed with flights and ground truth in FY 1981. These are the Visible and Infrared Spin Scan Radiometer Atmospheric Sounder (VAS) to be flown on GOES-D and an airplane-mounted doppler lidar for mapping wind fields around storms.

In FY 1981, investigations into general oceanic circulation will provide a basis for viewing the larger-scale topography of the sea surface via radar altimetry. The studies will examine the dependence of altimetry on factors such as surface wave height, and derive the surface current field by combining surface topography with knowledge of the gravity field and precise orbit. Just as a knowledge of the wind velocity field is central to understanding the dynamics of the atmosphere, a knowledge of the surface current field is central to understanding ocean dynamics, as well as predicting the ocean's effect on climate variations, pollutant dispersal, etc. Emphasis in FY 1981 will be on using SEASAT and GOES-3 altimetry data to initiate studies of detailed surface topography in the northwest Atlantic where geoid is accurately known; exploring ways to combine altimetry-derived surface topography with models of oceanic circulation; examining follow-on altimetry mission concepts using the Global Positioning System (GPS) for precise orbit determination; and, completing definition studies for a combined topography/gravity mission.

Air-sea interaction investigations will provide an observational basis for further understanding the smaller-scale conditions across the sea surface boundary utilizing both active (scatterometry and synthetic aperature radar) and new passive (radiometry) microwave techniques; and will determine the detailed dependence of such techniques on rain, water vapor, foam, surface temperature, and surface roughness. Such an improved observational capability will benefit both shorter-term weather forecasting as well as leading to a longer-term understanding of the ocean's role in climate. Data from both Nimbus-7 and SEASAT instruments will be used to explore the limitations on deriving near-surface conditions. Work will be initiated on production of an atlas containing detailed SEASAT Synthetic Aperature Radar (SAR) ocean imagery, and on planning and executing SAR field evaluations to be sponsored jointly by the Office of Naval Research and the National Science Foundation. A coordinated plan, including land and ice applications, will be developed for a SAR instrument to be flown on Shuttle.

Studies of coastal and inland waters will establish an observational basis for viewing water characteristics, primarily water color, and to use this information to permit the monitoring of pollutants, sediment transport, biological productivity, and water motion. The FY 1981 contribution to these goals will include completion of studies to evaluate the ability of the Nimbus-7's coastal zone color scanner to characterize biological productivity; completion of evaluation of an experiment utilizing remote sensing techniques to observe a controlled oil spill; and initiation of development of a ship-borne laser system to evaluate the performance

of future aircraft and satellite color scanners for biological monitoring.

Sea and glacier ice studies involve using a variety of active and passive microwave techniques to assist in making an unambiguous assessment of ice characteristics such as percent cover, thickness, age, and motion. In addition to providing a basis for understanding the relation of variations in ice/snow cover with climate variations, ice-observing capabilities are needed for numerous commercial ventures (shipping, petroleum, etc.) in near-polar regions. Nimbus-7 and SEASAT data are being used for this research. Additional tasks include production of an atlas of SEASAT/SAR ice imagery, initiation of a study using SEASAT/SAR imagery to evaluate the performance of models to predict deformation of the ice field under the influence of the surface wind field, and completion of definition studies for incorporation of ice-specific instruments on future satellites.

Marine boundary layer studies will provide a bases for improving the use of radar scatterometry to view the near-surface wind field. Studies will be supported for determining the dependence of scatterometry wind accuracies on factors such as the stability of the marine boundary layer, and for developing improved methods for the assimilation of this data into oceanic and atmospheric forecast models. During FY 1981, when final data tapes containing all SEASAT/Scatterometer winds become available, joint studies will be initiated with the Navy's Fleet Numerical Weather Central on the impact of SEASAT winds on the accuracy of atmospheric forecasts for both marine and land applications. Development will also be initiated on ocean mixed layer models capable of inputting SEASAT winds. Definition studies will be conducted to explore options for flying improved scatterometers on future missions.

Within the broader outlines of the National Climate Program, NASA will be taking the lead in solar and Earth radiation research. Accordingly, particular emphasis will be placed on the recently initiated special studies in radiation, extended cloudiness and aerosol effects. In FY 1981, measurements of the solar constant from the Shuttle will begin as a major step in developing a long-term program of solar monitoring. It is expected that the first global data set of stratospheric aerosols from satellite observations (Nimbus-7, SAGE) will be produced, and testing will begin of their importance in numerical model studies. Other special studies will continue in hydrological and cryospheric processes, and air/sea interactions recognizing their importance in the climate system. NASA's climate modelling activities, which will be enhanced by use of a new array processor, will focus on sensitivity studies needed to refine the requirements for future space observations of climate parameters. Advanced studies will be initiated for new sensors to measure precipitation, sea ice, and solar radiation.

Shuttle/Spacelab Payload Development (Environmental Observations)

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Measurement of air pollutants from satellites (MAPS)	500	800	500	100
Atmospheric trace molecules observed by spectroscopy (ATMOS)	3,750	3,200	3,650	600
Atmospheric cloud physics laboratory (ACPL)	3,500	3,400	4,300	2,800
Principal investigator instrument development and reflight program*	--	2,200	1,150	4,700
Total	7,750	9,600	9,600	8,200

*Formerly included in the Upper Atmospheric Research Program.

OBJECTIVES AND STATUS:

The Space Transportation System offers the opportunity for frequent, short-duration flights for instruments and associated experiments. The Environmental Observations Program is incorporating this new capability in order to capitalize on three important facets: (1) early tests, checkout and design refinement of remote sensing instruments whose ultimate use is in a long-duration monitoring system on a free-flying satellite; (2) short-term data gathering of atmospheric and environmental processes for basic reasearch and analysis where long-term observations are not necessary or are impractical; and (3) research into processes which cannot be accomplished effectively in ground-based laboratories because of the effects of gravity.

The measurement of air pollutants from satellites experiment is a gas filter correlation radiometer designed to measure the levels of tropospheric carbon monoxide and the extent of interhemispheric mass transport in the lower atmosphere. The instrument has been developed and is presently being integrated onto a pallet at the Kennedy Space Center for flight on an early Shuttle orbital flight test.

The objective of the atmospheric trace molecules observed by spectroscopy experiment is to make detailed measurements of gaseous constituents (e.g., hydrogen chloride, water, ammonia, methane,) in the Earth's atmosphere using the techniques of infrared absorption spectroscopy. These data will allow the determination of the compositional structure of the upper atmosphere, including the ozone layer, and its spatial variability on a global scale. The instrument is in final assembly with environmental and qualification testing scheduled to occur in the mid-1980. Its first mission will be Spacelab-3.

The thrust of the atmospheric cloud physics laboratory program is to improve our understanding of microphysical atmospheric cloud processes by removing the gravitational effect from the experiment design. A unique multipurpose laboratory facility is being developed for flights in the habitable Spacelab module for low-gravity experimentation performed by payload specialists. The facility has recently undergone a detailed design review with assembly of subsystems scheduled to begin in the summer of 1980. It is assigned for flight on Spacelab-3.

Over the past summer, a selection process was conducted based on proposals in response to an Announcement of Opportunity. The experiments selected include reflights of some instruments under development for the Orbital Flight Test (OFT) series, Spacelab-1, and Spacelab-2, plus the development of a doppler interferometer for wind measurements and a microwave limb sounder for measuring minor species, pressures, winds, and temperatures. Development of these instruments has been initiated. Reflights and new principal investigator developments will continue the research activities in atmospheric chemistry, solar intensity and variability, and upper atmospheric winds.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The Spacelab Payload Development portion of the Upper Atmospheric Research Program has recently been combined with the Environmental Observations Shuttle/Spacelab Payload Development. The changes to the individual elements of this combination are as shown below:

Measurement of Air Pollutants from Satellites (MAPS) - The FY 1980 budget estimate for this instrument assumed that work would be initiated in FY 1980 on defining an investigation program for reflight of the MAPS. Since the definition of future missions and experimental objectives are not specific, this activity has been deferred and will be funded as required from the resources in the PI Instrument Development and Reflight Program. FY 1980 funding will support integration activities in preparation for launch on an orbital flight test. Science team activities will include preliminary algorithm development and testing.

Atmospheric Trace Molecules Observed by Spectroscopy (ATMOS) - The development of this instrument represents a significant advancement in the state-of-the-art of interferometric spectroscopy. The instrument design is now complete. A reassessment of the remaining effort has indicated that the cost will increase due to additional design effort, increased testing of the instrument, and the slip in Shuttle flight schedule.

Atmospheric Cloud Physics Laboratory (ACPL) - This project is also experiencing cost increases due to more complex design issues than originally expected.

Principal Investigator Instrument Development/Reflight Program - The adjustment is due to rephasing of the developments to cover the increased funding requirements of the other Shuttle instruments. Reflight studies have been delayed until FY 1981.

BASIS OF FY 1981 ESTIMATES:

Measurement of Air Pollutants from Satellites (MAPS) - FY 1981 funds will be used to support launch and mission operations and the interpretation of data gathered from the mission.

Atmospheric Trace Molecules Observed by Spectroscopy (ATMOS) - The instrument is scheduled for delivery from the contractor in August 1980. Subsequent to delivery, a verification and familiarization program will be performed by the experiment team to establish baseline characteristics of the instrument. Delivery of the instrument for integration into the Shuttle payload is scheduled for mid-1982.

Atmospheric Cloud Physics Laboratory (ACPL) - During FY 1981, the ACPL will be in the test phase of the development process. These tests include qualification of the hardware, principal investigator familiarization tests, payload specialists training for the Spacelab-3 experiments, and tests for generation of toxic substances or hazardous conditions.

Principal Investigator Instrument Development/Reflight Programs - A selection process for new Shuttle flight opportunities has been completed. The experiments selected included several instruments which will have flown in the early Shuttle/Spacelab flights. The instruments are: (1) an active cavity radiometer for solar irradiance measurements; (2) a solar ultraviolet spectral irradiance monitor; (3) an imaging spectrometric observatory for trace constituent measurements; and (4) a photometric imager for lightning research. Several foreign investigations which are complementary to the NASA programs have been selected; funding for these is provided by the foreign agency sponsoring the investigator. Activities to be accomplished include instrument refurbishment and reflight and instrument development of new multiple-flight instruments for long-term research purposes.

Development of a High Resolution Doppler Interferometer (HRDI) for measuring upper tropospheric windfields will continue. The detailed design of the microwave limb sounder will be completed and "bread-boarding" of high technology subsystems for proof of concept determinations will be continued. A definition study of solar irradiance measurements in the 168-365 nanometers spectral range will be completed. These instruments were also selected from the recent Announcement of Opportunity.

In 1981, selections from another Announcement of Opportunity will be made and new instruments/investigations initiated. New investigations and flight requirements with previously developed instruments will be defined.

Operational Satellite Improvement Program (OSIP)

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Research and development for improvement of operational satellite systems	6,100	7,400	7,400	10,700

OBJECTIVES AND STATUS:

The objective of the operational satellite improvement program is to carry out the research and development activities which will provide advanced sensors, spacecraft subsystems, and ground equipment for present and future operational satellite systems.

Current developments as well as expendable launch vehicle include design modification to the NOAA polar-orbiting, operational-meteorological spacecraft for Shuttle compatability, development of the advanced Visible and Infrared Spin Scan Radiometer (VISSR) Atmospheric Sounder (VAS), development of the Nimbus Solar Backscatter Ultraviolet (SBUV) instrument for deployment on future NOAA operational spacecraft, and modification and improvement of direct readout equipment for operational use.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 funds will provide for temperature and moisture data assessment of the VAS experiment to be launched on the Geostationary Operational Environmental Satellite (GOES-D) in August 1980. Development of the Solar Backscatter Ultraviolet (SBUV) instrument scheduled for flight on NOAA-F will be continued. The SBUV on NOAA-F is an important milestone since it will be the first operational monitoring of stratospheric ozone from space. An advanced microwave sounding unit with narrower and more accurate temperature and moisture profiles, and improvements in the High Resolution Infrared Radiometer/2 and Vertical Atmospheric Sounder instruments will be initiated to meet NOAA's operational requirements. Work will continue on modification of the NOAA operational spacecraft design to enable the spacecraft to be launched by the Shuttle or expendable launch vehicle.

Earth Radiation Budget Experiment

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Spacecraft	3,400	10,700	4,700	16,700
Sensors	3,300	11,800	11,800	11,800
Mission operations and data analysis	300	500	500	500
Total	7,000	23,000	17,000	29,000
Space Transportation Systems Operations	(--)	(--)	(--)	(300)

OBJECTIVES AND STATUS:

More solar energy is absorbed by some regions of the Earth than by others. At the same time, more thermal energy is radiated into space by some regions than others. This differential heating is thought to be the driving force that sets the atmospheric winds and ocean currents into motion so as to transfer heat from warmer areas to cooler areas. The excess in the amount of solar energy absorbed over the thermal energy radiated to space continually changes for any given region, depending on the time of year, degree of cloudiness, snow and ice cover, atmospheric dust and aerosols, and properties and conditions of the surface.

The objective of the Earth Radiation Budget Experiment is to measure the temporal and spatial variations in the radiation balance over the globe. General agreement exists within the scientific community that the Earth's radiation budget must be monitored from space if we are to gain basic insights as to reasons for climatic fluctuations.

Experimental Earth radiation budget instruments have flown on the Nimbus satellites, and sampling studies based on those experiments have shown that adequate global coverage requires a multiple satellite system. They also indicate the need for more stringent calibration of the sensors. Two NOAA satellites of the Tiros-N series will be flown in sun-synchronous orbits equipped with identical Earth Radiation Budget instruments. One of the NOAA satellites will have a morning equatorial passage time, while the other will have a mid-afternoon passage time. Adequate mid-latitude and equatorial coverage requires an additional satellite. Therefore, a third set of instruments will be flown on a NASA dedicated spacecraft in a 46° inclined orbit plane. Each equatorial region must be viewed at least once each month at each hour of the day, and the orbit altitudes and instrument view angles must be known to permit geographical location of the radiometer footprints. Together, the three satellites will provide accurate measurements of the monthly average radiation balance with regional, zonal, and global resolutions. The planned launch dates are 1983-1984 for the NOAA satellites and 1983 for the NASA dedicated satellite.

The scientific objectives and measurement requirements have been developed by a joint NOAA/NASA team of scientists that include leading scientists from the university community and other non-Government organizations. These requirements have been reviewed by a committee of the National Academy of Sciences. During FY 1979 the ERBE instrument specification and associated Request for Proposal package was released to potential contractors; TRW was selected as the contractor in May 1979. Engineering design of the instruments is in process. Design modifications to accommodate the ERBE instruments on Tiros-N/NOAA spacecraft bus are underway and the request for procurement for the NASA dedicated spacecraft bus and Shuttle interface has been issued. Data processing algorithms are being defined by the ERBE experiment team, which was selected through an Announcement of Opportunity process in November 1979.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The FY 1980 funding estimate has been reduced by $6 million to provide funds for the development of a larger propulsion module required by LANDSAT-D to permit Shuttle retrievability. Because the lifetimes of the Tiros-N and NOAA-6 satellites will be greater than expected, the planned launch dates for the follow-on NOAA satellites will be delayed. This in turn will require a delay in the launch readiness of the NASA ERBE spacecraft because of the program requirement for simultaneous measurements by the ERBE-instrument-equipped NOAA spacecraft and the NASA spacecraft. This reduced funding requirements in FY 1980 for the ERBE spacecraft makes the reallocation to LANDSAT-D possible.

BASIS OF THE FY 1981 ESTIMATE:

FY 1981 funding will be used to complete the design and continue the development of the ERBE instruments, and to support the initial fabrication of the NASA dedicated spacecraft plus the design of the Shuttle/spacecraft interface hardware. ERBE experiment team members have been selected and funding support for data processing, algorithms and model software effort for the team will be continued.

Halogen Occultation Experiment

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Sensor development	3,600	8,000	8,000	6,000

OBJECTIVES AND STATUS:

The Halogen Occulation Experiment (HALOE) will provide global stratospheric vertical concentration profiles of key chemical species involved in the catalytic destruction of ozone due to chlorine compounds. These measurements will assist in estimating the depletion of stratospheric ozone due to natural and man-made causes involving chlorofluoromethanes (CFM's). Specific objectives of HALOE are: (1) to monitor globally the vertical profiles of concentrations of stratospheric hydrogen chloride, hydrogen fluoride, water and other trace gases of importance to the chlorine chemistry; and (2) to use the measured data (a) in obtaining horizontal and vertical maps of gas concentrations; (b) to perform a chlorine source analysis; (c) to validate chemical and dynamic models describing the effects of CFM's on the ozone layer; and (d) to aid in assessing ozone depletion and depletion rate due to chlorine build-up in the stratosphere.

An initial test of the engineering model instrument is being planned for flight on a Shuttle mission to demonstrate the validity of the measurement technique in a space environment and to evaluate the instrument operating parameters. A longer duration mission of one to two years will take place on the Earth Radiation Budget Experiment mission in 1983. Conceptual design of the HALOE instrument was accomplished under the Advanced Applications Flight Experiments (AAFE) program. Design of the spaceflight instrument is in progress and fabrication has been initiated. A science team was selected through the Announcement of Opportunity process in November 1979.

BASIS OF FY 1981 ESTIMATE:

In FY 1981, fabrication of the engineering model unit to be flown on the Shuttle will be completed with delivery of the instrument for integration in mid-1981. Acquisition of major subsystems of the flight unit for the Earth Radiation Budget Experiment will be initiated. Science activities will be focused on modeling techniques and development of the inversion algorithms.

Extended Missions Operations (Environmental Observiations)

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Operations for the extended missions of:				
Nimbus-5, -6, and -7	--	5,200	5,200	7,500
Stratospheric aerosol and gas experiment	700	600	600	500
Geodynamic experimental ocean satellite	550	--	--	--
Total	1,250	5,800	5,800	8,000

RD 7-45

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OBJECTIVES AND STATUS:

Nimbus-5, -6, and -7 were launched in December 1972, June 1975, and October 1978, respectively. They have provided years of global data regarding such things as sea ice, atmospheric chemistry and dynamics, the Earth radiation budget, and ocean temperature and color. They have also demonstrated a number of measurement techniques some of which have been adopted on operational satellite systems. Reduction and analysis of this valuable data is continuing and there are a number of areas where additional data is urgently needed. These include, among others, global precipitation, soil moisture, snow and ice cover and the radiation budget. Continuation of this data will support studies in the trends of world weather over several years, severe storm analysis and prediction, and improving numerical forecast models.

The satellite carrying the Stratospheric Aerosol and Gas Experiment (SAGE) instrument, launched in early 1979, continues to provide essential global monitoring of ozone and aerosols by solar occultation means.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 funding will support continued flight operations of Nimbus-5,-6, and -7 and SAGE beyond their originally planned lifetimes. It will provide maximum reduction and verification of the sensor data including the development of some special data processing techniques for existing systems. Digitizing, formatting, calibration, annotation and referencing of sensor outputs into data sets and subsequent archiving will be supported. Such information will contribute to the ozone data base and provide additional information for detecting ozone trends.

National Oceanic Satellite System (NOSS)

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Spacecraft	--	--	--	2,000
Instrument development	--	--	--	3,200
Supporting activities	--	--	--	600
Total	--	--	--	5,800

OBJECTIVES AND STATUS:

The National Oceanic Satellite System (NOSS) will be an interagency project to demonstrate the capability of remote sensing of the oceans from space and the data processing and distribution necessary to meet the operational information needs of both the military and civil sectors--needs which range from operation of the Fleet to petrochemical exploration to management of marine resources. NOSS will also provide space observations of ocean conditions which are needed to improve our understanding of ocean processes and to extend the national capabilities to predict oceanic phenomena and to assess their interaction with human activities.

Both the Department of Defense and the Department of Commerce require timely, accurate oceanic information on a global scale. The United States Navy needs the NOSS data for the selection of operating areas, damage avoidance, ship routing, strategic submarine operations, logistic resupply, antisubmarine warfare accoustic predictions, and tactical ship routing. The National Oceanic and Atmospheric Administration (NOAA) needs this information to support such diverse activities as: (1) management and conservation of marine resources; (2) the prediction of weather; (3) the protection of life and property; (4) the preservation, conservation and development of the Nation's coastal resources; and (5) the provision of maps, charts, surveys, and specialized data for safe navigation. The NOSS data should be especially important in NOAA weather forecasting models. Provision of global ocean conditions data on a timely basis will improve the efficiency, safety and cost of ship operations, transportation, off-shore oil and gas exploration and drilling, platform operations, marine construction, commercial fishing, pollution monitoring, ice monitoring, and marine search and rescue.

The NOSS capability for remotely sensing the world's oceans and providing useful data to the user community in near real-time is not available by any other means. The vast majority of the world's oceans lie outside commonly traveled sea lanes and, thus, are unobserved by conventional methods. The capability of existing and planned meteorological satellites to measure characteristics of the oceans is severely limited. The collection of global and synoptic oceanic data by the deployment of more conventional techniques (e.g., ships and buoys) would require thousands of individual platforms. Such a technique would be prohibitive both logistically and monetarily.

The oceanic features to be observed by NOSS include directional wind stress, sea surface topography, ice cap profiles, significant wave height, directional wave spectrum, sea ice patterns, internal waves, ships, icebergs, sea surface temperature, wind speed, clouds, rain, and chlorophyll. NOSS will be designed to produce data products describing these features with typically no more than a three to twelve hour delay from acquisition of the data by the spacecraft. This will demonstrate the characteristics of the data system that user agencies would require in an operational system. Mission lifetime will be sufficient to allow user agencies to evaluate fully the data's utility in an operational environment.

The NOSS is planned to be a complete end-to-end oceanic monitoring system incorporating both microwave and optical oceanographic sensors, flown on two satellites, with a ground control, data processing, and distribution system. The initial NOSS spacecraft will be launched using the Space Shuttle in 1986.

The NOSS is a jointly defined and funded program. NASA has overall project management responsibility. NOAA and DOD are responsible for defining system requirements, data products and formats. NOAA and DOD will also operate the NOSS during the five-year demonstration period following launch of the first NOSS spacecraft. NASA and DOD will share the cost of developing and launching the initial spacecraft, and NOAA and DOD will share the cost of developing and launching the second spacecraft and the ground control, processing and distribution system's development and operations. The planning estimate for the total NASA share of the baseline program is $145-190 million in dollars of the FY 1981 budget, excluding launch and supporting activities. The NOAA and DOD share of development costs is estimated at approximately $545 million, excluding launch costs. The cost for launching the two NOSS spacecraft is estimated at $80 million, to be shared by the three agencies. Overall program policy and guidance for the NOSS Program is provided by a tri-agency NOSS Steering Committee composed of one senior representative from each of the three major organizations. Steering Committee directives and decisions are converted into implementation guidelines by a tri-agency Program Management Team and, ultimately into hardware and software by the tri-agency NOSS Project located at GSFC.

The NOSS will be designed and developed under a competitive procurement process. The Request for Proposals for the Alternate Systems Concept Studies was released to industry on October 3, 1979; proposals were received in early January 1980; contract awards are anticipated in the spring of 1980.

BASIS OF THE FY 1981 ESTIMATE:

In FY 1981 funding will support the selection of a Mission Contractor for system development and implementation, and procurement of the spacecraft sensors. During FY 1981, design of the spacecraft bus, the primary processing facility, and the spacecraft sensors will be initiated. Breadboard hardware subsystems for the Large Antenna Microwave Radiometer will be fabricated and engineering testing begun. In addition, geophysical algorithm development for conversion of the remotely sensed data into useable engineering units will begin in detail.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

APPLICATIONS SYSTEMS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Airborne instrumentation research program	6,530	10,300	15,547	18,100
Shuttle/Spacelab mission design and integration*	6,260	8,300	7,300	--
NASA integrated payload planning*	1,160	1,700	1,700	--
Total	13,950	20,300	24,547	18,100
Space Transportation System Operations	(--)	(18,000)	(6,600)	(12,600)

*Funding responsibility for FY 1981 and subsequent years has been transferred from Space Applications to Space Science.

OBJECTIVES AND STATUS:

The Airborne Instrumentation Research Program (AIRP) provides flight support to major segments of the Space Applications Program as well as to other NASA programs. The aircraft fleet presently consists of two U-2C's, one WB-57F, one C-130, and one CV-990. These aircraft provide support as test beds for newly developed instrumentation and permit the demonstration of new sensor concepts prior to their being flown on satellites. The data acquired during the flights is used to refine algorithms and develop ground data handling techniques and preliminary proof of concept studies. Examples of such activities are flights over test sites to obtain crop signature data for the AgRISTARS program by the C-130 and flights in the U-2C's to acquire simulated thematic mapper data. A principal use of the WB-57F's and U-2C's is to acquire stratospheric air samples and conduct in situ measurements at altitude ranges above the capability of more conventional aircraft and below that of orbiting spacecraft. This is important in the Environmental Observation program where much interest exists regarding stratospheric transport mechanisms and where it is extremely desirable to penetrate the stratospheric region--which in the tropical interconvergence zone is normally found at altitudes of 60,000 feet and above.

CHANGES FROM FY 1980 BUDGET ESTIMATES:

The reduction of $1.0 million in Mission Design and Integration and the increase of $5.24 million in the Airborne program reflect internal program reallocations to provide for the initial funding of the acquisition of an ER-2 aircraft (U-2R). This aircraft will be obtained in conjunction with a United States Air Force procurement at a total estimated cost of $13 million and will replace one of the aging U-2's which will then be returned to the Air Force inventory. The ER-2 aircraft offers additional altitude and range capability and payload capacity over the U-2C. This enhanced capability should permit both more economical operation of the high altitude fleet and an improved capability to penetrate important regions of the stratosphere where there is considerable scientific interest.

BASIS OF FY 1981 ESTIMATE:

FY 1981 funds are required to continue the operations of the aircraft fleet at approximately the same level as during FY 1980. In addition, the request includes $7 million to complete the procurement of the ER-2 aircraft.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

TECHNOLOGY TRANSFER

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Applications systems verification and transfer	900	1,700	1,700	1,800
Regional remote sensing applications	3,500	3,800	3,657	4,100
User requirements and supporting activities	4,500	4,800	4,730	6,600
Civil systems	1,800	---	---	---
Total	10,700	10,300	10,087	12,500

OBJECTIVES AND STATUS:

The objectives of the remote sensing Technology Transfer program are to provide for the validation, transfer and widespread dissemination of proven technology applications to operational use.

The Applications Systems Verification and Transfer (ASVT) program conducts the demonstration, verification, and transfer of total applications systems in a representative user setting and with participating user organizations, emphasizing cost reduction and system compatibility with the user setting. The program is increasing the awareness and use of remote sensing by other Federal agencies, state and local governments, and private sector users. Projects are now underway with the National Park Service, the Corps of Engineers, the Pacific Northwest and Appalachian Regional Commissions, and the State of Texas. Additional projects will be undertaken in FY 1980 with the states of California and Alaska, and with regional water management districts in the state of Florida.

The Regional Remote Sensing Applications Program provides for broad assistance to state and local governments in evaluating and implementing proven Landsat applications in natural resource and environmental management. The program has provided major impetus to state use of Landsat data through data analysis training to over 750 state, local and Federal personnel and the completion of four multi-disciplinary state application demonstration projects. Additional projects with 21 states are presently being conducted. Follow-on technical assistance is leading to the establishment of operational Landsat data processing capabilities in over a dozen states as well as significantly increased technical communication and cooperation between states, and support for state use of private sector capabilities. Increased use of geobased information systems in the transfer projects has increased the relevance and utility of Landsat data utilization to other state programs. Other initiatives are expanding county and other local government exposure to and use of Landsat data both independently and through the use of established state capabilities.

Under User Requirements and Supporting Activities, continuing communications at the national level are maintained between NASA and the user community to determine and analyze national priorities and user needs, inform users of existing and planned technological capabilities, obtain external evaluations of Space Applications programs for planning purposes, and develop program awareness and technical capabilities in educational institutions. In FY 1980 a dynamic user requirements planning function is being developed with particular emphasis on external drivers to technology use such as Federal and state legislation. The formal contacts with national user interest groups and change agents such as the National Conference of State Legislatures and the National Governors Association have continued to be valuable in focusing and accelerating state government interest in technology transfer through establishment of two-way communications, increase of user awareness, and participation in needs definition. A program to increase transfer to locally based private industries including architectural and engineering (A&E) firms, environmental and development consultants, and data processing companies, is being implemented through a network of community colleges. We are also continuing to encourage the development of geographically distributed university capabilities to demonstrate the practical benefits of remote sensing through the conduct of research, education and public service activities. Twenty-one universities are currently participating in the program, with recent additions expanding the technical areas of interest from remote sensing to include materials processing, geodynamics and geology.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The $213 thousand change in FY 1980 funding for Technology Transfer is the result of two actions: a reduction of $13 thousand in Regional Remote Sensing Activities as part of a general Congressional reduction in the Agency's budget; and, a reduction of $130 thousand in Regional Remote Sensing Activities and $70 thousand in User Requirements and Supporting Activities to be applied toward procurement of an ER-2 aircraft. This high altitude aircraft will provide support for the remote sensing requirements of both of these activities.

BASIS OF FY 1981 ESTIMATE:

Major emphasis for FY 1981 will be in the following areas:

ASVT projects with the State of Texas (Natural Resources Inventory/Monitoring) and the National Park Service (National Park Management) will be completed in FY 1981. In FY 1981, approximately three new ASVT's will be initiated. Program thrusts in FY 1981 will address private sector applications with architectural/engineering consultants in route and site locations, public utility companies in power demand prediction and agri-businesses in agricultural forecasting as well as new evolving Federal programs in the area of environmental quality. In addition, private industry service suppliers will be utilized more fully in conducting ASVT projects with user organizations.

Regional Remote Sensing Applications Program activities in FY 1981 will complete Landsat Multispectral Scanner (MSS) application demonstration programs with 15 state governments. In addition, demonstrations in the remaining four states not yet involved in NASA's technology transfer activities will be initiated in FY 1981. An additional six to eight projects with universities will continue the development of curricula and capabilities for independent training support to operational state government Landsat programs. Transfer of Landsat technology to state governments will continue with the introduction of new technology, including limited use of Return Beam Vidicon (RBV) data, and expanded use of geobased information systems. Increased emphasis will be placed on follow-on technical assistance to operational users through documentation of analysis software and application case studies, technology surveys, and involvement of private sector professional associations in developing user service capabilities. Technology transfer to substate governments will be expanded to national scale in FY 1981 through an estimated 20 to 25 projects with county governments (as well as regional government entities). This program will be undertaken in cooperation with national representative organizations (such as the National Association of Counties) to provide technology sharing and a multiplier effect among users. The program will continue with a selected number of representative users in succeeding years.

The User Requirements and Supporting Activities will focus on strategies to expand the involvement of the private sector in NASA's technology transfer efforts both as a supplier of remote sensing services and as an independent end-user of remote sensing. Studies will be performed to evaluate private user needs and address their major needs through joint transfer projects, thereby providing private companies an opportunity to use

remotely sensed data in increasing their own productivity. Emphasis will also be placed on increased use of private industry service suppliers as the technical arm in NASA's transfer projects with both public and private users. Market evaluations will be conducted to lay a foundation for transfer projects addressing new technology applications in the environmental quality and weather data areas. Formal institutional relationships with the National Conference of State Legislatures (NCSL), National Governors Association (NGA) and a substate user group will be continued and broadened to promote awareness and transfer of technologies in addition to Landsat. In addition, it is planned to continue to phase in additional universities in FY 1981 as some of the present university programs are completed. Selection of these universities and areas of application will be made in concert with the Remote Sensing Applications and ASVT programs in order to reinforce the establishment of state and local government capabilities to use remote sensing.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

MATERIALS PROCESSING IN SPACE

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
	(Thousands of Dollars)				
Space processing applications rocket (SPAR) project.....	3,600	2,100	2,100	---	---
Applied research and data analysis.....	4,850	6,900	6,450	11,700	RD 7-54
Shuttle/Spacelab payload development.....	11,950	10,800	11,218	10,500	RD 7-56
Total.....	20,400	19,800	19,768	22,200	
Space Transportation System Operations.....	(---)	(---)	(600)	(1,600)	

OBJECTIVES AND STATUS:

The Materials Processing in Space (MPS) program's emphasis is on the fundamental science and technology of processing materials under conditions that allow detailed examination of the constraints imposed by gravitational forces. Its goal is to test and demonstrate the capabilities of the space environment for materials processing and to provide opportunities for independently funded users to exploit space flight for processing activities related to their own needs. As these development, test, and demonstration efforts proceed, the technology will be transferred as appropriate to non-NASA users for their use.

Ground-based research, technology development, and payload definition activities in FY 1981 will concentrate on three major processing areas: crystal growth and solidification, containerless processing, and

fluid and chemical processing. These activities will provide the scientific basis for future space applications of materials processing technology. Several joint agreements will be negotiated during 1980 with industrial concerns through the Joint Endeavor mechanism developed in 1979: such projects are intended to facilitate early transfers of space activity in materials science and technology to private sponsorship. Also, a small advanced payload planning study of future orbital systems will be coordinated with the Office of Space Transportation Systems.

The Shuttle/Spacelab payload development project will provide opportunities to perform materials science experiments in an extended, microgravity environment. Critical design reviews for the payload equipment will be completed in the first quarter of FY 1981, and most of the work of fabrication and testing will be completed during that year. As currently configured, this equipment includes two systems which serve multiple Principal Investigators: the Fluid Experiment System, which is used to determine density gradients and fluid flows during crystal growth and other fluid processes, and the Solidification Experiment System, which is used to perform a wide range of controlled high temperature melting and freezing experiments. Also included is specialized equipment for experiments on vapor crystal growth of mercuric iodide and space production of polymer latexes with uniform particle sizes.

The Space Processing Applications Rocket (SPAR) project will be completed in 1980. Six SPAR flights were conducted over the past five years, two flights are scheduled for CY 1980, and the final flight is scheduled for 1981. The Materials Experiment Assembly (MEA), a system of interface hardware that will enable SPAR payload apparatus to be used in the Shuttle payload bay, will complete its development phase in 1980.

Applied Research and Data Analysis (Materials Processing)

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Ground-based investigations, analysis, and studies.....	4,850	6,900	6,450	11,700

OBJECTIVES AND STATUS:

The Applied Research and Data Analysis (AR&DA) activity provides the scientific foundation for all current and future projects in the Materials Processing in Space program. The emphasis is placed on ground-based research which is expected to develop into space investigations with potential for future applications. In addition, the AR&DA program supports technology development for future ground and space capabilities, equipment definition studies responding to identified space experiment needs, and commercialization activities looking toward space enterprises involving private industry.

Most research projects in the AR&DA program are initiated as a result of unsolicited proposals from the scientific community, which are extensively peer-reviewed prior to selection. The FY 1980 funding augmentation has been used to initiate funding of a set of new three-year research projects proposed by leading members of the materials science community, and to establish a Materials Processing Center at the Massachusetts Institute of Technology (MIT) for work in areas of joint interest to NASA and industry. Current research, which will continue in FY 1981, concentrates on scientific investigation and technology advancement in infrared detector materials, inertial confinement fusion targets, floating zone crystal growth, separation and synthesis of biological materials, fluid flow effects in materials processes, and containerless processing techniques. The commercialization effort includes studies of institutional, legal, and economic issues of joint NASA/industry ventures, information activities directed toward industry involvement in MPS projects, and negotiations with companies interested in undertaking joint space endeavors with NASA.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The decrease of $450 thousand reflects both an internal program decision to increase the funding in the Materials Processing in Space Shuttle/Spacelab Payload Development project by $418 thousand for scientific investigators utilizing the Spacelab experiment systems and a $32 thousand reduction as part of a general Congressional reduction in the Agency's budget.

BASIS OF FY 1981 ESTIMATE:

The level of effort budgeted for FY 1981 will continue the expanded ground-based research program initiated in FY 1980 in response to recommendations from the National Academy of Sciences. The FY 1981 budget request will maintain the activities initiated in 1980 at MIT and elsewhere, which include investigations of crystal growth, self-generated flows in weightless fluids, separation processes for biological materials, controlled solidification processes, and containerless processing.

In FY 1981, the program's current principal equipment definition activities will continue. These include definition of scientific requirements and technology needs for floating zone crystal growth and acoustic containerless processing experiment systems, and system definition of a free-flying payload carrier which will allow extended time in orbit for materials processing payloads through interface with the 25-kw power module or other future free-flying host vehicles.

The AR&DA funding augmentation requested for FY 1981 will provide for increased effort in advanced technology development to meet needs identified in the ground based research program, and definition studies on space experiment systems to perform investigations arising from MPS materials research. New materials processing technology will be developed in the area of electromagnetic, acoustic, and electrostatic levitation, high temperature heat pipes, materials properties measurements, holography, and the production and purification of biological materials. Definition studies will be performed for future initiatives including the Electromagnetic Containerless Processing System, Bioprocessing System, High Gradient Furnace, and Space Vacuum Technology Demonstration.

Shuttle/Spacelab Payload Development (Materials Processing)

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Payload development and operation.....	11,950	10,800	11,218	10,500

OBJECTIVES AND STATUS:

The Space Processing Shuttle Payloads project includes the design and development of a basic set of payload equipment for space experiments on materials and processes, and provisions for conducting experiments with this equipment on Space Transportation System (STS) flights. The first series of experiments to use the equipment will be flown on the Spacelab 3 mission in 1982 and a pallet mission in 1983. Investigations selected for these flights cover topics in crystal growth, fluid flow effects, physical metallurgy, specialized composite materials, and polymerization. All of the equipment will be designed for repeated use and a long service lifetime, so that it can be used for further experiments on later missions without new development or substantial modification.

Four equipment systems are under development and scheduled for Preliminary Design Reviews in FY 1980. Two of these are multiuser facilities: the Fluid Experiments System (FES), a sophisticated holographic optical measurement system to determine density gradients and fluid flows during crystal growth and analogous processes, and the Solidification Experiments System (SES), a versatile electric furnace system capable of performing a wide range of controlled high temperature melting and freezing experiments. In addition, two apparatus systems are being built specifically for individual investigations: the Vapor Crystal Growth system (VCG) will grow massive single crystals of mercuric iodide by evaporation and recondensation, and the Monodisperse Latex Reactor (MLR) will be used to study the kinetics of latex particle growth under conditions that produce particles of uniform size. The scheduled development of the Polymer Latex Reactor (PLR) and the Acoustic Containerless Processing Module (ACPM), planned for flight in 1982, has been deferred because of a combination of technology problems in the ACPM and higher than anticipated cost estimates for both systems.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase of $418 thousand reflects an internal program adjustment from AR&DA to meet current requirements for scientific investigators utilizing the Spacelab experiment systems.

BASIS OF FY 1981 ESTIMATE:

Critical Design Reviews for all four apparatus systems will be completed by late 1980, and hardware fabrication will be performed through FY 1981, leading to delivery for integration early in FY 1982. Principal Investigators will complete development of their flight experiment protocols and samples for the missions to be flown in FY 1983, and detailed development will begin on experiment protocols for new and deferred investigations that will fly experiments using the same apparatus on subsequent flights.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

SPACE COMMUNICATIONS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
		(Thousands of Dollars)			
Search and rescue mission	8,000	5,000	5,000	2,300	RD 7-60
Technical consultation and support studies	3,100	3,000	2,982	3,200	RD 7-61
Applied research and data analysis	3,900	6,200	6,200	16,600	RD 7-62
Follow-on data analysis and operations	4,500	3,800	3,783	2,300	RD 7-64
Applications data service definition	100	2,400	2,400	3,000	RD 7-65
Data management	1,800	1,500	700	1,600	RD 7-66
Adaptive multibeam phased array (AMPA) system	1,200	1,400	1,660	---	RD 7-67
Total	22,600	23,300	22,725	29,000	

OBJECTIVES AND STATUS:

The objective of the Space Communications program is to provide for the most effective use of limited geosynchronous orbit and radio spectrum resources while promoting United States leadership by support of technology development in satellite communications. In FY 1981, the communications program will continue the development of a strong technology base--particularly in multibeam antennas and on-board switching techniques--from which future plans for new capabilities and flight test programs can be developed. It also will concentrate on the definition of systems techniques which provide data to users in a more timely and more useable manner. A primary thrust will be advanced technology development for communication spacecraft to operate in the frequency band at 30/20 gigahertz (GHz). Activities in FY 1981 will include development of critical subsystems technology, completion of pre-project studies, and development of experiment plans.

The communications research and development effort reflects the policies set forth by the President in 1978 which state that United States leadership in communications satellite systems will be supported by NASA and that selected technological opportunities to provide better frequency and orbit utilization and other longer-term opportunities will be pursued. This effort also responds to Congressional support for a revitalized Federal communications research and development effort. The advice of the communications industry has been incorporated and will complement private sector research and development, using NASA's unique capability to provide technology proof-of-concept testing in high risk areas. This will enable industry to more confidently approach future improved systems and less costly service offerings to all user communities.

FY 1980 funds will complete the development of the Adaptive Multibeam Phased Array (AMPA) antenna. This antenna will be used to conduct ground-based experiments in quickly forming, shaping, and pointing transmit and receive beams to ground users in various locations, while avoiding potential interference.

The experimental Search and Rescue program, which will use satellites to aid in the detection and location of distress beacons carried by ships and aircraft, will continue in FY 1981. During FY 1979, modification of the appropriate NOAA operational meteorological spacecraft (NOAA-E, -F, -G) to accept Canadian and French equipment, and the development of the spacecraft antennas were initiated. Spacecraft modifications will be completed during FY 1980. Other activities in FY 1980 include building a ground station to accept satellite data, and developing a flight test program. This work will be done in conjunction with the Departments of Transportation, Commerce, and Defense and with France, Canada, and the USSR.

Technical consultation and support studies will continue to provide the necessary technical information concerning the growth of existing satellite services and the inclusion of new satellite applications. Special emphasis will be placed on orbit and spectrum utilization studies and on assessing the impact of the General World Administrative Radio Conference (GWARC) on present and future telecommunications and remote sensing. Orbit and spectrum utilization studies include the development of frequency and orbit sharing techniques and strategies, design standards, and the determination of the effects of propagation phenomena and man-made noise on performance, design, and efficient use of the geostationary orbit and radio spectrum.

FY 1981 funds will support the continued operations of Applications Technology Satellites-1,and -3, while providing for the orderly phaseout of the Applications Technology Satellite-6 and Communication Technology Satellite public service user experiments and demonstration. These funds will also provide for the transition of federal public service communications activities from NASA to the National Telecommunications and Information Administration (NTIA) within the Department of Commerce. During FY 1981, work will continue with the NTIA and its Interagency Committee on Satellite Telecommunications Applications, representing 18 Federal agencies, undertaking technology development which will enable industry to meet more effectively the growing communications needs of Federal agencies.

FY 1981 funds will support definition of the Applications Data Service (ADS), a data sharing network service, to meet future user data access and integration needs. Pilot demonstrations defined in FY 1980 will be implemented to evaluate ADS standards and concepts. In addition, FY 1981 funds will support generalized data systems studies as well as specialized data management technique development tasks.

Search and Rescue Mission

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Search and Rescue Mission	8,000	5,000	5,000	2,300
Atlas (expendable launch vehicles program)	(---)	(2,000)	(1,200)	(---)

OBJECTIVES AND STATUS:

The objective of the Search and Rescue Mission is to demonstrate the feasibility of using satellites to provide a significant improvement in the capability for search and rescue forces to detect and locate distress signals from general aviation aircraft and certain marine vessels during emergencies. Systems studies have shown that satellites flying at an 850 kilometer altitude can detect the emergency beacons presently carried by aircraft and ships. Preliminary calculations indicate that the satellite can fix the position of these beacons to an accuracy of about 15-20 kilometers (based on the presently employed emergency frequencies, 121.5 and 243 MHz), and could position a proposed new beacon (using the recently allocated 406 MHz frequency), with its stronger signal, to about 5 kilometers. The experiment will permit rescue forces to arrive at the accident scene more quickly than is presently possible, because of the more comprehensive coverage a satellite system can provide using conventional frequencies, and the combination of improved performance and added coverage using the new frequency.

This interagency program is being conducted jointly with Canada and France; negotiations with the Soviet Union for the operation of a compatible spacecraft system have been completed. The U.S. will provide the spacecraft, launch vehicle, and the U.S. ground stations; the Canadians will provide the space telecommunications equipment and ground station in their country; and France will provide an onboard processor and receiver. The Soviet Union will launch and maintain in orbit two spacecraft operationally compatible with the U.S., French, and Canadian system and will operate their own ground station. In addition to NASA, the Departments of Defense and Transportation are expected to purchase and operate ground stations and participate in the program test and evaluation phase while NOAA is providing the spacecraft for modification.

The design of the spacecraft modification to accommodate the Search and Rescue instrumentation and the design of the required spacecraft antennas have been completed. Fabrication of the spacecraft and antennas has begun. A new improved 406 MHz Emergency Locator Transmitter is currently being developed. The Local User Terminal is being procured, with development planned to begin in mid-FY 1980.

BASIS OF FY 1981 ESTIMATE:

FY 1981 funding will support the integration and test of the Search and Rescue instrumentation with the NOAA-E, -F, and -G spacecraft; continue the development of the Local User Terminal, the Emergency Locator Transmitter and the necessary modifications to the NOAA ground stations; and begin the development of the demonstration and evaluation test plans.

Technical Consultation and Support Studies

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Technical Consultation and Support Studies.....	3,100	3,000	2,982	3,200

OBJECTIVES AND STATUS:

The objective of this program is to provide technical consultation, special studies, and experiments on frequency and orbit utilization for NASA and other U.S. Government agencies. Studies and experiments being performed help provide the necessary technical information concerning the growth of existing satellite services and the inclusion of new satellite applications. The effort is grouped into three main categories: orbit and spectrum utilization; satellite systems support; and communications satellite application system studies.

Orbit and spectrum utilization includes the development of frequency and orbit-sharing techniques and strategies, design standards, and the determination of the effects of propagation phenomena and man-made noise on performance, design, and the efficient use of the geostationary orbit and radio spectrum. Satellite systems support includes design and flight readiness reviews and technical assessments on Intelsat and Domsat systems for the Federal Communications Commission (FCC) and special studies on high priority FCC and NASA program office requests. Communications satellite application system studies are primarily structured to meet statutory and regulatory requirements and to ensure compatibility of NASA flight programs with other space and terrestrial services.

These studies and experiments have supported U.S. preparations for and NASA participation in the 1979 General World Administrative Radio Conference. Our preliminary assessment of the 1979 GWARC is that the results were generally favorable, inasmuch as almost all of the positions sought and staffed by NASA were successfully obtained. In FY 1980, a more detailed assessment of the results of the GWARC with respect to

NASA, national, and international implications has been initiated. A draft of the Propagation Design Handbook for satellite system designers has been completed and is currently being reviewed by industry and universities. Propagation effects measurements at 30/20 GHz using COMSTAR are continuing at four university locations.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

As part of an overall Agency adjustment due to the general Congressional reduction in the Agency Research and Development Appropriation request, a minor reduction was made in the funds allocated for this project.

BASIS OF FY 1981 ESTIMATE:

In FY 1981, emphasis will be placed upon assessing the results of the 1979 General World Administrative Radio Conference (GWARC), and their implications for U.S. telecommunications. Studies will be expanded in support of the 1983 Region 2 (Western Hemisphere) Conference on Broadcast Satellites and the proposed International Conferences on Space Services Planning (geostationary orbit and frequency assignment planning).

Studies and experiments will also be continued in the areas related to the use of active and passive microwave sensors essential to resource and environmental observations; broadcast and mobile satellite services; emergency and disaster communications; energy transmission from space; and techniques, models, and strategies for improving the use of the radio frequency spectrum and the geostationary orbit.

Applied Research and Data Analysis (Space Communications)

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Wideband 30/20 GHz definition	---	1,200	1,200	1,200
Applications pilot test	497	---	---	---
Advanced communications research	3,103	5,000	5,000	5,400
Advanced technology development	---	---	---	10,000
Development of advanced flight experiments	300	---	---	---
Total	3,900	6,200	6,200	16,600

OBJECTIVES AND STATUS:

The Applied Research and Data Analysis (AR&DA) activities consist of system studies, development of technology for proof-of-concept flight programs, and experiments which provide new technology and technique concepts to aid private industry in offering new, improved and affordable communications services.

The communications traffic forecasts conducted by communication common carriers for NASA predict that the capabilities of current technology communications satellites will be saturated about 1990. In order to provide growth beyond that time, new frequency bands, multiple beam spacecraft antennas providing frequency re-use, and on-board switching systems must be developed. While these systems show great promise, they also entail high technical risks because of the uncertainties involved in rainfall attenuation at the 30/20 GHz band, and in the cost of development and tests of new transmitters and receivers, multibeam antennas, and on-board switches and signal processors. The focusing of NASA efforts upon this program will provide for a clearer understanding of the technology developments and verification testing needed to reduce the perceived risks of commercial utilization of these technologies. These activities will resolve development uncertainties (performance, schedule, and cost) in all major subsystems for future experimental missions. They will also advance U.S. industry's capabilities well beyond that available elsewhere in the world. Further, they will establish the feasibility of unique new communications capabilities involving vastly greater bandwidths (2.5 GHz versus 0.5 GHz) for point-to-point applications, and direct-to-customer services that will benefit from small antenna diameters, low cost earth stations, and locations in metropolitan areas. The former capabilities will alleviate spectrum-orbit congestion, while the latter will allow entirely new communications services to develop.

BASIS FOR FY 1981 ESTIMATE:

The primary thrust of AR&DA is focused on the design and development for the critical subsystem technology required for a 30/20 GHz communications satellite, with frequency reuse in multiple beam spacecraft antennas, and on-board switching systems to permit interconnections between multiple beams. FY 1981 funding will support critical component technology development required for a 30/20 GHz communications satellite. These critical components include an advanced multibeam antenna system for direct-to-user applications, an advanced multibeam antenna system for point-to-point trunking applications, a radio frequency switching matrix for interbeam switching of analog signals, a baseband switching system for interbeam switching of digital signals, a high power transmitter for the 20-GHz downlink from the satellite, and a low noise receiver for the 30-GHz uplink to the satellite.

Follow-on Data Analysis and Operations

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
Follow-on Data Analysis and Operations	3,996	3,000	2,983	1,400
Applications Pilot Test	504	800	800	900
Total	4,500	3,800	3,783	2,300

OBJECTIVES AND STATUS:

The objective of this program is to continue experiment support for ATS-1, -3, and -5; and complete, appropriately document, and archive the wide range of user experiments and demonstrations in the application of satellite communications. Past experiments with NASA experimental satellites (ATS series and CTS) have generated great interest nationally and internationally in satellite telecommunications. Nearly 400 communications experiments using the ATS series and CTS have been successfully conducted during the extended lifetimes of these satellites to provide user experience for making decisions regarding their communications functions. NASA's stimulus in encouraging use of these unique facilities has led to wider use of commercial satellites, which can now better meet needs for flexibility and continuity of services. Complete reports on experiment results will be prepared for use by the many interested groups that could not directly participate. Public service user experiments on ATS-6 and CTS were completed on June 30, 1979. ATS-1, -3, and -5 experimentation continues.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The decrease of $17 thousand in FY 1980 is a result of an overall Congressional general reduction in the FY 1980 Research and Development appropriation request.

BASIS OF FY 1981 BUDGET ESTIMATE:

FY 1981 funding will provide for continued support of the ATS-1,and -3 experimentation and support activities. Public service user experiments on ATS-6 and CTS were completed on June 30, 1979. FY 1981 will complete the phasedown years, during which results of 400 experiments performed since 1969 will be compiled so that the results may be of value to future communications activities. The results of these experiments will continue to support the National Telecommunications and Information Administration's (NTIA) efforts to

transfer the public service satellite communications community to commercial satellites and services. A continuing activity in this support will be the Systems Architecture Study in which a thorough and careful investigation of all practical commercial communications links for the Public Service user is made. Additional support to NTIA will include Technology Transfer Policy Analysis and Public Services Policy Analysis.

In the Applications Pilot Test program, NASA will continue to support the public service communications project with the Public Service Satellite Consortium to provide for technology transfer of satellite communications applications.

Applications Data Service Definition

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Applications Data Service Definition.....	100	2,400	2,400	3,000

OBJECTIVES AND STATUS:

The objective of the Applications Data Service (ADS) definition activity is to analyze approaches for economically and efficiently meeting future applications data access and integration needs. In the 1980's effective use of information gained from multiple sources is key to the users success in dealing with large scale modeling in agriculture, ocean studies, and weather and climate forecasting. This requires timely access to and integration of data from a dozen or more interdisciplinary sources.

The ADS will build upon existing and future applications data systems, encourage the convergence of those systems and their products into a compatible and integrated structure through the definition of data and data systems standards, and develop a network service for data transmission and integration.

ADS preliminary requirements and concept studies presently are underway and will be completed by late 1979. FY 1980 studies will define initial standards as well as a pilot activity to test/demonstrate ADS concept feasibility.

BASIS OF FY 1981 ESTIMATE:

FY 1981 funding will be used to implement two to three small ADS pilot activities which will test/demonstrate ADS standards and data system concepts as applied to specific NASA applications. FY 1981-82 pilot

activities will focus and validate ADS standards and concepts, providing required definition material for support of full-scale network service implementation. Full-scale ADS implementation could begin as early as FY 1983 in anticipation of having a fully operational system by the mid-1980's.

Data Management

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
Data Management	1,800	1,500	700	1,600

OBJECTIVES AND STATUS:

The objective of the data management effort is to define and help meet the Applications Program needs for extension of current data system technology or techniques. Trends toward increasing data volumes and complexity coupled with more stringent data timeliness requirements make the successful identification and development of such technology key to future Applications Programs/user success. The completion of cluster coding technique development and test will occur in FY 1980; in addition, the initial results from a data base/management systems study and panel review will be available.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The decrease in FY 1980 reflects a reallocation to provide funds for the procurement of the ER-2 aircraft. Lower priority data management activities to be deferred include identification of common data requirements among Space Applications disciplines, planning for future data systems analysis and workshops, and a system analysis study to identify spacecraft attitude control technology to aid in image data registration for mapping.

BASIS OF FY 1981 ESTIMATE:

In FY 1981, generalized systems studies as well as specialized technique development tasks will be continued or initiated. Analyses will consider new systems structures which take advantage of data or system requirements common to multidisciplines. Technique development work will continue for specific areas of data base/management systems as well as for the processing of Synthetic Aperture Radar data. Study efforts will begin on cross-correlative multidisciplinary data/information overlay techniques and auto-mosaicking of multispectral imagery.

Adaptive Multibeam Phased Array (AMPA) System

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Adaptive Multibeam Phased Array (AMPA) System.....	1,200	1,400	1,660	---

OBJECTIVES AND STATUS:

The objective is to develop a promising communications system that will capitalize on the unique properties of adaptive phased arrays to provide satellite communications capability to small low cost mobile Earth terminals.

An adaptive multibeam phased array (AMPA) can form, shape, and point several independent transmit and receive beams quickly to small ground areas in different geographic locations, while avoiding interference. This allows a large number of low cost ground user terminals to be served on demand, by reusing frequency within a limited frequency spectrum. This type of antenna has direct application for service to small mobile earth terminals that might be used on cars, trucks, boats, or data collection platforms.

In 1980, work will be completed on the development of an experimental AMPA system under contract with the Airborne Instrument Laboratory. In 1981, ground-based performance verification and preliminary application tests will be conducted in-house. No FY 1981 R&D funding is planned for this activity. The program is proceeding smoothly and the system will be ready for overall operational performance tests in 1982.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase in the FY 1980 budget reflects an internal adjustment of funds to meet current requirements. Plans for a Spacelab mission have been deferred and the AMPA development will be completed in FY 1981. Laboratory tests, to be conducted in 1982, will be undertaken as part of the development contract. This laboratory testing of the experimental AMPA system will allow continued technology progress and permit easier modification of the instrument design to Shuttle specifications if a flight test is decided upon for the post-1982 timeframe.

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE AND TERRESTRIAL APPLICATIONS — TECHNOLOGY UTILIZATION PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
		(Thousands of Dollars)			
Technology dissemination	3,200	3,800	3,800	4,100	RD 8-4
Technology applications	4,500	4,400	4,400	4,800	RD 8-4
Program evaluation and support	1,400	1,500	1,500	1,600	RD 8-4
Civil systems*	(1,800)	2,400	2,400	2,600	RD 8-5
Total	9,100	12,100	12,100	13,100	
Distribution of Program Amount by Installation:					
Johnson Space Center	145	200	100	150	
Kennedy Space Center	100	150	100	150	
Marshall Space Flight Center	562	500	550	540	
National Space Technology Laboratories	---	50	100	75	
Goddard Space Flight Center	865	900	800	880	
Jet Propulsion Laboratory	569	1,700	1,700	1,990	
Wallops Flight Center	4	200	300	375	
Ames Research Center	733	1,000	920	1,250	
Dryden Flight Research Center	54	60	37	50	
Langley Research Center	710	1,000	800	890	
Lewis Research Center	415	400	800	750	
Headquarters	4,943	5,940	5,893	6,000	
Total	9,100	12,100	12,100	13,100	

*Prior to FY 1980, this effort was included in Space Applications.

OFFICE OF SPACE AND TERRESTRIAL APPLICATIONS — TECHNOLOGY UTILIZATION PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION

Technology Utilization program objectives encompass the transfer of new knowledge and innovative aerospace technology resulting from NASA R&D programs for application and use in the private and public sectors of the U.S. economy. Important public sector areas include medicine, transportation, environment, urban development and public safety. Specific program objectives are:

(1) To accelerate and facilitate the application and use of new technology, shortening the time between generation of advanced aeronautics and space technologies and their use in the economy;

(2) To encourage multiple secondary uses of NASA technology in industry, education and Government where a wide spectrum of technological problems and needs exist;

(3) To understand more fully the technology transfer process and its impact on the economy, and to manage and optimize the process in a systematic way; and

(4) To develop applications of NASA's aerospace expertise - its technology, technologists and unique facilities - to priority nonspace needs of the nation.

Aerospace technology is transferred to the public and private sectors of the nation's economy through a variety of established mechanisms developed and managed under the NASA Technology Utilization program. These mechanisms or project areas include: publications and announcements, Industrial Applications Centers, the Computer Software Management and Information Center (COSMIC), State Technology Applications Centers, applications teams/applications engineering projects, and civil systems projects.

OBJECTIVES AND STATUS:

User response to the NASA Tech Brief journal this past year has dramatically increased with nearly 180,000 industrial inquiries received by NASA for technical details concerning new technologies announced therein. This three-fold increase in inquiries over the previous year has also been accompanied by a steady growth rate of the journal mailing list during 1979 of 1,800 industrial recipients per month compared to 1,300 per month the previous year. Such response and interest by U.S. industries continues to reflect the importance of the NASA Tech Brief journal in the Agency's technology transfer programs.

The NASA sponsored Computer Software Management and Information Center (COSMIC) and the NASA Industrial Applications Center (IAC) network continued to provide U.S. industry with relevant information services and computer programs as evidenced by the industrial support to these activities. Total IAC industrial income for services rendered by these centers reached $2.8 million in 1979 compared to $2.2 million the previous year. This 27 percent increase continues to indicate a strong growth pattern in industrial use of aerospace technology, particularly in small, high technology business firms. In this regard, NASA has continued its cooperative project with the Small Business Administration during this past year to provide IAC services to small businesses in the northeastern, midwestern and western regions through IAC's located in those areas.

Evidence of technology transfer has been systematically documented and evaluated as part of NASA's continuing transfer research and impact studies activities. Selected cases of transfer and use are published and disseminated in the annual "Spinoff" report to industry and the general public, in order to create widespread awareness of program activities and results of NASA technology transfer programs. Program evaluation efforts continued to increase the efficiency and effectiveness of NASA's transfer programs and projects during this past year.

Over seventy applications engineering projects for adapting existing aerospace technology to defined needs in the public sector were active last year. These projects, which are jointly funded by NASA and user agencies such as the Departments of Transportation and Health, Education and Welfare and the Environmental Protection Agency, include: the portable firefighting module developed for the U.S. Coast Guard; a highly reliable water quality monitor for EPA; and a human tissue stimulator being developed in conjunction with Johns Hopkins University Medical Center (Pain Center) and the National Institutes of Health. Continuing attention will be devoted to the problems of the handicapped, with special emphasis placed on developing aids for assisting the aged and for rehabilitation work.

Transfer of the Civil Systems program to Technology Utilization consolidated all NASA Terrestrial Applications engineering projects for public and private sector organizations. Current projects include: the Advanced Ocean Technology Development Platform (AOTDP) for use in evaluating and generating new deep ocean instrumentation and sensors; and environmental sensors and systems to detect and analyze air and water pollutants. A systems design will be accomplished for a sea bed lander as part of the Office of Naval Research/Woods Hole Oceanographic Institute High Energy Benthic Boundary Layer Experiment (HEBBLE). This project will investigate a broad range of physical phenomena accompanying high velocity currents at the sea floor/ocean interface at depths of 4,000 to 6,000 meters.

Documented evidence of technology (i.e., the annual "Spinoff" report) is continually recorded, evaluated and disseminated to industry and the general public as a means of creating widespread awareness of program activities and available NASA technology transfer services. Efforts continue on methods and procedures to increase the efficiency and effectiveness of all programs.

BASIS OF FY 1981 ESTIMATE:

Technology Dissemination

In FY 1981, NASA plans to meet the growth demands of the Tech Brief journal (up to an estimated level of 75,000 industrial recipients) and maintain the continued operation of NASA's information dissemination network, including the seven Industrial Applications Centers, the State Technology Applications Centers in Florida and Kentucky, and the Computer Software Management and Information Center (COSMIC). NASA plans to continue its joint program with the Small Business Administration to provide NASA information dissemination center services to small business firms. A similar joint program for minority businesses will be sought during FY 1981 with the Minority Business Development Agency of the Department of Commerce. Additionally, NASA will continue its efforts in FY 1981 to increase and accelerate the flow of NASA technology into selected industrial sectors through interactive efforts with industrial and trade associations.

Technology Applications

In FY 1981, NASA plans to continue operation of its three Biomedical Applications Teams as well as its application teams in transportation, public safety and manufacturing to identify national problems and needs in these public sectors which can be addressed through the application of aerospace technology and capabilities. Additional emphasis will be placed on problem identification and solution in environment and water quality during FY 1981 as well as those noted above. Multiyear application projects, such as a gas analysis instrument to detect toxic substances for firefighters and nickel-zinc battery developments for prosthetic devices for the handicapped, will be supported during FY 1981 in cooperation with user agencies.

Program Evaluation and Support

In FY 1981, NASA will continue transfer research and impact studies to identify benefits and economic impacts resulting from its technology transfer programs. Program evaluation and socio-economic assessments will be continued to determine the most effective transfer mechanisms and to focus on selected opportunities for increasing the benefit of those program efforts. Scientific and Technical Information (STI) data base support for NASA Industrial Applications Centers will continue as will publication inquiry support at the NASA STI Facility.

Civil Systems

In FY 1981, NASA plans to continue most of its Civil Systems projects already initiated with other Federal agencies including, for example, environmental monitoring and control and agricultural productivity. In addition, the program will allow for a limited degree of flexibility in the selection of new projects that explore innovative applications of aerospace-derived technology to other non-aerospace-oriented disciplines. Specific projects include the extension of our automated water monitoring system to measure contaminants in potable water and monitoring the quality of natural water bodies. In the area of ocean technology, continuing demonstration of the Advanced Ocean Technology Development Platform (AOTDP) in the deep ocean environment and the application of remote sensing techniques to studying the sea floor will be pursued.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES

RESEARCH AND DEVELOPMENT PLAN FOR AERONAUTICS AND SPACE TECHNOLOGY

Programs	Budget Plan			
	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
Aeronautical research and technology	264,100	300,300	308,300	290,300
Space research and technology	107,300	116,400	115,800	115,200
Energy technology	5,000	3,000	3,000	4,000
Total	376,400	419,700	427,100	409,500

AST 1

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

AERONAUTICAL RESEARCH AND TECHNOLOGY PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
		(Thousands of Dollars)			
Research and technology base	109,700	117,500	119,000	131,100	RD 9-4
Systems technology programs	154,400	182,800	189,300	159,200	RD 9-20
Total	264,100	300,300	308,300	290,300	
Distribution of Program Amount by Installation:					
Johnson Space Center	1,245	700	495	200	
Marshall Space Flight Center	1,113	900	725	800	
Jet Propulsion Laboratory	1,489	1,100	830	800	
Wallops Flight Center	614	700	600	500	
Ames Research Center	48,564	51,900	54,800	53,400	
Dryden Flight Research Center	8,903	13,400	13,300	13,200	
Langley Research Center	92,171	115,300	115,800	109,900	
Lewis Research Center	106,960	113,000	117,450	108,100	
Headquarters	3,041	3,300	4,300	3,400	
Total	264,100	300,300	308,300	290,300	

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY — AERONAUTICAL RESEARCH AND TECHNOLOGY PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The objectives of the Aeronautics program are to advance aeronautical technology to ensure safer, more economical, efficient and environmentally acceptable air transportation systems which are responsive to current and projected national needs; to maintain the strong competitive position of the United States in the international aviation marketplace; and to support the military in maintaining the superiority of the Nation's military aircraft.

The FY 1981 program supports these objectives by providing for technology advances in all aeronautical disciplines, stressing the technology areas judged to be the most critical by in-house and external assessments, industry, advisory groups, and other users of technology within and outside the Federal Government. Emphasis will be placed on improving aircraft energy efficiency and performance; reducing noise and pollution; improving safety and terminal area operations; and advancing long-haul and short-haul air transportation concepts.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase of $8 million is the result of Congressional actions which provided additional appropriations of $5 million for advanced rotorcraft technology and $3 million for variable cycle engine technology. A transfer of $1.5 million from the Systems Technology programs to the Research and Technology Base was made to more appropriately budget planned activities. This transfer is explained under the individual programs involved. In addition, the Aeronautics budget structure has been changed to provide for more effective and efficient program management. This change in the budget structure, which is consistent with the new OAST organization that went into effect in the fall of 1979, did not result in any programmatic changes. Programmatic changes are described in the individual program narratives.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 activities are designed to maintain a strong Research and Technology Base in the technology disciplines of aerodynamics, propulsion, avionics and flight controls, human factors, materials and structures. Strength in this fundamental research and technology is essential to the future development of new, improved aeronautical products. The aeronautics program also provides focused technology development

activities for each of the major classes of aeronautical vehicles, i.e., transport aircraft, rotorcraft, general aviation aircraft, vertical/short take-off and landing (V/STOL) aircraft, supersonic cruise aircraft, and high performance aircraft.

In the area of transport aircraft technology, progress in the aircraft energy efficiency efforts will continue toward the goal of providing, in the 1980's, the technology advances leading to a major reduction in aircraft fuel requirements. In the Energy Efficient Transport program, work will continue with the major airframe contractors to develop and evaluate advanced aerodynamic and active control technologies for derivative and new subsonic transport aircraft. Included are wind tunnel tests of advanced winglet concepts. In the Laminar Flow Control program, emphasis will be on completion of critical high speed wind tunnel tests and on evaluation of practical structural and surface material concepts. The safety efforts will be continued with emphasis on human-vehicle interrelationships, crash fire hazards, lightning effects, and ice accumulation protection.

Rotorcraft technology activities will be emphasized, addressing rotor aerodynamics, structures, avionics, flight dynamics, terminal operations, engines and drive systems, and rotor system design, and with new focus on analytical modeling and verification of selected systems and on augmenting the rotorcraft data base in critical areas. Flight research on the Rotor Systems Research Aircraft (RSRA) vehicles will be continued. Proof-of-concept and concept evaluation flight tests on the XV-15 Tilt Rotor Research Aircraft will be completed.

General aviation research and technology will continue to emphasize increased safety, improved utility and greater energy efficiency. Principal activities will include stall/spin alleviation, drag reduction, engine and propeller improvements, and avionics systems concepts for safer and simpler single pilot operations.

V/STOL technology efforts will emphasize broad-based technology for future military and civil aircraft applications. Flight research on the Quiet Short-Haul Research Aircraft (QSRA) will continue with emphasis on handling qualities and control laws development for short take-off and landing (STOL) operations at very high lift coefficients.

Supersonic cruise research will continue in all critical discipline areas. Emphasis will be placed on aerodynamic refinement for improved low speed, high lift characteristics, advanced noise suppression technologies, and advanced titanium fabrication and structural design.

In the area of high performance aircraft, efforts will continue on advanced multivariable digital control system concepts for aircraft and propulsion control, and on preparation for NASA/Air Force flight research on the variable-camber, variable-sweep AFTI-111 aircraft. Flight testing of Highly Maneuverable Aircraft Technology (HiMAT) concepts will be continued, employing subscale remotely piloted vehicles.

In the Advanced Propulsion Systems program the design, fabrication and testing of individual components to validate the technology for use in next-generation, high-bypass turbofan engines will continue in the Energy Efficient Engine program. The Variable Cycle Engine technology program will include new emphasis on development and demonstration of the critical lower speed and lower temperature technologies unique to variable cycle propulsion systems for future advanced supersonic cruise aircraft.

BASIS OF FUNDING REQUIREMENTS:

RESEARCH AND TECHNOLOGY BASE

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
		(Thousands of Dollars)			
Fluid physics research and technology	18,500	21,240	22,240	24,800	RD 9-4
Propulsion research and technology	25,500	26,900	26,900	30,900	RD 9-6
Materials and structures research and technology	15,200	16,100	16,100	17,800	RD 9-9
Avionics and flight control research and technology	4,000	4,800	4,800	5,400	RD 9-11
Human factors research and technology	5,000	5,700	5,700	6,500	RD 9-12
Multidisciplinary research and technology	3,600	3,260	3,760	4,300	RD 9-13
General aviation research and technology	6,800	7,000	7,000	7,500	RD 9-14
Low speed aircraft research and technology	11,100	11,200	11,200	11,500	RD 9-16
High speed aircraft research and technology	14,000	14,800	14,800	15,300	RD 9-17
Transport aircraft research and technology	6,000	6,500	6,500	7,100	RD 9-18
Total	109,700	117,500	119,000	131,100	
Fluid Physics Research and Technology	18,500	21,240	22,240	24,800	

OBJECTIVES AND STATUS:

The objective of the Fluid Physics Research and Technology program is to develop a technology base which will enhance our capability to predict aerodynamic phenomena enabling aerodynamic optimization of advanced aircraft during the early design stage. This objective is being pursued through an integrated approach involving computational, analytical and experimental methods.

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The technology base in computational fluid dynamics continues to expand with an increased capability to predict realistic flow situations and configuration geometries. During the past year, new numerical methods have been tested and incorporated into codes which solve the unsteady, compressible Navier-Stokes equations. New fast methods have been developed for generating transformed coordinate meshes for use in finite difference solutions of the fluid dynamics equations, and large-eddy simulations of turbulent flow have been carried out for simple flow geometries. Also, work was started in developing and verifying three-dimensional transonic codes using various turbulence models.

Progress has been made in other research areas as well. An experimental data base was developed for unsteady aerodynamic loads and pressures at higher Reynolds numbers and frequencies than previously achieved; pilot studies of an adaptive transonic wall test section showed real promise of achieving a three-dimensional capability; anticipated gains in maximum lift coefficient and drag-rise Mach number for a family of rotorcraft airfoils have been achieved experimentally; the cryogenic test technology base has expanded in the areas of model construction and instrumentation development; and it was demonstrated that net reductions in turbulent drag of exposed surfaces were possible by devices which reduced the size of the turbulent eddies in the flow.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase of $1 million reflects a transfer of budgetary responsibility and funds from the Low Speed Aircraft Systems Technology program to the Fluid Physics Research and Technology program for the planned improvement of the Ames Research Center ILLIAC computer memory.

BASIS OF FY 1981 ESTIMATE:

Expanded efforts in computational fluid dynamics will continue in FY 1981. Computer codes will be developed to calculate inviscid, laminar and turbulent flows with limited and extensive regions of separation, with emphasis on the transonic speed regime. Advanced vector processing computers (the ILLIAC IV and CDC STAR) will be used to generate pilot codes to solve the time-averaged Navier-Stokes equations for a variety of two- and three-dimensional geometries with various turbulence models, and work will proceed to calculate turbulence from first principles. Efforts will be made also to include coupling of potential flow codes with advanced boundary layer codes capable of predicting flow separation more rapidly and less expensively. Methods will be developed for automatically generating meshes about complicated aerodynamic wings and bodies and to integrate their use into steady and unsteady codes in such a way that the convergence and resolution properties of these codes are not degraded.

In the area of high lift aerodynamics, theoretical methods will be developed to analyze and design multielement airfoils and wings, and tests will be conducted to verify the analyses. The work will involve Reynolds stress modeling of multielement airfoil drag problems and the determination of the effects of

transverse pressure gradients on the boundary layers and wakes. In the area of airfoil development, expanded efforts will concentrate on natural laminar flow airfoils, and on the production of airfoil designs applicable to high altitude, low speed remote controlled aircraft. A more intensive research program in wake vortex alleviation, in conjunction with the Federal Aviation Administration, will focus on aerodynamic design information to minimize wake vortex effects at the source with minimum deleterious effects on performance and noise.

The development of nonintrusive flow measurement methods and instrumentation such as holographic interferometry, laser velocimetry and infrared photography to provide data otherwise unobtainable, to improve data collection efficiency, and to gather data in a form more amenable to on-line analysis will be expanded in FY 1981. Work on the integration of theory and experiment will continue, with emphasis concentrated on computer code validation, high incidence forebody vortex flow problems and the use of airframe/propulsion blending techniques to provide a data base for more efficient hypersonic aerodynamic configurations.

Research and technology activity will continue in the accelerated development of cryogenic test technology for full-scale Reynolds number simulation. Intensive efforts include model construction, instrumentation development, and pressurized cryogenic wind tunnel control and operation. An expanded activity in the development of wind tunnel walls to eliminate three-dimensional wall interference effects in transonic flows will be conducted. This activity will permit the testing of larger models with greater accuracy and productivity.

Exploration of viscous drag reduction schemes will be continued and the most promising will be studied in depth. In particular, large-eddy break-up devices have shown substantial promise and additional work will study the underlying phenomena and potential applications.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Propulsion Research and Technology.....	25,500	26,900	26,900	30,900

OBJECTIVES AND STATUS:

The objectives of the Propulsion Research and Technology program are to increase aircraft propulsion system efficiency; to improve engine performance; to reduce fuel consumption and dependence on rigid fuel property specifications; to improve the reliability and durability of engine components; to reduce engine noise and exhaust pollution to environmentally acceptable levels which are economically and operationally sound; and to evaluate the potential of advanced, new propulsion system concepts. The

efforts include research on gas path components, mechanical components, control systems, fuels, computational methods, instrumentation, emissions, and noise. These activities provide advanced technology that supports propulsion system improvements for all vehicle applications ranging from small, general aviation private aircraft to commercial transports and helicopters to military aircraft of all types. The effort in this program also provides a technology base in noise and emissions for use by the Government in establishing aircraft environmental regulations.

Increasing emphasis on internal flow computational fluid dynamics, small turbine engine components, and broad-specification fuels research continues in FY 1980. In the area of aircraft engine noise, considerable progress has been made toward establishing and understanding the effects of large-scale turbulence and forward velocity on jet and fan noise, and in coannular nozzle noise reduction research. Turbomachinery component research continues to explore concepts to improve fan, compressor, and turbine efficiency and reduce secondary flow and clearance losses. Advances have been made in evaluating lean prevaporized, premixed combustor concepts to determine their stability, autoignition, and NO_x formation characteristics. As part of an expanding effort in fuels technology, the impact of hydrogen content on flame radiation, liner temperature, and soot formation were identified and the effect of freezing point on fuel pumpability continues to be explored.

BASIS OF FY 1981 ESTIMATE:

Fuels research will continue in response to the growing concern over current jet fuel shortages. Broadening the allowable deviation in jet fuel properties would provide a more flexible and reliable supply of fuel and would reduce energy required for specialty refinement. Activity will continue toward developing a better understanding of the effects of fuel property variation on aircraft and engine fuel systems and evaluating advanced design concepts to accommodate these fuels. Fuel characteristics such as flame luminosity, soot formation, thermal stability, and freeze point will be investigated in FY 1981 for both petroleum-derived and synthetic-based fuels in coordination with related combustion and emissions research.

In FY 1981, noise research will reflect increased emphasis on the development of rotor and propeller noise prediction capabilities. Further investigations of the potential for jet noise reduction with coannular exhaust nozzles will be conducted and the assessment of installation and forward velocity effects on in-flight noise generation and propagation will be continued.

Research on inlets and nozzles will concentrate on development of analytical techniques which will accurately predict localized internal flow phenomena, including shock wave/boundary layer interactions in the presence of boundary layer bleed. Detailed, small-scale experimental investigations will verify these fundamental internal flow processes.

Research in computational fluid dynamics for turbomachinery will continue to receive increased emphasis in FY 1981 with efforts to improve computing speed and accuracy of codes developed for inviscid and viscous and two- and three-dimensional flows. Of particular importance will be the work done in establishing critical empirical turbulence correlations needed to accurately model complex viscous flows through turbomachinery blading.

Trends towards higher operating temperature and pressures in commercial turbofan engines will be paced by advancements in turbomachinery. Continuing research in fans, compressors, and turbines in FY 1981 will concentrate on fundamental technology to improve performance and durability of these components. In combustion and emission reduction research, efforts to develop techniques for improving liner durability and reducing emissions will continue with increased emphasis directed towards understanding the fundamentals of combusion and pollution formation. Of particular importance are the efforts to extend advanced technology features developed for large gas turbine engine components down to smaller propulsion systems suitable for helicopter, commuter, and general aviation aircraft.

In FY 1981, instrumentation research on high pressure and high temperature measurement techniques, clearance sensing between rotating and stationary machinery, vibration and stress measurements, and nonintrusive gas path flow measurement and visualization techniques will be conducted. Considerable emphasis will be placed on thin film strain and temperature measurements on metal surfaces and on high temperature electronics for on-board engine processing of experimental data.

Power transfer research will continue to focus on evolutionary technology improvements in gears, seals, bearings, and lubricants. Emphasis will be placed on improving the understanding of basic mechanical wear phenomena and on developing the technology for advanced power transmissions for helicopters and advanced turboprop systems.

In FY 1981, engine dynamics and controls research efforts will continue to investigate advanced control concepts such as nonlinear control theory, advanced sensors and actuators, signal transmission and severe environment electronics, failure accommodation controls, and reliable control software. Analytical modeling techniques to predict the dynamic behavior of engine compression systems will continue, and experimental efforts will determine the distortion sensitivity of a small helicopter engine.

Advanced propulsion system research will continue to focus on the development and validation of computational methods to predict inlet flow fields and combustion kinetics associated with hypersonic propulsion. Fabrication will be completed and tests will be initiated to study the performance of an improved supersonic combustion ramjet configuration.

Promising advances in propeller performance can be achieved through application of recent developments in computational methods, high strength composite materials, and fan, gearing, and advanced control

technologies. In FY 1981, fundamental propeller research will focus on efforts to improve analysis and design procedures for advanced propeller supporting applications ranging from general aviation to commercial transport aircraft. The performance of selected advanced designs will be verified through scale model wind tunnel tests.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Materials and Structures Research and Technology.....	15,200	16,100	16,100	17,800

OBJECTIVES AND STATUS:

The objectives of the Materials and Structures Research and Technology program are to develop advanced metallic, ceramic, polymer and composite materials and structural concepts; and to develop analytical techniques to define critical loadings, response, and stability behavior of these structural concepts. This technology will provide significant improvements in the performance, safety, durability and economy of commercial, military and general aviation aircraft. Areas of emphasis include high temperature engine and airframe materials and structural concepts, including composites and life prediction procedures; improved prediction methods for structural loads, thermal and dynamic response, and aeroelasticity; and more accurate and efficient integrated design methods for airframes and engines.

Improvements are being made in the properties of several high temperature metal alloys, ceramics and composites that promise increased performance and efficiency in gas turbines and aircraft structures. Advances also are being made in the capability to predict the life of composites and metals which will improve the reliability of aeronautical systems. Flight evaluation of an active flutter suppression system on a research wing of a drone flight vehicle is underway in FY 1980 and will supplement wind tunnel data for the validation of both concept and design methodology. A "decoupler pylon" concept for the passive flutter suppression of high performance military aircraft with stores is being validated by wind tunnel tests and design studies leading to future flight validation. Continuation of a U.S. program to measure unsteady pressure distributions on a variety of wing configurations is leading to a fundamental understanding and comparison with newly developed unsteady transonic flow prediction methods. A program was initiated in FY 1980 to define transport airframe response and failure during a crash, the forces transmitted to occupants, and the technology needed to improve crash safety.

BASIS OF FY 1981 ESTIMATE:

Research on high temperature materials will continue to emphasize improving the strength and service life of gas turbine materials. During FY 1981, materials processing and design technology will continue to be developed for an oxide dispersion alloy and a tungsten fiber reinforced superalloy which have

potential for hollow turbine blade applications. A manufacturing method will be developed to produce a low cost, dual property disk alloy having improved mechanical properties. Basic research on the mechanisms of corrosion and oxidation of turbine alloys will continue. Ceramic materials will continue to be developed, with emphasis on improving high temperature strength and impact resistance.

Research will continue on the fatigue and fracture behavior of metallic, ceramic, and composite materials in both benign and active environments. Research will be accelerated to extend existing life prediction techniques and analyses. Studies will continue on the mechanism of hydrogen embrittlement of steels with the objective of developing hydrogen-resistant alloys. To predict service durability of composites, a damage growth law will be developed.

Research on composites will continue to be emphasized in the development of stiff, lightweight, strong structural materials. In FY 1981, studies will continue on low cost fabrication processes, and applications of composites in fixed-wing aircraft. Study emphasis will be placed on methods for evaluating and increasing the durability and damage tolerance of composite components. Exploratory research will be initiated on new resins that will permit the development of tougher, impact resistant, more processable composites. The fabrication and evaluation of advanced composites for high performance engine blades will continue in FY 1981. A data base and fundamental understanding will continue to be developed for the combustion characteristics and the thermochemical, thermophysical, and photochemical properties of new and advanced polymers.

In loads, dynamics and aeroelasticity research, the FY 1981 program will continue to develop improved methods for the prediction of unsteady aerodynamic loads for engine fan, compressor and turbine blades, and for aircraft wings and control surfaces operating in the transonic speed regime. Experimental validation of these methods will be accomplished through wind tunnel tests of two-dimensional airfoil models, rectangular and high aspect ratio supercritical wing models, and wing-tail combination models. Nonlinear analysis methods applicable to the rotating subassemblies of engines and the crash behavior of composite airframe structures will also be examined in FY 1981. Methods for predicting transient high temperature thermostructural design loads will be developed in FY 1981, and the reliability and efficiency of three actively cooled airframe concepts will be demonstrated through wind tunnel tests.

Development of integrated analysis/synthesis methods in FY 1981 will focus on methods for simultaneous optimization of the structural and aerodynamic performance attributes of airframes that incorporate new technologies such as active controls and advanced composite materials. An ongoing program to develop a prototype finite element computational device using microprocessor components will be continued in FY 1981 toward eventual hardware demonstration in FY 1982.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Avionics and Flight Control Research and Technology...	4,000	4,800	4,800	5,400

OBJECTIVES AND STATUS:

The objective of the Avionics and Flight Control Research and Technology program is to support the development of advanced electronics for applications to both civil and military aviation. Major efforts are directed toward enhancing utility, safety and efficiency, while reducing costs, in the areas of navigation/guidance, cockpit displays, controls and systems integration techniques.

A spectrum of navigation schemes is being investigated for the development of concepts for use in improving traffic flow in the national airspace system. Cooperative tests with the Department of Transportation and the State of Vermont are underway to evaluate the use of LORAN-C for aircraft operations in mountainous areas. Simulations are being conducted to investigate precision time-controlled guidance concepts supplemented by appropriate cockpit displays to enhance the orderly and efficient mix of four-dimensional equipped and unequipped aircraft in the Air Traffic Control environment without costly delays in time and fuel consumption. Innovative ideas based on hybrid concepts are being studied for improving both enroute and terminal area navigation/guidance functions. New concepts based on high cost inertial measurement system technology are being investigated to reduce the complexity and cost, for application to a broad class of aircraft exposed to only moderate acceleration levels and limited altitude variations. In the cockpit avionics area, promising approaches are being examined to provide appropriate contrast control and drive circuits for enhancing the application of flat panel liquid crystal displays, and exploratory research is being conducted into the use of thin film electroluminescent displays. A programmable display generation system has been developed as a laboratory system for simulations and analysis in conjunction with advanced flat panel display media for evaluating advanced cockpit concepts.

In controls research, a technology base program has been initiated to focus on the development of highly reliable electronic control devices and architecture for use in future engine power plants. A technique for recovering from a generic software failure in redundant flight control systems is being developed for evaluation in FY 1981. In the area of systems integration, the development of system reliability assessment tools is progressing and preliminary tests have been completed on the potential effects of lightning strikes on digital systems so that realistic, nondestructive test techniques can be devised.

BASIS FOR FY 1981 ESTIMATE:

Results of a recently conducted in-depth assessment in avionics and controls indicate promising opportunities for major technological advances in several areas. The program will examine design concepts for the development of an ultrareliable flight control system using low cost microprocessor techniques. Simulations will be completed on an experimental network data bus using fiberoptics to improve reliability and maintainability. Increased emphasis will be placed on the functional and physical integration of avionics and controls hardware and software providing innovative system architectures based on very large scale integration (VLSI) concepts. Coupled with human factors considerations, "hot bench" laboratory evaluations will be initiated to evaluate conceptual designs of advanced cockpits for enhanced management efficiency. Laboratory model tests will be completed in the design and siting of emergency locator transmitter (ELT) antennas on civil aircraft. As a follow-up to last years lightning effects testing, hardening concepts which have been developed for digital control systems will be validated.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Human Factors Research and Technology.....	5,000	5,700	5,700	6,500

OBJECTIVES AND STATUS:

The objective of the Human Factors Research and Technology program is to provide a research and technology base for solutions to the human factors related problems which influence the growth, efficiency, and safety of air transportation. The program has three areas of emphasis: flight management, flight simulation technology and human response to noise.

During FY 1980 a number of research studies are being conducted within the major areas. Included are joint programs with the Federal Aviation Administration (FAA) to enhance aircrew performance and alleviate the potential for human error.

The Head Up Display (HUD) research has completed its basic laboratory and simulation tests and has begun the full crew mission simulation evaluation of two candidate HUD systems. A second NASA/FAA program is the Cockpit Display of Traffic Information (CDTI). NASA and the FAA have drafted a joint, multiyear program plan for CDTI research. The plan is in the final stage of negotiation and should be signed early in 1980. NASA's CDTI research in FY 1979 developed a candidate display and performed a preliminary evaluation of pilots' ability to interpret the display. A third NASA/FAA program is the Aviation Safety Reporting System (ASRS). During FY 1980, the ASRS accomplished 39 investigations of safety related problems including: runway

incursions, near midair collisions, clear air turbulence and altimeter deviations. The simulation technology research program has developed and performed preliminary evaluations of techniques for use of multiple computers in aircraft simulation. These distributive computer techniques, which will be given full evaluations in the coming year, hold a great deal of promise for increasing all aspects of simulation fidelity. In the human response to noise rsearch effort, studies have been conducted on "time-of-day" vibration effects and on community response to helicopter noise.

BASIS OF FY 1981 ESTIMATE:

In the flight management area, joint NASA/FAA programs will continue in FY 1980. Included are studies concerning Head Up Displays (HUD) and Cockpit Display of Traffic Information (CDTI). This includes completion of the full mission simulation evaluation of alternative HUD displays, and development of a methodology for measuring crew workload with and without the CDTI, devising and evaluating procedures for using CDTI and determining the utility of a CDTI in typical wide-body aircraft. Work will continue in the development of models characterizing information processing and decision making processes which are necessary to establish human factors guidelines for automating cockpit systems. The development of the CDTI referred to above will continue. Oculometer research is continuing to develop quantitative parameters for advanced cockpit design. The Aviation Safety Reporting System (ASRS) will continue and new research investigations, based on problems identified from the ASRS data base will be initiated.

Flight simulation technology will include an investigation of total simulator training for pilots, simulator motion washout requirements, the effect of reduced visibility on approach and landing and distributive computer configurations for simulators. Studies will be conducted to quantify and apply objective pilot performance measurement techniques.

The human response to noise effort will continue to assess the utility of community response models through laboratory and field studies. This work is designed to produce a model for use in evaluating the noise abatement resulting from aircraft modifications, aircraft operations and land use strategies.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Multidisciplinary Research and Technology.....	3,600	3,260	3,760	4,300

OBJECTIVES AND STATUS:

The objective of the Multidisciplinary Research and Technology program is to conduct novel, long-range, high risk basic research investigations in engineering and physical sciences related to aeronautics. This research is conducted at universities through the Fund for Independent Research, which supports

unsolicited proposals and proposals received in response to announcements of research opportunities in specific areas, and through the Graduate Program in Aeronautics, which supports graduate studies where the thesis research is performed, at least in part, at a NASA Research Center using NASA facilities.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase of $500 thousand reflects a transfer of budgetary responsibility from Aeronautical System Studies, which is in the Systems Technology program. This increase supports a Post-Baccalaureate Associate program designed to encourage graduate engineers to perform research at the universities and at the NASA Centers which is mutually desirable to both the parent university and to NASA.

BASIS OF FY 1981 ESTIMATE:

The Fund for Independent Research will continue to support basic research at universities. The Graduate Program in Aeronautics will be increased substantially to: (1) initiate up to three university institutes in Computational Fluid Dynamics to increase the number of scientists trained in this rapidly developing and important discipline; and (2) expand the graduate programs in aeronautics to encourage more newly graduated engineers to enter the aeronautics profession by offering greater opportunities for them to train with NASA senior research staff members at the Research Centers.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
General Aviation Research and Technology.....	6,800	7,000	7,000	7,500

OBJECTIVES AND STATUS:

The objective of the General Aviation Research and Technology program is to provide the technology base for achieving important improvements in general aviation aircraft safety, utility, and energy efficiency. Multidisciplinary in nature, the program encompasses aerodynamics (performance, stability and control), materials and structures, propulsion and fuels, avionics and human factors.

In aerodynamics research, airfoil leading edge modifications to reduce the severity of stall and to prevent the development of unrecoverable flat-spin modes have been demonstrated in flight tests of a representative low wing aircraft type, and emergency spin recovery systems for flight test aircraft were developed. Stall/spin research is being extended to investigate high wing and T-tail aircraft configurations. Wing drag reductions using airfoils which extend the region of natural laminar flow over both upper and lower surfaces have been demonstrated in wind tunnel tests. Research on flapped airfoils continues, in preparation for the

design of a practical experimental natural laminar flow wing for full-scale flight test investigation. Progress has been made also in developing techniques for characterizing and utilizing wing wake flow fields for improved agricultural aerial applications, and preparations are underway for flight evaluation of wake modification and drag cleanup design improvements on an agricultural airplane. In structures research, energy-absorbing seat designs have demonstrated that peak loads transmitted to occupants during simulated crash tests can be reduced by fifty percent. Further design improvements are being made for test evaluation, as well as energy-absorbing fuselage subfloor structural modifications. In propulsion research, techniques for measuring cooling drag of internal combustion engine installations were developed, and laboratory tests of several spark-ignition air-cooled engine design improvements indicate promise for near-term applications to lower fuel consumption by ten percent while reducing both exhaust emissions and cooling air requirements. Longer-term engine design improvements were also studied, and the potentials of unconventional internal combustion engine types, including stratified charge rotary combustion and diesel types, were explored. Studies of low horsepower gas turbines revealed technological opportunities for improvement in fuel consumption and cost, both of which must be achieved if this highly attractive power plant is to achieve more extensive use in general aviation. Propeller research validated a new low speed noise generation theory, and studies were initiated to define technological opportunities for simultaneous improvements in propeller efficiency, noise and structural properties. Studies have been initiated in the areas of human factors and avionics systems, with particular emphasis on improving single pilot operations under instrument flight rule conditions.

BASIS FOR FY 1981 ESTIMATE

Aerodynamics research in FY 1981 will include important extensions of previous stall/spin investigations, expanding the data base with tests of additional configurations. Additional emphasis will also be placed on the development of analytical methods and design techniques for improved stall/spin characteristics of light aircraft. The design of a natural laminar flow wing for flight test will commence, as will the planning of appropriate flight experiments. Further research on aerodynamically integrated aerial applications systems will also continue. In structures, the development of nonlinear methods for the analysis and design of improved crash load alleviating aircraft structure will proceed, guided by empirical data from extensive simulated crash testing in recent years.

Propulsion research will continue to assess the effectiveness of several air-cooled reciprocating engine improvements designed to achieve greater energy efficiency for near-term applications. Technology for more efficient and higher pressure ratio turbo-superchargers will also be pursued. Studies of longer-term improvements through advanced engine concepts and unconventional designs will continue. Studies of the comparative merits and regimes of optimal application for each new engine type will be completed to assist in focusing further engine research and plans for future systems technology programs. Similarly, ongoing focused research on low speed propellers for general aviation plus results of studies to define technology opportunities and design tradeoffs will be utilized in developing plans for necessary future systems technology demonstrations for a range of general aviation applications. Avionics and human factors research will continue to study concepts and techniques to improve general aviation single pilot operations.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Low Speed Aircraft Research and Technology.....	11,100	11,200	11,200	11,500

OBJECTIVES AND STATUS:

The objective of the Low Speed Aircraft Research and Technology program is to provide technology advancement in the areas of (1) rotorcraft structures, dynamics, aerodynamics, flight dynamics, controls, avionics, and man-system integration; and (2) vertical and short take-off and landing (V/STOL) aircraft propulsion, aerodynamics, and flight dynamics.

The noise and performance characteristics of several large-scale rotor systems, including the XV-15 Tilt Rotor, the circulation control rotor, and the X-wing stopped rotor, have been measured in the 40-by 80-foot wind tunnel. Initial large-scale model studies were completed on a representative current hub/pylon configuration aimed at gaining a better understanding of means of reducing rotorcraft drag and improving cruise performance. Work is continuing to develop improved methods of predicting the aerodynamics of V/STOL airtraft, including basic studies of the effect of the ground on deflected jet flows during low speed and hover flight and the effect of inlet and exhaust flow interactions on V/STOL configurations in subsonic, transonic, and supersonic flight.

Tests were completed of the system noise of the NASA Quiet Clean Short-Haul Experimental Engine (QCSEE) mated with typical wing flap configurations during simulated powered-lift aircraft approach and take-off operation; information was obtained for over-the-wing and under-the-wing blow-flap configurations.

BASIS OF FY 1981 ESTIMATE:

In FY 1981, rotorcraft research will include large- and small-scale wind tunnel model tests to verify the capability of predicting rotorcraft loads, vibration, aeroelastic stability, and performance; ongoing research on multicyclic control of controllable twist rotors (for vibration alleviation) will be extended to conventional rotors. Contracted and in-house investigations to develop improved analytical prediction methods will be expanded. Increased emphasis will be given to the provision of practical data on the noise of current and promising advanced rotor concepts, and to the verification of the capability of predicting such noise characteristics. The conceptual design of a total automatic flight control system to reduce guidance and control problems of helicopters during terminal area operation will be completed. Initial studies will be completed to explore the comparative advantages of auditory and visual displays to the pilot for the presentation of obstacle information during low level rotorcraft

flight. Small-scale wind tunnel tests will be carried out on a hybrid rotor/airship configuration to assess such design variables as rotor size and location and hull shape, as well as to examine propulsion/aerodynamic interactions, check scale effects, and verify drag levels.

V/STOL research activity in FY 1981 will continue to develop compact propulsion simulators for use in tests of small-scale wind tunnel models of high performance V/STOL configurations to examine all major high speed propulsion system/airframe interactions. Evaluation of the performance of a full-scale advanced exhaust nozzle for use on supersonic V/STOL configurations will be conducted in an engine altitude test chamber. An investigation will be initiated to compare the relative merits of flight director versus situation perspective displays for improving pilot/vehicle performance during V/STOL aircraft operation in the terminal area.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
High Speed Aircraft Research and Technology.....	14,000	14,800	14,800	15,300

OBJECTIVES AND STATUS:

The objective of the High Speed Aircraft Research and Technology program is to generate technology advancements needed both to achieve safe, reliable, and economical high speed civil aircraft and to establish and maintain technological superiority in military vehicles and systems.

In the area of flight dynamics, significant advances are being made to achieve the capability to design new high performance aircraft with satisfactory high angle-of-attack flying qualities and spin resistance. During the past year, in cooperation with the military services and the aircraft industry, extensive analyses, wind tunnel and free-flight model tests were performed on new configurations to establish the effects of aerodynamic factors and flight control system characteristics on stall departure, spin entry and spin recovery behavior. In the area of missile aerodynamics, an assessment in three different wind tunnels of Reynolds number effects on high angle-of-attack longitudinal and lateral-directional characteristics has shown that test Reynolds numbers an order of magnitude below expected flight values will be satisfactory to establish the correct force, moment and surface pressure values, thus easing test requirements.

BASIS OF FY 1981 ESTIMATE:

In FY 1981, the flight dynamics effort will continue to explore the high angle-of-attack behavior and maneuverability of unique aerodynamic configurations, such as canard designs and swept forward wings, as well as new control concepts such as the use of vectoring two-dimensional nozzles.

The combat vehicle and missile aerodynamics activities will concentrate on promising concepts such as monoplanar missile configurations with high speed cruise and maneuver capability, high aspect ratio nonaxisymmetric nozzles for thrust vectoring and reversing, and supersonic maneuver wings. Analyses and wind tunnel testing will be performed to generate an aerodynamic technology data base for efficient stores integration, carriage and separation at supersonic speeds. Advanced aerodynamic wing design concepts will be evaluated, with emphasis on the trade-offs of optimum features in different speed regimes.

In FY 1981, as part of the interagency and industrial assistance and testing effort, wind tunnels and simulators will be used to provide support for a broad range of aircraft and missile developments. Joint activities with other Government agencies and with the aircraft/missile industry will be conducted to insure the preeminence of current and future U.S. military and civil high speed air vehicles.

The FY 1981 remotely piloted research aircraft technology activities will continue to concentrate on the development of new concepts for the high speed testing and recovery of remotely piloted research vehicles, including enhancement of the ground controller's management of the flight operation.

Flight experiments support activities will be conducted to provide a broad base of high speed research vehicle support, including chase operations and remotely piloted vehicle air drops.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Transport Aircraft Research and Technology.....	6,000	6,500	6,500	7,100

OBJECTIVES AND STATUS:

The objective of the Transport Aircraft Research and Technology program is to provide a broad base of safety-oriented technology for understanding and dealing with aeronautical safety hazards and their consequences, and improving criteria for design of systems and operating techniques leading to reduction in accidents, loss of life and injuries, and loss of equipment.

Significant progress is being made in understanding the effects of meteorological phenomena on aircraft safety. A specially equipped F-106 airplane has initiated flights to obtain measurements of lightning, winds, and turbulence for characterizing severe storm hazards and providing the basis for establishing aircraft protection criteria. A computer code has been developed with potential for predicting convective storms. Microwave radiometry studies have indicated good potential for detecting, warning, and providing avoidance of clear air turbulence, which accounts for many in-flight injuries. Digitized flight

load measurements are being obtained and analyzed for updating operating practices and aircraft structural design criteria. An icing research program has been initiated to define the ice accretion problems in aircraft, particularly rotorcraft, and determine the effectiveness of deicing concepts.

Considerable progress has been made in enhancing our knowledge of crash-fire dynamics, which will be utilized in the development of various fire-modeling and fire testing techniques. A NASA-developed fire resistant airplane window, which offers improved fire protection to passengers, is being evaluated in test. Advanced dry chemical fire suppression agents have demonstrated effectiveness in extinguishing simulated, in-flight, nacelle fires and delaying reignition. Rheological studies to characterize the quality of antimisting kerosene (AMK) are continuing, and a determination of AMK-engine compatibility has been initiated.

In landing systems technology, wear, friction and temperature characteristics of several tire tread elastomers have been obtained, and a NASA formulation has demonstrated improved friction characteristics. Work has been initiated in analytical tire modeling, active control landing gear development, and ground handling simulator development.

BASIS OF FY 1981 ESTIMATE:

FY 1981 research will include gust gradient measurements for providing previously unavailable, information in support of flight simulation and updating of structural design criteria. Lightning discharge phenomena will be studied to provide the basis for design criteria applicable to advanced avionics, materials and structures, and fuel systems. New ice protection concepts will be evaluated under simulated and natural icing conditions.

Modeling of crash-fire scenarios will continue. Further rheological studies of antimisting kerosene characteristics will continue and the assessment of practicability of using antimisting kerosene in modern turbine engines will be completed. A much needed data base of aircraft interior, fire-resistant materials will be established.

Operating characteristics of braking systems will be determined, including factors affecting tire casing strength. Additional attention will be given to the dynamics and effect of blown tires and failed wheels on stopping performance. Work will continue on active control and air cushion landing systems to establish their behavior characteristics and develop design methodology.

BASIS OF FUND REQUIREMENTS:

SYSTEMS TECHNOLOGY PROGRAMS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
	(Thousands of Dollars)				
Materials and structures systems technology	3,300	5,555	5,555	9,600	RD 9-21
Propulsion systems technology	3,600	6,700	6,700	6,400	RD 9-22
Avionics and flight control systems technology	3,000	2,850	2,850	1,550	RD 9-23
Aeronautical system studies	4,825	4,600	4,100	4,600	RD 9-25
General aviation systems technology	3,000	800	800	100	RD 9-26
Low speed aircraft systems technology	14,970	19,250	23,250	23,450	RD 9-27
High speed aircraft systems technology	9,800	14,800	14,800	16,800	RD 9-29
Transport aircraft systems technology	44,750	58,545	58,545	40,500	RD 9-31
Advanced propulsion systems technology	66,255	69,500	72,500	56,200	RD 9-33
Aerodynamic vehicle systems technology	900	200	200	---	---
Total	154,400	182,800	189,300	159,200	

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	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Materials and Structures System Technology.....	3,300	5,555	5,555	9,600

OBJECTIVES AND STATUS:

The objective of the Materials and Structures Systems Technology program is to accelerate the transfer of advanced structures and materials technologies to application in the design of aircraft and engines.

The Materials for Advanced Turbine Engines (MATE) effort involves the identification of promising high temperature materials for production and development of engineering data, followed by engine testing. In the MATE FY 1980 effort, large powdered metallurgy superalloy turbine disks have been hot isostatically pressed to shape, 300 advanced directionally solidified eutectic turbine blades are being fabricated, and single crystal turbine blades are being fabricated. These blades and disks will be used in subsequent engine testing.

The Aeroelasticity of Turbine Engines (ATE) technology activity is a joint Air Force/NASA effort to improve the understanding and prediction capability for aeroelastic instability phenomena in turbine fan stages. In the ATE activity, significant progress has been made in developing analyses to predict supersonic and stall-flutter instabilities of turbine blades and flutter boundary mapping of engine fan blades.

The Integrated Program for Aerospace Vehicle Design (IPAD) efforts in FY 1980 include the detailed design of all first-level software components and completion of the preliminary version of the data base management system, which will be released for industry evaluation.

The Turbine Engine Hot Section Technology (HOST) activity is to provide the technology base for improved life assurance and life management of the hot section components of advanced turbine aircraft engines. Major tasks are to develop analytical and design methods which will enhance hot section component durability. These methods will provide environment definition, thermal and mechanical load prediction, structural analysis, and local response and failure mode characterization. Combined use of these methods will increase the capability for hot section component life prediction. This system technology program is an outgrowth of past basic research and fundamental technology development, such as combustor and turbine blade durability analyses and laboratory experiments.

BASIS FOR FY 1981 ESTIMATE:

During FY 1981, the emphasis in the MATE effort will be on demonstrating the performance in engine test of single crystal turbine blades, an advanced powdered metallurgy disk, an advanced directionally solidified turbine blade, and an advanced turbine blade erosion coating. The goal is to reduce the specific fuel consumption in engines by 1.5 percent using these materials.

The FY 1981 ATE effort will include correlation of analytical predictions with experiments on the vibration modes of blade, shroud, and disk systems of advanced fans and compressors and completion of the development of a prediction technique for blade flutter and comparison with experimental tests.

The IPAD effort is to develop the preliminary design and prototype computer software system for the management of aerospace vehicle design processes. In FY 1981, the first level IPAD data base management system performance will be evaluated by NASA and industry applications. Enhancements needed will be identified and work initiated for improvements to the data base management system.

During FY 1981, the initial emphasis of the HOST activity will be on defining the turbine environment through the conduct of "benchmark" component simulation tests and the development of associated instrumentation. In these tests, relatively simple hardware elements containing stress concentrations will be subjected to high temperature, low cycle, creep fatigue conditions. Simultaneously, analytical solutions for stresses and strains of the stress discontinuity will be obtained from available three-dimensional, finite-element, elastoplastic computer programs. Direct measurements of the local strains in the high temperature testing activity will provide the desired check on the ability of the structural analysis to accurately calculate the stress-strain conditions and provide insight for future needed improvements. In addition to the "benchmark" tests, a broad range of component simulation tests will be designed and conducted for defining static and cyclic thermal and mechanical loadings, the materials and structural responses, as well as failure locations, modes, and lifetimes for combustor liners, vanes and blades, disks, gas path seals and static structure. These simulations will provide documented test conditions and durability data for use in model formulation and subsequent predictive methods evaluation.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Propulsion Systems Technology.....	3,600	6,700	6,700	6,400

OBJECTIVES AND STATUS:

The objective of the Aeronautical Propulsion Systems Technology program is to provide focused systems oriented activity to achieve improved performance, reduced environmental impact, lower fuel consumption, improved durability and reliability, and fuel flexibility for advanced propulsion systems for application to a broad range of vehicle systems through the integration of advanced components.

The Helicopter Transmission Systems Technology effort is providing a systems evaluation of many advanced technology components which have been under investigation for a number of years. The design of a high ratio, traction-drive transmission is nearing completion and fabrication will be initiated in FY 1980. The Broad Specification Fuels Technology activity is aimed at demonstrating the compatibility of future aircraft fuels, which were defined and characterized in the Research and Technology Base, for operation in current and next generation jet engines. Combustor design requirements and criteria have been established and tests of selected combustor concepts will be initiated in FY 1980. The Advanced Low Emissions Combustion effort establishes and demonstrates the technology necessary to reduce exhaust emissions from modern gas turbine aircraft engines consistent with the requirements for improved durability, performance, and fuel flexibility. Design and fabrication of the most promising combustor concepts have been completed and experimental evaluations continue.

BASIS OF FY 1981 ESTIMATE:

The Helicopter Transmission Systems Technology efforts will continue in FY 1981 with initiation of testing of a low ratio traction-drive transmission, a high ratio traction-drive transmission and an advanced technology gear-type transmission. In the Broad Specification Fuels Technology activity in FY 1981, tests of conceptual combustors and fuel systems operating with experimental broad specification fuels will be completed. Testing of optimized designs based on conceptual combustor evaluations will be initiated. The Advanced Low Emission Combustion effort will focus on the experimental screening of combustor concepts. Upon completion of screening, the most promising concepts will be further refined and evaluations will be initiated to assess durability and fuel flexibility.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Avionics and Flight Control Systems Technology.....	3,000	2,850	2,850	1,550

OBJECTIVES AND STATUS:

The objective of the Avionics and Flight Control Systems Technology program is to apply the fundamental knowledge gained in the Research and Technology Base to demonstrate technology readiness and to promote the transfer of advanced systems techniques to the aircraft industry through experimental testing and verification in a realistic environment.

In recent years, a significant increase in the implementation of digital systems has been made by the aircraft design community to take advantage of benefits in size, weight, power consumption and the ability to perform more sophisticated functional operations. This trend is expected to accelerate and has necessitated an improvement in the understanding of software system verification/validation technology to facilitate the checkout and certification process. A joint program with the Federal Aviation Administration is underway based on NASA's past experience with digital systems and simulation technology. Reliability and failure effects surveys have been completed, workshops conducted to apprise the Federal Aviation Administration personnel of current technology, and the development of a validation system based on laboratory simulation techniques has been initiated.

Flight demonstration tests are being completed on an analytic redundancy management technique to minimize the sensor complement and enhance the reliability of digital control systems. This represents the final element of our highly successful F-8 Digital Fly-By-Wire program.

BASIS OF FY 1981 ESTIMATE:

The principal emphasis in the joint Federal Aviation Administration activity will be the completion of the development and checkout of the laboratory simulation system and the initiation of tests leading to techniques for improving the systems verification/validation process as applied to transport aircraft. The overall program is expected to provide optimum configurations to reduce flight test requirements and costs associated with the certification process.

In the controls area, flight evaluations will be completed on a technique in which backup software is embedded in the primary software structure to protect redundant flight control systems against generic software failures. To improve the fault tolerance of redundant aircraft computers, flight demonstrations will be conducted on a "reset" concept which detects momentary computer outages and restores the unit to its normal function unless a true or "hard" failure is present.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Aeronautical System Studies.....	4,825	4,600	4,100	4,600

OBJECTIVES AND STATUS:

Aeronautical System Studies are conducted as a means of identifying the need for, and assessing the impact of, technology advances. The objectives of aeronautics system studies are to determine the feasibility, technology requirements, costs, benefits and impacts of advanced civil and military aeronautical systems through mission, system and conceptual design studies. The studies integrate the mutual effects of technology and a wide range of related factors.

Significant recent results include identification of technology requirements and evaluation of technology benefits for small commuter transports, multirole large transports for civil cargo and military airlift applications, and several new rotorcraft applications. Feasibility studies have also been conducted on high altitude, long-endurance sensor or data-relay airborne platforms, and on potential aircraft applications of electromechanical technology advances employed in the Shuttle program.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The decrease of $500 thousand reflects the transfer of budgetary responsibility in support of the Post-Baccalaureate Associate program to the Multidisciplinary Research and Technology program where it is more appropriately budgeted.

BASIS FOR FY 1981 ESTIMATE:

In FY 1981, rotorcraft studies will emphasize the development of modeling techniques for assessment of far-term technology advances, preliminary evaluation of advanced rotorcraft control integration concepts, and low cost navigation aids for remote area operation. Studies of the Vertical/Short Take-Off and Landing (V/STOL) and hybrid heavy lift airship vehicle concepts will be conducted.

Long-haul transport studies will continue and will include additional focus on alternative fuels, variable geometry designs, application of advanced materials, and assessment of new vehicle and avionics concepts.

High speed systems studies will continue to concentrate on advanced supersonic cruise and maneuver, high performance combat aircraft and advanced technology considerations related to high performance missile carriage, separation and flight. The technology studies will be directed at identification of technology needs consistent with anticipated future military applications.

Advanced propulsion systems studies will address potential turboprop applications for future small as well as large aircraft and will define desirable options for experimental verifications of advanced propulsion systems, such as variable cycle engines and turboprop systems.

General aviation studies will explore the feasibility of advanced vehicle and avionics concepts and evaluate the benefits of potential propulsion system and propeller advances.

Short-haul transport studies will continue to assess the technology needs of this class of aircraft, relying heavily on the technologies being studied and developed in the long-haul and general aviation areas as well as the impact of advanced turboprops on such an aircraft system.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
General Aviation Systems Technology.....	3,000	800	800	100

OBJECTIVES AND STATUS:

The General Aviation Systems Technology program purpose is to demonstrate and verify the feasibility and availability of new technology for general aviation, thereby promoting the earliest possible transfer to and utilization of new technology by industry. Objectives of program elements include improvements in safety, utility and energy efficiency.

With the successful conclusion of the Quiet, Clean, General Aviation Turbofan program at the end of FY 1979, program emphasis in FY 1980 is concentrated on avionics and human factors in the General Aviation Demonstration Advanced Avionics Systems. The objective is to provide the critical information required by industry to proceed with the design of a reliable, low cost, advanced avionics system which can enhance the safety and utility of a majority of general aviation aircraft, particularly for single pilot operation. System design was completed, and fabrication, installation and checkout of the flight system is proceeding.

BASIS OF FY 1981 ESTIMATE:

Checkout and flight test of the Demonstration Advanced Avionics System will be conducted during FY 1981, and evaluations by NASA, industry and selected guest pilots will be initiated.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Low Speed Aircraft Systems Technology.....	14,970	19,250	23,250	23,450

OBJECTIVES AND STATUS:

The objective of the Low Speed Aircraft Systems Technology program is to accomplish focused ground-based and flight research to generate required engineering and operational design criteria data on promising systems for future civil and military applications. The aircraft categories involved include rotorcraft and vertical/short take-off and landing (V/STOL) aircraft. The broad areas of concern include propulsion; configuration optimization and modeling; integrated flight controls, guidance, and navigation; and structural systems involving aeroelasticity, vibration, acoustics, and advanced lightweight materials applications. The activity involves coordinated research efforts in analysis, model testing, and flight testing or rotorcraft and V/STOL and STOL aircraft.

The two new Rotor System Research Aircraft (RSRA) vehicles have been accepted by the Government and are undergoing baseline flight tests. The second XV-15 Tilt Rotor Research Aircraft is proceeding well in its proof-of concept flight test program. Extensive flight envelope documentation has been completed for the Quiet Short-Haul Research Aircraft (QSRA). The consolidation of NASA experimental helicopters at the Ames Research Center has been accomplished. Emphasis on V/STOL systems technology in FY 1980 has been on propulsion control analysis, and on experimental evaluation of configuration concepts in both the low speed V/STOL and the high speed cruise/maneuver flight regimes. The ground-based flight simulation capabilities at the Ames Research Center are being enhanced to perform complete real-time simulation of rotorcraft and V/STOL aircraft in their complex terminal area flight regimes.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase of $4 million is the net result of two unrelated actions: (1) a budgetary realignment and the associated transfer of $1 million of Low Speed Aircraft Systems Technology funds to the Fluid Physics

Research and Technology program for the planned improvement of the ILLIAC computer memory; and (2) a Congressional approval of an additional $5 million for advanced rotorcraft technology.

BASIS OF FY 1981 ESTIMATE:

Flight tests of the Rotor System Research Aircraft (RSRA) in FY 1981 will expand and document their basic flight characteristics with their delivered five-blade S-61 rotors. Adaptation will begin of an existing modern four-blade rotor system for evaluation on RSRA, and studies will be undertaken of more advanced rotor system concepts that may warrant future large-scale wind tunnel and flight evaluation on RSRA. Detailed pressure and flow measurements will be made in highly instrumented blade tip regions of an AH-1G helicopter in flight for a better understanding of complex tip aerodynamics having powerful effects on performance and acoustics.

Proof-of-concept and concept evaluation flight tests will be completed with the XV-15 Tilt Rotor Research Aircraft to validate its flight characteristics throughout its flight envelope, to provide design and operational data upon which certification and design criteria can be established and to evaluate the general potential of the tilt rotor concept to perform military and civil mission profiles. Studies will be continued of advanced rotor and control systems for possible future evaluation on the aircraft.

On rotorcraft operating systems, ground-based simulation and flight research will continue on airborne radar systems for terminal area approach guidance, on a NASA airborne V/STOL guidance and navigation system (used primarily for V/STOL aircraft) coupled to a ground-based microwave landing system, on ring laser gyros as sensors in guidance systems, and on overall integrated flight systems optimization. Flight test vehicles include the UH-1H, SH-3A, XV-15, and CH-53A.

A focused effort will be initiated in the area of advanced rotorcraft technology with emphasis on analytical modeling and verification of selected systems through ground-based and flight testing. The FY 1981 activity will build on the ongoing program and address the critical technology needs of rotorcraft. Advanced rotor modeling will address new concepts for reduced noise and improved performance from hover to high speed flight. Small- and full-scale wind tunnel tests will provide the basis for selection of follow-on flight testing. In the area of structural systems, a special task team will define the state-of-the-art of unified airframe vibration prediction and assess specific needs for future research tasks. Additional activities will address structural vibration reduction techniques by active and passive means and define selected techniques for internal noise reduction. All-weather operations will be addressed with attention to the remote site and high density terminal area environments. Selected modern guidance, navigation, and display components and system concepts will be assessed to define selected simulation efforts and follow-on flight investigations of advanced systems. The critical aspects of human factors and aircraft icing will be considered. Analyses and modeling of advanced rotorcraft propulsion systems will be conducted as a precursor to future component and

system ground-based research. Emphasis will be placed on scaling down new technology available in larger engine designs to foster the improvement of moderate and small engine performance, efficiency, and reliability. The special problems of analytical modeling of large, very high power transmissions will be defined and appropriate ground-based research tasks will be defined as a basis for selected, follow-on testing activities.

A generalized mathematical model will be generated that can represent all significant details of V/STOL propulsion system controls in a real-time, dynamic environment. Preliminary high speed wind tunnel evaluations will be completed for four V/STOL fighter-type configurations designed around different thrust/lift propulsion concepts. Preparations will continue to incorporate sophisticated propulsion simulators in the models for follow-on test of propulsion system/airframe interactions. Also, effectiveness of a vented, rotating nozzle for vectoring V/STOL thrust from propulsive force to lifting force will be investigated using a TF-34 turbofan engine on a static test stand.

Flight experiments with the Quiet Short-Haul Research Aircraft (QSRA) will focus on research that can only be performed with that aircraft due to its very high lift performance and low noise in terminal area STOL operations. Included will be the initiation of an effort to validate handling qualities criteria and develop control laws for such operations at lift coefficients up to 5.5.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
High Speed Aircraft Systems Technology.....	9,800	14,800	14,800	16,800

OBJECTIVES AND STATUS:

The objective of the High Speed Aircraft Systems Technology program is to generate engineering and design data applicable to the advancement of high performance, high speed aircraft for military and civil applications. The objective is accomplished by performing detailed and extensive analysis and experimental research, including wind tunnel tests, ground-based simulation studies and flight tests.

The Supersonic Cruise Research activity is a continuing focused and detailed activity addressing the high potential technologies in the critical aircraft disciplines of aerodynamics, propulsion, high temperature materials, lightweight long life structures, and engine/airframe integration. Significant progress has been recently demonstrated in advanced titanium fabrication processes and structural design concepts. The Flight Experiments efforts will provide an extensive data base in a number of areas.

The F-15 airframe/propulsion interactions have been established to provide a baseline for the advanced controls concepts to be flown on the aircraft in future years. The F-14 aircraft incorporating the NASA developed aileron-to-rudder interconnect is in flight test and will be evaluated jointly by NASA and Navy personnel. Planning support for both the Advanced Fighter Technology Integration-16 and the AFTI-111 joint programs with the Air Force has continued with wind tunnel testing to refine final configurations along with preparation of NASA instrumentation systems to be included in each aircraft during construction. The major accomplishment in the Highly Maneuverable Aircraft Technology (HiMAT) effort was the initiation of the flight research activities with the first flight in July 1979. The flight envelope expansion activities are continuing in preparation for the extensive research flights to begin later this year.

BASIS FOR THE FY 1981 ESTIMATE:

In FY 1981, the Supersonic Cruise Research efforts will continue in all discipline technologies. The aerodynamics technologies will receive special attention with construction of several new wind tunnel models to study refinement of planform and low speed/high lift concepts to cover the full speed range. The propulsion system/airframe integration activities will address both advanced noise suppression technologies for the inlet and nozzle along with a wind tunnel experimental test of noise suppression and low speed performance of an axisymmetric inlet. The materials and structures activities will continue to emphasize the titanium fabrication and structural design with broadly based work in superplastic forming and diffusion bonding, adhesive bonding techniques for titanium honeycomb, cold forming of the beta alloy and fabrication of a small primary structural element. In addition, an activity in advanced flight procedures for low noise with improved aerodynamics and handling qualities will be expanded.

The Flight Experiments efforts in FY 1981 will address a broad array of technologies using a variety of high performance aircraft available for research purposes. The F-15 aircraft is dedicated to flight evaluation of advanced full authority multivariable digital propulsion control concepts. Several concepts, evolved in laboratory demonstrations performed by DOD and NASA, will be installed and integrated to the twin-(F-100)-engine F-15 aircraft for flight testing. The joint NASA/Air Force AFTI-16 aircraft incorporating an advanced digital multivariable fly-by-wire control system and extensive flight-test instrumentation will be delivered to NASA in late FY 1981; flight test planning will be completed and a first flight is anticipated in early 1982. The AFTI-111 program is also a joint NASA/Air Force effort. Construction of the complex variable-camber, variable-sweep wing will be completed along with the installation of the extensive, NASA supplied, instrumentation system. NASA research flight planning will continue through the year converging with delivery of the complete aircraft in early 1982.

The HiMAT effort will be into the flight research phase in FY 1981. Both aircraft will be utilized in evaluation of the technologies designed into these aircraft with detailed studies of the advanced aerodynamics of the closely coupled wing/canard and the aeroelastically tailored performance of the graphite

composite wing/canard structure. These tests will be conducted at various altitudes, over a range of high speeds, at high angles-of-attack and under maneuvering flight conditions. The utility of the Remotely Piloted Research Vehicle (RPRV) technique for low cost flight research purposes will be assessed during the year.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Transport Aircraft Systems Technology.....	44,750	58,545	58,545	40,500

OBJECTIVES AND STATUS:

The objective of the Transport Aircraft Systems Technology program is to develop and demonstrate advanced technology for enhancing aircraft energy efficiency, providing operational compatibility with the future national aviation system, and accelerating application of advanced fireworthy materials.

The Laminar Flow Control effort will develop and demonstrate a practical, reliable, and maintainable boundary layer control system for viscous drag reduction of future subsonic transport aircraft. Emphasis in FY 1980 is being placed on initiation of contracted work in support of leading edge systems flight test and for manufacturing development of wing suction surface systems components, and continuation of Phase II of in-house technology development in key areas such as aerodynamics, structures, and suction systems.

The Energy Efficient Transport activity will develop and evaluate advanced aerodynamics, propulsion/airframe integration, and active controls technology for near-term application to derivative and new transport aircraft. In FY 1980 advanced aerodynamics and active controls technology programs for selected transport design concepts are being continued by three major airframe manufacturers, a flight evaluation of drag-reducing winglets will be completed with a KC-135 aircraft, and contractor test and evaluation of two fault-tolerant computer models will be completed. In-house efforts include wind tunnel tests of advanced winglet concepts and completion of a high Reynolds number evaluation of the low speed aerodynamic characteristics of a basic wing and high lift system.

The objective of the Composite Primary Aircraft Structures effort is to accelerate the introduction of weight and cost saving composite secondary and medium primary structures in future derivative and new commercial transport aircraft by designing, developing, and certifying six representative composite components. During FY 1980, development of the two remaining secondary composite components (B-727 elevator

and L-1011 aileron) will be completed. Predicted weight savings of 26-29 percent have been validated. Manufacturing development and testing of medium primary composite structures (L-1011 and DC-10 vertical fins and B-737 horizontal stabilizer) will continue. Final results of the carbon fiber risk assessment showed that the free carbon fiber risk from aircraft application of composites is insignificant.

The objective of the Terminal Configured Vehicle Systems effort is to identify and validate aircraft system and flight management technology that will benefit conventional take-off and landing aircraft terminal area operations in the future national aviation system environment. This technology program involves analytical studies, simulations, and application of advanced technology through the hardware flight test phase to reduce risk to the point where the technology will be accepted and applied to future aircraft configurations for safer and more productive flight operations. During FY 1980 this effort will continue experiments in close cooperation with the Federal Aviation Administration with systems under development for the future air traffic control system such as the Microwave Landing System and the Discrete Address Beacon System.

The objective of the Fire Resistant Materials Engineering (FIREMEN) effort is to accelerate the development of materials with improved flammability resistance and low smoke and toxic yield in civil aircraft through development and systems testing of new and modified fire-resistant materials and material systems. During FY 1980 evaluation of material systems developed earlier will continue, providing materials data needed by designers for interior panels, enclosures, windows, seat fabrics, moldings and cushioning. Full-scale fire testing of material systems under the FIREMEN Phase I effort will be completed.

BASIS OF FY 1981 ESTIMATE:

In Laminar Flow Control, efforts will continue to develop the technology for a practical, reliable, and easily maintained system. In FY 1981, design and development will be underway on suction surface and ducting, insect protection/removal, and deicing systems for a spanwise section of the leading edge of a wing back to the front spar. Flight testing of two promising systems will commence in FY 1983 at representative flight conditions and in an operational environment. Wing suction surface panel structural design activities for large transports will be emphasized following award of two industry contracts for alternate designs in late FY 1980. During FY 1981, the first phase of Laminar Flow Control swept wing supercritical airfoil high speed model wind tunnel tests will be completed in-house.

In the Energy Efficient Transport effort, work will continue with major airframe and engine manufacturers to develop, refine, and evaluate advanced aerodynamic, airframe/propulsion integration, and active control technologies. During FY 1981, advanced computer evaluations will continue for application to high reliability/high maintainability active flight controls, including an initial demonstration of the software-implementable fault tolerance concept. Airframe/propulsion integration investigations will examine the effects of internal/external aerodynamics, static/dynamic loads, and other factors on installation efficiency,

performance gains and deterioration. Airframe manufacturers will continue investigation of the integrated application of active controls technology to advanced energy efficient transport designs, and will continue development activities which will lead to separate flight evaluations of drag-reducing wing tip winglets and a reduced area horizontal tail on wide-bodied aircraft during FY 1982.

In the Composite Primary Aircraft Structures effort, three of the six component activities will continue in FY 1981. Manufacturing development of the composite B-737 horizontal stabilizer will be completed during that period. The DC-10 composite vertical stabilizer ground test unit will be subjected to fatigue, vibration, and other environmental tests, while fabrication and assembly of flight test and flight service units continue. The simulated 20-year durability test program to demonstrate production readiness for the L-1011 vertical fin will continue during FY 1981 with spar and cover environmental chamber cyclic flight profile tests, and with static and dynamic loads ground test of completed vertical fin assemblies. In support of larger composite primary structures, small subcomponents will be designed and fabricated for investigation of fuel integrity, crashworthiness, and durability.

During FY 1981, the potential of cockpit displayed traffic information will continue to be explored in the Terminal Configured Vehicle effort with simulation and flight experiments. Automatic flight control system improvements and new concepts for flight and turnoff guidance will be demonstrated and validated for greater precision of touchdown in windshear conditions and reduced runway occupancy times. A study to redefine the B-737 research airplane flight deck for greater crew efficiency will be completed in FY 1981.

In the Fire Resistant Materials Engineering area, full-scale testing of improved fire resistant fabrics and cushion materials for aircraft seats will be completed in FY 1981. Development of test methods and conditions will continue, in conjunction with the Federal Aviation Administration, National Academy of Sciences, and National Bureau of Standards, in the search for relevant toxicological evaluations of the pyrolysis products of aircraft materials under typical aircraft fire conditions.

	1979	1980		1981
	Actual	Budget Estimate	Current Estimate	Budget Estimate
		(Thousands of Dollars)		
Advanced Propulsion Systems Technology.....	66,255	69,500	72,500	56,200

OBJECTIVES AND STATUS:

The objectives of the Advanced Propulsion Systems Technology program are to achieve improved performance, lower fuel consumption, and reduce noise and emissions in advanced aircraft engines through the integration of advanced propulsion components.

The component development and integration phase of the Energy Efficient Engine (EEE) program continues. The detailed design of major engine components was completed, and full-scale engine component rig tests have been initiated. In the Engine Component Improvement effort, development of performance improvement concepts continues, and orders have been placed by airlines for four of the improved technology components. In the Advanced Turboprop (ATP) program, efforts are continuing to address aerodynamic, acoustic, and structural problems related to advanced turboprop propulsion systems. Emphasis in FY 1980 will focus on the establishment of a design data base developed from small-scale prop-fan models. In the Variable Cycle Engine (VCE) technology effort, performance and emissions testing of the duct burner system over its full operational regime will be completed in late FY 1980. Fabrication of the core-driven fan test system will be completed and aero/acoustic testing will be in progress by the end of FY 1980. An assessment of exhaust stream a acoustic suppression provided by thin sheath thermal shielding will also be in progress.

CHANGES FROM FY 1980 ESTIMATE:

The $3 million increase reflects Congressional action to add $3 million to the Variable Cycle Engine technology effort for FY 1980.

BASIS OF FY 1981 ESTIMATE:

The Energy Efficient Engine (EEE) full-scale component tests of the fan, high pressure compressor, full annular combustor, and high pressure turbine will be completed in FY 1981. Fabrication of the core system and integrated core and low spool system will be initiated. Supporting technology activities that verify advanced EEE concepts such as the thermal barrier coatings and shroudless hollow fan blades will be completed. The results of the FY 1981 experimental activities will provide for the second major update of the EEE Flight Propulsion System.

The Variable Cycle Engine technology effort will focus on development and demonstration of the critical low spool technologies unique to variable cycle propulsion systems for future advanced supersonic cruise aircraft. In FY 1981, new concepts will be investigated and promising concepts identified in prior years will be developed further with emphasis on advancing the technology required to achieve noise reductions greater than have been demonstrated to date. Selected designs of these components and additional flow modulation and acoustic suppression techniques will be integrated into system demonstrations to verify critical component/system performance. Efforts will be initiated on the design, fabrication, and component testing of coannular/suppressor nozzle systems, flight-type duct burners, and an advanced variable flow fan.

The Advanced Turboprop (ATP) program will emphasize the technology necessary for advanced high speed propellers capable of providing up to 25 percent fuel savings relative to current high-bypass-ratio turbofan engines. In FY 1981, efforts will continue to address aerodynamic, acoustic, and structural problems in

order to provide the essential data base not only for advanced turboprop-powered commercial transports but also for short-haul and commuter aircraft. Major emphasis in FY 1981 will be directed toward the design of large-scale, high speed propellers and the development of wind tunnel test methods to evaluate the structural dynamics of these propellers.

RESEARCH AND DEVELOPMENT
FISCAL YEAR 1981 ESTIMATES
BUDGET SUMMARY

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

SPACE RESEARCH AND TECHNOLOGY

SUMMARY OF RESOURCES REQUIREMENTS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
	(Thousands of Dollars)				
Research and technology base	86,277	99,300	99,785	103,400	RD 10-3
Systems technology programs	12,023	14,100	11,015	9,700	RD 10-17
Standards and practices	9,000	3,000	5,000	2,100	RD 10-20
Total	107,300	116,400	115,800	115,200	
Distribution of Program Amount by Installation:					
Johnson Space Center	5,284	9,440	10,045	8,200	
Marshall Space Flight Center	9,279	6,500	6,642	7,150	
Goddard Space Flight Center	9,656	9,300	8,848	9,400	
Jet Propulsion Laboratory	20,918	24,600	22,673	20,800	
Ames Research Center	9,904	9,840	9,881	9,800	
Langley Research Center	24,472	27,400	27,882	30,000	
Lewis Research Center	22,866	25,420	23,694	25,900	
Headquarters	4,921	3,900	6,135	3,950	
Total	107,300	116,400	115,800	115,200	

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OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

SPACE RESEARCH AND TECHNOLOGY PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The objectives of the Space Research and Technology program are to provide the technology base necessary to support current and future space activities; to formulate technology options for the future; and to advance technology for further reducing the costs of space activities.

The FY 1981 program supports these objectives by stressing the technology areas judged to be most critical by advisory groups, a special in-house assessment, and in-house users of the technology needed to enhance planned missions and to enable future missions which are beyond current capabilities. Emphasis is on increasing performance and reducing cost and risk in both fundamental technology and in the areas of information systems, spacecraft systems, and transportation systems. When required, the program demonstrates the readiness of new technology by space experiments to assure its acceptance for utilization on planned missions.

CHANGES FROM FY 1980 BUDGET ESTIMATES:

The Space Research and Technology program has been restructured to provide for more effective and efficient program management. These changes are consistent with the new OAST organization implemented in the fall of 1979, and simply reflect new locations within the overall program structure rather than changes in emphasis. Changes in emphasis are explained under each related program justification.

BASIS OF FUND REQUIREMENTS:

In FY 1981, activities are designed to maintain a strong research and technology base in the disciplinary areas of materials and structures, electronics and automation, entry fluid physics, chemical propulsion, and space power and electric propulsion, and in the systems areas of information, spacecraft, and transportation. These efforts will continue to provide the technology base for future missions.

Systems technology efforts include studies to focus the technology activities in directions which provide maximum benefits to future space programs. Other systems technology efforts are directed at developing the technology for advanced space communications systems and for conducting selected experiments in space. During

FY 1981, experiment integration into the Long Duration Exposure Facility (LDEF) will continue, and the LDEF will be maintained ready for integration with the Shuttle. The development and integration of experiments to be conducted on early Shuttle, Spacelab, and free-flying missions will be continued.

In the standards and practices area, emphasis is being placed on completion of standard hardware for use on multiple missions, product improvement through component upgrading, and improvement of program practices, concentrating on such areas as specifications, testing, and flight project analysis.

BASIS OF FY 1981 ESTIMATE:

RESEARCH AND TECHNOLOGY BASE

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
	(Thousands of Dollars)				
Entry fluid physics research and technology	5,200	5,400	5,400	6,100	RD 10-4
Chemical propulsion research and technology	8,600	8,900	8,900	9,300	RD 10-5
Materials and structures research and technology	16,400	16,400	16,400	16,500	RD 10-6
Electronics and automation research and technology	8,200	8,550	8,550	8,800	RD 10-8
Space power and electric propulsion research and technology	17,000	19,750	19,750	20,300	RD 10-9
Multidisciplinary research and technology	2,000	2,700	2,700	2,900	RD 10-11
Information systems research and technology	16,308	20,600	20,600	22,600	RD 10-12
Spacecraft systems research and technology	5,495	7,250	7,250	8,700	RD 10-13
Transportation systems research and technology	7,074	9,750	10,235	8,200	RD 10-15
Total	86,277	99,300	99,785	103,400	

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Entry Fluid Physics Research and Technology	5,200	5,400	5,400	6,100

OBJECTIVES AND STATUS:

The objective of this effort is to improve the understanding of the aerothermodynamic, gasdynamic and flight mechanic problems of spacecraft designed for Earth orbital missions and planetary exploration. This knowledge will be used to improve the safety, reliability and efficiency of such spacecraft.

In the area of space vehicle configuration and aerothermodynamics, technology assessment studies have indicated that for advanced, heavy lift, single-stage-to-orbit vehicles, the far aft center of gravity location (75 percent of length) is a major design issue that must be addressed and solved before the advantages associated with advanced technology can be realized. In the area of planetary entry probes, the capability has been developed to calculate the turbulent flow field about a massively ablating sphere/cone entry body during descent through the atmosphere of Jupiter. In the flight data analysis effort, several experiments to be conducted on the Shuttle Orbiter are under construction. These experiments will provide research-quality data for use in evaluating theoretical and experimental methods.

BASIS OF FY 1981 ESTIMATE:

In the area of space vehicle configuration and aerothermodynamics, efforts are aimed at improving vehicle performance and reliability and reducing costs for a variety of potential space missions. In FY 1981, continued emphasis will be placed on development of theory, advanced computational methods, and computer codes for predicting vehicle flow fields and performance; development of improved ground-based experimental techniques, instrumentation and simulation capability; provision of advanced vehicle design integration capability; and development of a data base from ground facility and flight investigations for support of future vehicle design.

The planetary probe technology effort provides the aerothermodynamic base which supports current and future scientific missions to study the atmospheres of Venus, Mars, the outer planets and certain of their satellites. This technology base is used in the design, development, and verification of planetary probe configurations, and provides the flight mechanics data in support of the atmospheric reconstruction experiment. In FY 1981, theoretical and experimental efforts will be pursued in the areas of shock-layer radiation, ablation product radiation and absorption, lightly-blown shock-layers, probe flight mechanics, and mass loss and shape change.

These studies will be pursued to develop a data base to be used to minimize planetary mission costs, to maximize the scientific returns, and to insure a high probability of mission success.

The flight data analysis effort will use the Orbiter Experiment flight data to understand phenomena which cannot be simulated in ground facilities, to develop techniques for extrapolating ground facility results to flight conditions, and to verify analytical and computational prediction techniques. In FY 1981, analysis techniques and associate software will be developed and the data base will be defined in preparation for analysis of flight data.

	1979 Actual	1980 Budget Estimate	1980 Currect Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Chemical Propulsion Research and Technology.....	8,600	8,900	8,900	9,300

OBJECTIVES AND STATUS:

The objective of this activity is to advance the technology of high thrust chemical propulsion systems in order to achieve significant reduction in the development, production and operations costs and to improve the performance capability of future space transportation vehicles and long-life spacecraft systems.

Significant technological progress has been made during the past year, both in advanced space transportation system propulsion and in long-life spacecraft systems. The regenerative cooling capability of liquid oxygen was demonstrated as was the efficient operation of oxygen-hydrocarbon primary combustors and turbine drive gas generators at high pressures. Heat sterilization of a solid propellant formulation designed for planetary launch vehicles was also demonstrated.

BASIS OF FY 1981 ESTIMATE:

Technology demonstrating long service life for small oxygen-hydrogen systems is being completed. In FY 1981, the technology efforts will be oriented toward evaluating small oxygen-hydrogen engine concepts designed for very low thrust operations. Systems under consideration include single engines, designed for both high thrust and low thrust, and engines designed for low thrust operation only.

Research and technology on high density fuel engines for advanced Earth-to-orbit vehicles will continue to emphasize simplified servicing and maintenance techniques, component designs for long service life, combustion, heat transfer and cooling, and expansion nozzle configurations designed to maximize specific impulse over a variety of engine operating conditions and altitudes.

Long-life spacecraft propulsion technology activities are directed toward systems designed to operate reliably over long periods of time, up to 10 years in space, without benefit of repair or refurbishment. These research and technology efforts include planetary retropropulsion, deorbit, atmospheric entry, landing, and launch propulsion systems, as well as spacecraft auxiliary propulsion. Work has been initiated evaluating small pump-fed retropropulsion for more efficient placement of science payloads in orbit around the planets. Technology investigations focused on ways to produce oxygen from the Martian atmosphere for use as an Earth-return vehicle propellant will continue. The test firing of a complete solid motor following heat sterilization will be conducted in FY 1981.

Basic research to expand understanding of the chemical and physical processes that occur in rocket propulsion system will be continued. The search for advanced propulsion system concepts that will provide a new level of capability beyond conventional chemical systems will also continue. In FY 1981, the efforts will include continuation of combustion studies; exhaust plume definition; and analyses of effects, performance prediction techniques, solid propellant polymers and viscoelastic properties, behavior of fluids in a low gravity environment, and laser propulsion feasibility studies.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Materials and Structures Research and Technology	16,400	16,400	16,400	16,500

OBJECTIVES AND STATUS:

The objective of this activity is to develop the technology in advanced materials and structures for improving the performance, efficiency, durability and economy required for large area space structures for antennas and platforms, advanced space power generation, advanced space transportation systems, orbiting spacecraft and planetary probes, and payloads. Areas of emphasis include: (1) basic understanding of material science, including advanced metallics and intermetallics, long duration environmental effects of space, tribology, computational chemistry and surface physics, and bearings, lubricants and seals technology; (2) development of composites, including both polymeric and metal matrices and the identification of environmental effects and damage mechanisms; (3) development of metallic and nonmetallic thermal protection systems; (4) definition of loads, dynamics and aeroelasticity of aerospace vehicles, payloads and spacecraft systems; and (5) development of advanced structural concepts, integrated analysis and synthesis techniques for design and qualification procedures involved in new systems with operational requirements well beyond the current state of technology.

A major research effort is being directed at determining the durability of structural composite materials, both metallic and nonmetallic, in the space environment and identifying the significant damage mechanisms so that synthesis of resistant materials may be achieved. Work is continuing on high temperature resin matrix composites and new fibers for metal matrix composites to achieve higher performance levels in space structures. Fundamental work on friction and wear, directed at higher temperature longer life bearings and seals, continues to demonstrate that improvements are possible. Several products previously developed are now being used in critical areas of the Space Shuttle Orbiter. Advanced thermal protection systems for both space transportation systems and planetary probes have been developed and are under evaluation. Several advanced insulation systems have progressed to the point that the technology can be incorporated into the Space Shuttle. Other advanced systems offer application options for the future. In FY 1980, a dynamic, acoustic, thermal experiment (DATE) was initiated for flight measurements of the Shuttle payload environment. This experiment has as its major objective the development and validation of advanced technology for prediction of the environment and associated payload responses in cargo areas of space vehicles. The secondary objective of the DATE experiment is to improve current knowledge of environments for design of Shuttle payloads. Nonlinear analysis and synthesis techniques for dynamic and thermal response, stability and control, and structural design, including optimization, are being developed for advanced space transportation systems, payloads, large space structures, and spacecraft. Erectable and deployable platform configuration concepts have been developed, and a ground test program to verify deployment dynamics and assembly techniques is in progress.

BASIS OF FY 1981 ESTIMATE:

Basic research activities in FY 1981 will include corrosion, chemisorption, catalysis, hydrogen embrittlement, fiber-matrix interface properties, and lifetime prediction in elastomeric systems. An improved understanding of these phenomena and processes will provide the foundation for improving performance of space materials. In FY 1981, increased attention will be given to the effect of the space environment on the properties of composite materials. Materials which have good long-term resistance to space radiation will be identified. Aluminum matrix composites will be evaluated for the feasibility of low cost forming and enhancements possible with new fibers such as aluminum, silicon carbide and specially-coated boron. Liquid and solid lubricants will be studied for their stability at high temperatures and in vacuum. High pressure seal concepts will be evaluated in a simulated turbopump. Studies will be initiated to examine the characteristics of intermetallic aluminides for high strength to density applications.

Thermal protection concepts and materials will continue to be evaluated for the protection of re-entry vehicles and planetary probes. In FY 1981, emphasis will be on obtaining better understanding of fundamental material surface behavior through the application of computational chemistry. For insulating heat shields, the emphasis will be on evaluating refractory fibers capable of withstanding temperatures as high as 3500°F. Candidate heat shield materials for planetary and solar probes will also be developed and tested to evaluate their performance.

In FY 1981, research and technology efforts will continue the evaluation of selected structural concepts for deployable and erectable space systems and the identification of design and qualification procedures required to meet possible future mission requirements.

In the area of integrated analysis and synthesis methods, emphasis will be on improved computational efficiency and continued development of structural modeling and analysis methods to meet the design needs of future space systems, including nonlinear behavior due to large deformations and nonisotropic composite material application, fatigue life of advanced metallic and composite materials, and structural/controls dynamic interactions.

In loads, dynamics, and aeroelasticity, the focus will include the adaptation of payload loads and vibroacoustic design methods to Shuttle-type vehicles, the development of concepts for control of structural dynamic modes of space systems, and improved methods of dynamic model testing.

The high temperature structures effort will continue development of metallic structures for Earth entry vehicles capable of withstanding temperatures of 1500°F or more, metallic multiwall thermal protection systems, and validated thermal stress prediction methods.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
Electronics and Automation Research and Technology	8,200	8,550	8,550	8,800

OBJECTIVES AND STATUS:

The objective of the Electronics effort is to provide advanced electromagnetic concepts technology and special devices needed to improve the electronics, sensing and detection capabilities required for future planetary and Earth-orbiting spacecraft missions. The program emphasis is shifting from that of completion of the development of existing concepts to exploration of new concepts. The Automation activity provides the theoretical and technology base needed to expand the application of automation to greatly increase the productivity and effectiveness of humans, spacecraft, space operations and facilities. This is accomplished through basic research and synthesis and adaptation of nonaerospace automation technology to space oriented problems. Basic theories of automated general problem solving are being developed to the stage that they can treat realistic space automation-type situations, such as automatic experiment sequence generation, for use in planetary probe missions.

BASIS OF FY 1981 ESTIMATE:

The Electronics program will continue to investigate the physical phenomena associated with microelectronics and detectors and develop new concepts, models and components to provide significant advances in laser technology, solid state imaging techniques, high density and high reliability integrated circuits, and mission cost-effectiveness by optimizing component functions. This and related technologies in sensing and detection will considerably increase system sensitivity and extend observable wavelength capabilities into the far infrared regime and greatly increase data recording capacity. During FY 1981, emphasis in the Automation effort will be on establishing the technology base for the full range of automatic decision making in a synthesized form so that adaptability to high potential cost/benefit activities can be explored. In particular, automatic sequence generation activities for space missions and automatic process control of support functions for Earth orbital missions will be examined.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Space Power and Electric Propulsion Research and Technology	17,000	19,750	19,750	20,300

OBJECTIVES AND STATUS:

The objectives of this activity are to provide the research and technology for major advances in the generation, conversion and transmission of energy, and in high specific impulse electric propulsion systems. Advances in all of these areas are needed to extend our capabilities in near-Earth space and in the exploration of the solar system.

Advances in battery separators, electrodes, internal components and reconditioning procedures have been demonstrated, which can more than double the cycle life of alkaline batteries for space use. In the photovoltaic area, progress in understanding radiation damage and thermal annealing behavior in silicon solar cells has increased the potential of overcoming the degradation in performance experienced with current solar arrays. Innovations in surface treatment of the electrodes of thermionic converters have continued to increase the conversion efficiencies and available voltages of these devices.

The Air Force SCATHA (Spacecraft Charging at High Altitudes) satellite, designed to investigate the buildup of electrical charges on spacecraft on high Earth orbits, was successfully launched from KSC on January 30, 1979, and has experienced electrical charging during several electromagnetic substorms. The NASA Spacecraft Charging

Analyzer Program (NASCAP) is being used to reduce and interpret the SCATHA charging data in a cooperative NASA/USAF effort.

Ion thrusters and power processors have been fabricated, acceptance tested, and assemble into a preprototype electric propulsion system in preparation for functional, thermal vacuum, vibration, and other evaluations. Endurance tests to establish a thruster operational life capability in excess of 15,000 hours have been initiated.

BASIS OF 1981 ESTIMATE:

Photovoltaic research and technology will continue efforts which improve conversion efficiency, reduce mass, reduce cost and increase operating life of photovoltaic converters and arrays. In the area of cells, attention will be focused on demonstrating the feasibility of an 18% silicon cell and evaluating thin cell approaches for gallium arsenide. Work will continue on understanding radiation damage and thermal annealing in order to increase operating life. Blanket and concentrator technology will continue for high concentration ratio arrays for high power-to-weight ratios. Alternate photovoltaic approaches such as thermophotovoltaic and spectrophotovoltaic technology will be evaluated, and emphasis on thin substrates, covers and encapsulants will continue for both lightweight and low cost technology.

In the area of advanced energetics, assessments will continue on advanced concepts for space energy generation, conversion, storage and distribution and development of key technologies required to determine their feasibility. Work will continue on investigations of direct conversion of fission and solar energy into laser radiation, on novel means to convert solar and laser radiation efficiently to electricity, on photochemical cell technology and on laser welding and annealing of solar cells.

In electric propulsion, the performance of mercury ion thrusters will be extended to higher power and thrust density, and the range of useful specific impulse will be broadened. A theoretical and experimental study of ion sputtering and its effects on ion thrusters will be completed. An evaluation of magnetoplasmadynamic thruster performance and internal erosion characteristics will be completed, and the feasibility of inert gas (argon and xenon) thrusters will be examined.

In power management, work toward advanced components such as transistors, inductors and power transfer devices will continue and the design of a solar thermoelectric generator will be completed. The spacecraft charging activities will be completed, and a cooperative effort with the Air Force on high voltage space plasma interactions will be initiated.

In thermal-to-electric energy conversion, the demonstration of improved energy conversion efficiencies in thermionic diodes and in thermoelectric materials will continue, and a preliminary evaluation of alternative conversion technologies for nuclear electric propulsion applications will be made.

Research aimed at understanding fundamental life-limiting mechanism in nickel-cadmium space batteries will be intensified, leading to the development of improved processing specifications. Development of the technology for high capacity energy storage required for future high power missions will continue, with emphasis on fuel cell electrolyzers and high capacity battery cells. In addition, work on very high energy-density storage systems, based on lithium and sodium, will also continue.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Multidisciplinary Research and Technology.....	2,000	2,700	2,700	2,900

OBJECTIVES AND STATUS:

The objective of the Multidisciplinary Research and Technology effort is to conduct novel, long-range, high-risk basic research investigations in engineering and physical sciences related to space. This research is conducted principally at universities through the Fund for Independent Research and the Physics and Chemistry Experiments in Space (PACE) program. The Fund for Independent Research is supporting basic research on many topics of fundamental importance, such as materials properties at high pressures, development of a free-electron laser, energy storage by spin-aligned (triplet) hydrogen, precision cryogenic maser capable of testing the general theory of relativity, molecular binding between materials and ceramics, TV real-time imagery, crosslinking on polymeric membranes, optical constants of transition metals, and nonlinear interactions in superfluid dynamics. The PACE program supports basic studies leading toward the development of experiments that need the unique characteristics of the space environment to make fundamental new discoveries about materials properties and processes. Some of the work supported includes immiscible liquid drops, mass transfer, surface driven convection, concentric rotating drops, granular soil behavior, superfluid helium lambda point measurement, and combustion.

BASIS OF FY 1981 ESTIMATE:

The research supported under this activity provides the opportunity to study innovative ideas that underlie and cut across the established disciplinary structure, and thus contribute to long-term growth in space technology.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Information Systems Research and Technology.....	16,308	20,600	20,600	22,600

OBJECTIVES AND STATUS:

The objectives of the Information Systems Research and Technology program are to provide advanced sensor and instrumentation systems that will improve the data acquisition capabilities of future space application and science missions and to provide processing, reduction, and distribution systems to convert that data for effective and timely user information exchange. Solid state focal-plane array technology is being developed to improve the infrared observational capabilities of remote sensing systems. Lasers and electro-optical systems are being developed for acquiring specific data related to terrestrial and atmospheric properties. Both passive and active microwave systems are being developed for a near all-weather, 24-hour per day remote sensing capability. Instrument pointing research aims at new concepts and components to provide accurate pointing and onboard video landmark tracking capability. Cooling systems technology is being advanced in the area of ultra low temperature refrigeration systems for cooling of sensors, and experiments in space.

Design and testing of a cold field emission cathode power amplifier for space communications systems has resulted in a new amplifier system with increased power capacity and virtually unlimited life.

The first charge-coupled device (CCD) linear imaging array capability in the long wavelength infrared region has been developed and tested. A submillimeter wavelength radiometer was developed and flight tested to provide near all-weather, 24-hour-per-day sensing capability to measure upper atmospheric water vapor.

The second phase of the NASA End-to-End Data System (NEEDS) program was initiated during FY 1979. The current NEEDS program emphasizes technologies of sensing through archiving and focuses on real-time data management. During the past year an improved method of handling space-derived data was developed. Data from each sensor are separated into complete, self-contained "data packets". Each packet includes sensor identification and auxiliary data, such as time of observation, location and spacecraft attitude. These autonomous, correlated records are developed onboard the spacecraft instead of by the current method of after-the-fact generation at ground processing facilities.

BASIS OF FY 1981 ESTIMATE:

In FY 1981, in the area of advanced sensors and instrumentation systems, linear and area array focal-plane systems will be developed covering the spectral range from 1 to 120 μ-meters. Laser ranging systems, laser heterodyne receivers, and active laser ultraviolet and visible lidars will be developed for crustal motion

measurements and detection of atmospheric constituents and pollutants. Millimeter-wave, submillimeter-wave, and synthetic aperture radar systems will be developed for investigating oceanographic, stratospheric, and terrestrial properties of the Earth and other planets. The Annular Suspension and Pointing System (ASPS) will be tested to demonstrate pointing accuracy of 0.01 arc seconds. Laboratory prototypes for a 5-Watt, long-life ($\sim$ 1 year) mechanical cooler will be demonstrated.

Data systems concepts will be modeled and evaluated to provide improved end-to-end data systems efficiency and effectiveness. During FY 1981 a distributed microprocessor based data system will be fabricated and tested. An advanced onboard data processor concept will be evaluated to provide real-time multispectral data classification. High speed data transfer technology is focused on providing the technology and techniques to enable high rate transfer and distribution of data from future NASA missions. During FY 1981, an x-band transponder will be developed to meet the communications requirements of the International Solar Polar spacecraft. In the NEEDS program during FY 1981, a prototype optical archival mass memory system with storage capacity of 10^{13} bits will be fabricated and tested. The design and fabrication of a data base management system will be completed in FY 1981.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Spacecraft Systems Research and Technology.....	5,495	7,250	7,250	8,700

OBJECTIVES AND STATUS:

The objective of this program is to develop and demonstrate system-level technologies required by spacecraft for current and future space missions. The program extends the accomplishments of the research and technology programs in the fundamental discipline areas to integrated activities such that the transfer of a complete capability is possible; research and technology activities are conducted in areas where a multidisciplinary approach is essential to objective accomplishment. These activities share the common goal of eventual transfer and use of the technology in NASA developed spacecraft. This requires establishment of technical feasibility and acceptable levels of risk and cost.

The Large Space Systems Technology program is the principal element in the Spacecraft Systems Research and Technology area. The program has three major parts. The antenna activity has the objective of developing the technology for low-mass structures which deploy into 300-meter shaped surfaces. The design of two concepts will be completed in FY 1980 and the fabrication of critical test components initiated. Several surface control concepts are being studied and test hardware is being fabricated. The platform activity seeks to develop the fundamental data and analysis techniques required for large space systems. The design

of critical deployable platform elements will be completed and the fabrication of test articles is being initiated; the detailed design of a platform assembly device will be completed, and assembly scenarios for large platforms are under development. Support activities include: the development of an interactive analysis and design capability which permits structures, control, and thermal disciplines to be considered simultaneously; the activities necessary to develop and test concepts for the control of the position, attitude, and shape of the antenna and platform; and the provision and test of materials for both the antenna and platform concepts.

The space-storable, fluorine-hydrazine propulsion system is under development to provide the long-life, high performance system required by planned planetary missions. Technology readiness will be demonstrated by a system-level space simulated test in 1982.

Ground tests of the 8-cm ion auxiliary propulsion system hardware (to be flown on a USAF free-flying spacecraft) are being conducted to establish operating limitations, develop the flight operation test plan and provide a data base for analysis of the flight data.

The concept of utility-type distribution and management of electrical and thermal energy is being studied at an integrated system level. The effort builds on the discipline research and technology activities in power generation and storage and will seek to develop a system in the 100-kW region.

BASIS OF FY 1981 ESTIMATE:

In the large space systems technology program, deployment and shape control tests will be conducted on selected antenna designs using subscale models and large scale critical components. These tests will provide data on the ultimate performance of the full-scale systems. In the platform area, tests of critical deployable platform components will be conducted and the fabrication of full-scale deployable modules will be initiated. These modules will be used for subsequent system tests. A model of a platform assembly device will be fabricated and a test program conducted. In the support areas, attitude- and shape-control concepts will be defined and the development of simulation models will be initiated. In the material support area, vacuum and thermal cycling tests of candidate composite materials will be conducted.

For the fluorine-hydrazine propulsion system, the thrust chamber and subsystem components to be used for the system level test in 1982 will be delivered. Assembly of the test hardware will be initiated.

The flight operation test scenarios for the launch of the ion auxiliary propulsion system will be completed.

The utility distribution and management program plan will be developed. Emphasis will be on integrating the results of the discipline research and technology programs into a system-level capability. The results of the FY 1980 thermal management study will be used to define subsequent research.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Transportation Systems Research and Technology.....	7,074	9,750	10,235	8,200

OBJECTIVES AND STATUS:

The objectives of this program are: to provide the data base required for design and development of advanced aerospace vehicles; to provide the technology necessary for selected improvements in the current Space Transportation System (STS); and to support as required the on-going development of the STS. These objectives are accomplished through testing in ground-based facilities and through in-flight research and technology demonstration using the current Orbiter as an entry research vehicle.

During FY 1980, aerodynamic tests in ground-based facilities in support of the baseline STS will be completed and tests of modified configurations are being initiated. These include an STS augmented with solid strap-on motors and configuration changes necessitated by the addition of instrumentation developed by this program.

In FY 1980, final preparations will be completed for the first in-flight research using the Orbiter vehicle. This includes the completion of the instrument development effort and the integration of the instruments into Orbiter 102. A flight data bank is being established so that the data acquired during the early Shuttle flights will be available for future research and technology efforts. Data from both the standard and special instrumentation will be included. Instrumentation developed in this program will be carried on all the early Shuttle missions.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase of $485 thousand reflects a realignment of effort and associated funding from the Spacecraft Systems Technology program element. This action followed an extensive review of the program plans involving the use of the Shuttle and Spacelab for technology experiments to determine how to most efficiently use a lower level of funding. It was decided that it would be most appropriate to accelerate experiments which will provide technological information concerning the operations of the Space Transportation System.

BASIS OF FY 1981 ESTIMATE:

During FY 1981, ground facilities will be used to conduct aerodynamic tests of modifications to the basic Orbiter configuration. Included are changes which increase the performance or capabilities of the current STS, and changes necessary to accommodate instrumentation developed in this program. In addition, tests to

investigate specific areas in support of the first Orbiter flights will be conducted. Such tests will investigate specific problems, increase operating margins, and explore new operation scenarios.

Three instrumentation package experiments will provide the basic aerodynamic data necessary for the Orbiter to be used as a research vehicle. The aerodynamic coefficient package, which was integrated into Orbiter 102 for OFT-1, will provide data during early Orbiter flights. Both the low and high altitude research air data systems will undergo final system tests and be delivered for integration into Orbiter 102. The first flight of these packages will occur in late FY 1982.

Two instrumentation package experiments will examine aerodynamic heating uncertainties and thus the requirements of the thermal protection system and operating limitations. The windward instrumentation package which is mounted in the C-141 Kuiper Aircraft Laboratory will be used during early Orbiter flights. The leeside instrumentation package will undergo final system tests and will then be integrated into the tail pod on Orbiter 102. The first flight will occur in late 1982.

Two experiments to examine the characteristics of the current thermal protection system will be conducted on OFT-2 and will be used to obtain additional data on subsequent early Orbiter flights. The experiments will be serviced between flights and the data will be analyzed.

The first instrumentation package to measure the dynamic, acoustic, and thermal environment in the Orbiter cargo bay will be delivered for integration. Flight of this first in a series of phase 1 packages will occur on an early OFT flight. The second phase 1 package will be in fabrication and test in preparation for a FY 1982 delivery.

Additional research areas identified as candidate orbiter experiments in FY 1980 will be investigated in FY 1981. This will include technical justification and definition of the experiments as well as feasibility studies to determine the compatibility of the instrumentation packages with the Orbiter.

All the data obtained by the basic Orbiter flight instrumentation, the OFT development flight instrumentation, and the special instrumentation developed in this program will continue to be cataloged and filed for research purposes. This data base will be used to support research activities which deal with generic vehicle technology or specific STS problems.

BASIS OF FUND REQUIREMENTS:

SYSTEMS TECHNOLOGY PROGRAMS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
		(Dollars in Thousands)			
Space system studies	2,000	2,200	2,200	2,200	RD 10-17
Information systems technology	---	2,600	2,600	5,100	RD 10-18
Spacecraft systems technology	10,023	9,300	6,215	2,400	RD 10-19
Total	12,023	14,100	11,015	9,700	
Space System Studies	2,000	2,200	2,200	2,200	

OBJECTIVES AND STATUS:

The objectives of Space Systems Studies are to identify and evaluate the technology requirements of advanced system candidates; to investigate future space mission alternatives; to assess the effects of technology advances; and to provide a data base to support technology program selection and program planning. Studies will continue to examine the development of future program technology needs, to determine the subsequent detailed technology requirements, and to consider alternative solutions for satisfying needs and requirements.

During FY 1980, studies were redirected towards the identification of needs and opportunities for planning the technology programs of spacecraft, information, and transportation systems and for generating an expanded and validated Space Systems Technology Model.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 efforts will continue to study the technology for spacecraft, information, and transportation systems. Analyses will be conducted to catalogue and rank available, planned, and forecast technology from sources within and outside NASA. Continuing studies will rank technology options and develop strategies for the attainment of long-range goals through application to near-term missions. Special study emphasis will be given to key technology issues, such as automation, large space structures, spacecraft support services, reusable propulsion, end-to-end data management, and large power sources.

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The Space Systems Technology Model will also continue to provide the basis for the forecast of mission requirements and of capabilities in technology disciplines.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Information Systems Technology.....	---	2,600	2,600	5,100

OBJECTIVES AND STATUS:

The objective of this effort is to integrate advanced electronic devices or system concepts developed in the Research and Technology Base with supporting technology to demonstrate and validate improved performance, increased reliability and reduced costs of space information systems.

In FY 1980, the Satellite Communications Technology program was initiated. The purpose of this activity is to provide, through research, design and experimental tests, the components and enabling technology needed to open new frequency bands and to support NASA satellite communications systems developments. Current focus is on the critical components, techniques, and subsystems which are required for the complete communications system, such as high power, efficient transmitters, beam-shaping antennas, frequency reuse conservation techniques, multiple spot beams, on-board message switching, high frequency devices at low cost, bandwidth-compression conservation techniques, low cost Earth terminals and intersatellite links. In FY 1980, work began on the basic research, advanced development, technology investigations, analyses, and experiments in high risk critical technology areas to determine viable concepts and approaches.

BASIS OF FY 1981 ESTIMATES:

Research and technology effort in the Satellite Communications Technology program will continue on solid state power amplifiers suitable for single or multidevice power amplifier circuits; advanced transponder concepts which incorporate multiplexers, filters, driver amplifiers, modulators, and demodulators; new tube amplifier fast wave devices for shorter wavelength and higher power applications; and new power processor devices for efficient energy transfer.

In FY 1981, system parameters will be established, and design specifications for the critical, high risk components, techniques and subsystems needed for satellite communications and distribution technologies for future NASA missions in the 1987-2000 timeframe will be developed. During FY 1981, work on multibeam antenna feeds and on-board switching systems will be initiated. Fabrication and tests will be completed on an experimental 20 gigahertz (GH_z) traveling wave tube. Work will begin on power-combining techniques and the fabrication and test of matrix switches.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Spacecraft Systems Technology	10,023	9,300	6,215	2,400
Space Transportation System Operations	(---)	(4,800)	(3,500)	(8,900)

OBJECTIVES AND STATUS:

The objective of this effort is to provide the capability to extend research and technology programs into the environment of space using the Space Shuttle, the Spacelab, and free-flying vehicles. Research and technology programs are so extended when the unique space environment is essential to the progress of the effort, when an in-space test is cost-effective, or when an in-space verification will accelerate the utilization of advanced technology. This effort provides an effective means to demonstrate technology readiness so that the advanced technology capability can be used for important space missions at an acceptable cost and risk.

The activity includes the development, integration, and flight operations of experiments to be conducted in the Spacelab, the development of the Long Duration Exposure Facility (LDEF), the development and integration of experiments for the first LDEF mission, and completion of a flight of an ion auxiliary propulsion system on a free-flying Air Force satellite.

The Spacelab experiments remaining in the program are assigned to early Spacelab missions. They are all being completed on schedules compatible with the integration requirements of their assigned missions.

The LDEF is complete and in storage. The experiments are in various stages of development, and fabrication, and some experiments have been placed in storage. Integration of the experiments with LDEF and the LDEF with the Shuttle are continuing.

The 8-cm ion auxiliary engine flight demonstration on the USAF P80-1 spacecraft will provide the in-space demonstration of technology readiness.

CHANGES FROM FY 1980 ESTIMATE:

The decrease of $3,085 thousand reflects three unrelated changes. The first was a reallocation of $485 thousand to the Transportation Systems Research and Technology program. This action followed an extensive review of the program plans involving the use of the Shuttle and Spacelab for technology experiments to determine how to most efficiently use a lower level of funding. It was decided to accelerate experiments which will provide technological information concerning the operations of the Space Transportation System. The second change reflects a portion of the Congressional appropriation reduction from the NASA Research and

Development request. The third change provided an additional $2 million to the Standard and Practices line item for a necessary study of the Shuttle verification/validation program. The budgetary impact on this program is minimal due to the slippage of the Shuttle launch schedule.

BASIS OF FY 1981 ESTIMATE:

In FY 1981, the Spacelab experiments assigned to missions will all be completed and, in most cases, delivered to integration sites. These experiments will either be integrated into flight packages or placed into storage to await future integration and flight.

Development will continue on unfinished LDEF experiments and, by the end of FY 1981, nearly all experiment development will be completed. In anticipation of the 1982 launch date, the LDEF will be removed from storage and prepared for shipping. Experiments will be retested and further prepared for integration; flight batteries and other life-limited components will be procured.

Flight hardware for the experimental test of the 8-cm ion engine auxiliary propulsion system will be delivered to the U.S. Air Force in FY 1980 in preparation for integration with the USAF P80-1 spacecraft.

BASIS OF FY 1981 FUNDING REQUIREMENTS:

STANDARDS AND PRACTICES

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Standards and practices.....	9,000	3,000	5,000	2,100

OBJECTIVES AND STATUS:

The objectives of this activity are to improve overall NASA program practices, serve as a technical review resource within the Agency and reduce the costs of NASA projects by encouraging the use of space-qualified equipment on multiple missions. Those objectives are accomplished through independent reviews of NASA programs, support to design effort, participation in flight readiness reviews, setting up of special task activities when critical problems occur, and by participation in interagency activities to insure adequate communications on special activities or problem areas.

All standard equipment developed under the Standards and Practices program will be completed in FY 1980. Eighteen regular standard equipment items have been qualified for use by NASA programs, six are in process of

qualification, and a commercial source is being solicited for one propulsion item. Four ground support equipment items are in the inventory for use by NASA programs, two other items have been fabricated, and one is currently being fabricated.

A review of the standard equipment program determined that the cost savings were marginal because of a considerably lower rate of utilization of the equipment and more rapid changes in technology than originally planned. As a result, it was decided to phase out the standard equipment development program.

However, to insure that maximum advantage is taken of the presently flight-qualified equipment and of other hardware that is available within NASA and throughout the aerospace industry, a computer-based data bank is being developed which will list standard and available flight-qualified equipment. A pilot program is being conducted in FY 1980 to encourage users to consider these items before beginning independent designs.

Within the program practices activities, audit results of reliability, quality assurance, standard components, safety and environmental health programs are being compiled. This will establish a store of information on trends which indicate undesirable practices and which will provide guidelines for improving program and project management. These efforts will continue to enable the office to monitor the technical and programmatic execution of NASA programs and to take early corrective actions when indicated.

A recent special assignment, being directed by the Chief Engineer, is an independent review by a senior technical group from outside the Shuttle program of the flight readiness certification program for the first Space Transportation System flight (STS-1).

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase in funding for FY 1980 will provide the additional resources needed to conduct the independent review and assessment of the adequacy of the first Space Transportation System flight (STS-1) Verification/Certification Program.

This assessment has been divided into 13 main areas:

- o Propulsion
- o Integrated Vehicle Loads
- o Orbiter Loads
- o Aero and Thermal Analysis
- o Thermal Protection Systems
- o Flight Control Hydraulics System and Associated Electronics
- o Launch and Ascent Guidance, Navigation and Control

- o Entry and Landing Guidance, Navigation and Control
- o Landing/Deceleration System and Miscellaneous Critical Mechanisms
- o Environmental Control and Life Support System (ECLSS) and Crew Equipment
- o Separation Systems
- o Electrical Power Distribution and Control (EPD&C)
- o Ground Systems

A "cognizant engineer" has been assigned responsibility for each of the areas. Support will be provided by technical experts from within and outside NASA, and through contracts with organizations familiar with the technical areas under review. A preliminary analysis of the adequacy of the Verification/Certification Program for STS-1 is expected to be completed in mid-1980. Reviews of specific areas of concern will then be keyed to the Shuttle launch schedule.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 program shifts emphasis from development of standard equipment to encouraging greater utilization of already flight-qualified equipment. Continued efforts to improve program practices throughout the Agency and increased emphasis on efforts to evaluate and predict product quality, reliability and performance in expected radiation environments and mission life of spacecraft components and systems are also included.

In addition, systems level hardware and software product assurance reviews and analyses are added due to the increasing complexity of spacecraft components and systems. Similarly selected pilot demonstration efforts will be undertaken to build confidence in special systems configurations, such as very large-scale integrated circuits which present unique problems associated with testing and qualification for space use.

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

ENERGY TECHNOLOGY

SUMMARY OF RESOURCES REQUIREMENTS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Energy technology	5,000	3,000	3,000	4,000
Distribution of Program Amount by Installation:				
Johnson Space Center	650	---	---	150
Marshall Space Flight Center	1,205	850	1,000	1,250
Jet Propulsion Laboratory	1,160	1,050	1,000	1,750
Lewis Research Center	1,265	1,100	978	700
Headquarters	720	---	22	150
Total	5,000	3,000	3,000	4,000

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

ENERGY TECHNOLOGY

PROGRAM OBJECTIVES AND JUSTIFICATION:

The objective of this program is to relate NASA's aeronautical and space technologies, engineering, scientific, and managerial expertise, and existing facilities capabilities to the research and development needs of the Department of Energy and other agencies. These activities contribute to the search for solutions to energy-related problems on Earth. The Energy Technology activity accomplishes the program objective through investigations of the potential application of NASA capabilities to energy-related problems. When these capabilities are shown to be sufficiently mature, plans are developed for reimbursable support from the appropriate agency. This process assures the development of plans that are not only technically sound, but which are properly related to the program needs of the user agency. The success of this approach is supported by the fact that in FY 1980, NASA's energy-related reimbursable work for the Department of Energy and other agencies is expected to total approximately $300 million, an increase of about thirty percent over FY 1979.

As a result of the independence attained through direct funding, NASA is now a major contributor in Wind Energy, Photovoltaic Energy Conversion, Solar Heating and Cooling, Advanced Ground Propulsion Systems, and Energy Storage. Significant progress has also been made toward defining the major technology problems bearing on the feasibility of using a Satellite Power System to convert sunlight to electric power for transmission to the Earth for utilization.

BASIS OF FY 1981 ESTIMATE:

During FY 1981, NASA will continue to focus on areas where NASA-developed expertise could be utilized. This will include investigations in: evaluation of Stirling engine concepts for power generation; new concepts for advancing coal conversion technology; opportunities for industrial energy conservation; small dispersed solar systems applications; the exploration of bio-energy as a promising source of nonfossil fuel energy; and an examination of the future technology needs of electric utility systems.

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE TRACKING AND DATA SYSTEMS

TRACKING AND DATA ACQUISITION PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
		(Thousands of Dollars)			
Operations	249,903	275,800	264,500	271,500	RD 12-3
Systems implementation	40,497	46,400	57,300	76,200	RD 12-12
Advanced systems	9,500	10,600	10,600	11,300	RD 12-21
Total	299,900	332,800	332,400	359,000	
Distribution of Program Amounts by Installation:					
Goddard Space Flight Center	216,557	238,200	234,000	249,700	
Jet Propulsion Laboratory	59,021	68,800	69,800	74,400	
Wallops Flight Center	5,800	6,300	6,500	9,800	
Dryden Flight Research Center	3,150	3,000	3,300	3,600	
Headquarters	15,372	16,500	18,800	21,500	
Total	299,900	332,800	332,400	359,000	

OFFICE OF SPACE TRACKING AND DATA SYSTEMS

TRACKING AND DATA ACQUISITION PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The purpose of this program is to provide vital tracking and data acquisition support to meet the requirements of all NASA flight projects. In addition to NASA flight projects, support is provided, as mutually agreed, for projects of the Department of Defense, other Government agencies, commercial firms, and other countries and international organizations engaged in space research endeavors.

Support is provided for: sounding rockets, research aircraft, earth orbital and suborbital missions, for planetary spacecraft, and for deep space probes. It also includes the support of all phases of the Space Shuttle flight program, from the completed Approach and Landing Tests to the upcoming Orbital Flight Tests, and the Space Transportation System operational flights.

The various types of support provided include: (a) tracking to determine the position and trajectory of vehicles in space; (b) acquisition of scientific and earth applications data from onboard experiments and sensors; (c) acquisition of engineering data on the performance of spacecraft and launch vehicle systems; (d) transmission of commands from ground stations to spacecraft; (e) communication with astronauts and acquisition of biomedical data on their physical condition; (f) communication of information between the various ground facilities and central control centers; and (g) processing of data acquired from the launch vehicles and spacecraft. Such support is essential for achieving the scientific objectives of all flight missions, for executing the critical decisions which must be made to assure the success of these flight missions, and, in the case of Shuttle missions, to insure the safety of the crew.

Tracking and acquisition of data from the space flight projects is accomplished by the use of a worldwide network of NASA ground stations. These facilities are interconnected by ground communications lines, undersea cables, and communications satellite circuits which are leased from communications carriers, both domestic and foreign. This interconnection provides the communications capability needed between spacecraft and the control centers from which the flights are directed.

To meet the support requirements levied by the wide variety and large number of flight projects, NASA has established two types of facilities to meet the needs of the two classes of NASA flight missions. These are the Spaceflight Tracking and Data Network (STDN), which supports earth orbital missions and the Deep Space Network (DSN), which supports planetary and interplanetary flight missions.

Computation facilities are maintained to provide real-time information for mission control and to process into meaningful form the large amounts of scientific, applications, and engineering data which are collected from flight projects. In addition, instrumentation facilities are provided for support of sounding rocket launchings and flight testing of aeronautical research aircraft.

In future years the operation of the Tracking and Data Relay Satellite System (TDRSS) will be an important aspect of the NASA space program. This system will support all earth orbital spacecraft missions and will greatly improve NASA's earth orbital tracking and data acquisition capabilities. NASA will obtain use of this system through an arrangement under which the contractor will establish the system and provide NASA with TDRSS services beginning in FY 1982.

With the advent of TDRSS services several of the STDN tracking stations will be closed in 1982. Planning is also underway to consolidate the remaining core STDN stations with those of the DSN under the management of the Jet Propulsion Laboratory. The consolidation is keyed to providing a single network in the mid-1980's to support synchronous, highly elliptical, and planetary missions while reducing operations and maintenance costs.

The Research and Development appropriation provides funds for: (a) the operation and maintenance of the worldwide facilities; (b) the engineering and procurement of equipment to sustain and modify the network systems to support continuing, new, and changing flight project requirements; and (c) the development of advanced tracking and data acquisition systems and the investigation of advanced tracking and data acquisition techniques.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The current estimate for FY 1980 is $400 thousand below the budget estimate. This reduction results from the Congressional general reduction in the FY 1980 NASA Research and Development appropriation request. The current estimates reflect adjustments between the operations and the systems implementation categories to consolidate funding for the more significant capabilities being implemented in the Space Tracking and Data Systems program. Explanations of these funding changes are provided under each individual program involved.

BASIS OF FUND REQUIREMENTS:

OPERATIONS

The FY 1981 funding requirements include a continuing support workload for an average of approximately 50 automated earth-orbiting and planetary missions. The operations funding also provides for the prelaunch support activity required for upcoming approved missions and for support to the Space Shuttle flights. The

increase in the FY 1981 funding request for Operations is due to two factors: (a) continuing cost escalation in all areas of Operations; and (2) support of the upcoming Shuttle Orbital Flight Test requiring additional wideband communications circuits to transmit the high volume of data between the Shuttle and the ground control facilities.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
		(Thousands of Dollars)			
Spaceflight tracking and data network	127,068	141,200	136,400	134,200	RD 12-4
Deep space network	51,032	55,600	49,500	54,500	RD 12-6
Aeronautics and sounding rocket support	4,516	4,800	5,300	5,500	RD 12-8
Communications	34,027	39,800	37,700	39,300	RD 12-9
Data processing	33,260	34,400	35,600	38,000	RD 12-10
Total	249,903	275,800	264,500	271,500	
Spaceflight Tracking and Data Network Operations	127,068	141,200	136,400	134,200	

OBJECTIVES AND STATUS:

The primary function of the Spaceflight Tracking and Data Network (STDN) is to support all NASA Earth orbital spaceflight missions, including the Space Shuttle. The majority of these missions have near-Earth orbits; however, the network also supports selected missions through lunar distances and beyond, such as the International Sun-Earth Explorer missions. In addition, the network provides launch support to NASA's automated planetary missions, as well as spaceflight missions of other nations, commercial firms, the Department of Defense, and other United States Government agencies. Accordingly, the network must be responsive to the requirements of a large number and wide variety of flight projects from launch through completion of the flight project objectives. In many instances, the period of network support required by flight projects continues for several years.

The STDN presently consists of 14 geographically dispered ground stations, 13 of which are located at remote sites and one at the Goddard Space Flight Center (GSFC), Greenbelt, Maryland. A network control center and mission control center complex are also located at the GSFC which has the field center management responsibility for the network.

These global facilities have the capability to electronically track the spacecraft, send commands for spacecraft and experiment control purposes, receive engineering and scientific data from the spacecraft, and in the case of manned flights, maintain voice communications for crew safety and other project related purposes. To meet the extremely precise tracking needs of NASA's Earth and Ocean Dynamics Programs, the network is supplemented by laser tracking systems capable of providing high precision ranging.

In addition to the operational facility at the GSFC, the 13 land stations are located at Fairbanks, Alaska; Goldstone, California; Merritt Island, Florida; Kauai, Hawaii; Rosman, North Carolina; Guam; Ascension Island; Canberra, Australia; Bermuda; Santiago, Chile; Quito, Equador; Winkfield, England; and Madrid, Spain. A transportable station is located at NASA's Dryden Flight Research Center, California, for support of the Shuttle program. Smaller transportable stations will be located at New Smyrna Beach, Florida, and Tula Peak, New Mexico, for support of the early Shuttle missions. An engineering test and network system training facility at the GSFC is also maintained and operated as part of the STDN.

The STDN is currently providing support for an average of nearly 50 automated applications and space science spacecraft. Examples of significant missions being supported include the Landsat-2, and -3. three Applications Technology Satellites (ATS-1, -3 and -5); the Heat Capacity Mapping Mission; the Orbiting Astronomical Satellite-3; two High Energy Astronomy Observatories (HEAO-2 and -3); Atmosphere Explorer (AE-5); Nimbus-5, -6, and -7; the Magnetic Field Satellite (MAGSAT); the International Sun-Earth Explorers (ISEE-1, -2, and -3); and the International Ultraviolet Explorer.

Upcoming missions to be supported by the network include the Solar Maximum Mission, the Space Telescope, the Dynamics Explorer mission, the Gamma Ray Observatory, and the Space Shuttle Orbital Flight Tests. The overall spacecraft support workload of the STDN is projected to average approximately 40 spacecraft during 1981.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The decrease of $4.8 million is a net reduction resulting primarily from the delay in the Shuttle orbital flight test schedule and the termination of ATS-6 support.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 funding requirements for the STDN operations provide for the maintenance and operation of the network and control center facilities, as well as the related logistics, network planning, scheduling, documentation, and computer programming costs associated with the around-the-clock operation of the network. The projected decrease from FY 1980 to FY 1981 is largely due to the planned phase down of very high frequency capabilities throughout the network and the transfer of budget responsibility for the laser and Smithsonian Astrophysical Observatory to the Office of Space and Terrestrial Applications.

The FY 1981 request includes funds for support of the Shuttle Orbital Flight Tests. Funds are also included in the request to provide a ground backup recording capability for Landsat-3 support in the event of failure of the on-board tape records. This capability will insure a continued flow of Landsat-3 data until Landsat-D can be launched.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Deep Space Network Operations.....	51,032	55,600	49,500	54,500

OBJECTIVES AND STATUS:

The primary function of the Deep Space Network (DSN) is to support planetary and interplanetary spaceflight missions. The DSN provides the vital two-way communication link by which the distant spacecraft are controlled and scientific data are acquired. As the planetary missions become more complex and flight distances continue to increase, this network requires systems, software, and operational techniques that push the state-of-the-art in telecommunications.

The DSN stations are located at Goldstone, California; Canberra, Australia; and Madrid, Spain. The stations consist of one 64-meter and two 26-meter diameter antennas at each location, except at Goldstone where one of the 26-meter antennas has been expanded to 34 meters. Similar modifications are currently underway to provide the same configuration at the two overseas locations in 1980. The three locations are approximately 120 degrees apart in longitude and permit continuous viewing of the planetary spacecraft. A centralized control center for the network is located at the Jet Propulsion Laboratory (JPL) in Pasadena, California. The JPL has field management responsibility for the network.

The current workload in the DSN consists of the seven on-going Pioneer spacecraft (Pioneer 6-11 and Pioneer-Venus), two Viking spacecraft (one orbiter and one lander), the two Helios missions, and the two Voyager spacecraft. Support of these missions will continue during FY 1981, except for the Viking orbiter.

The Pioneer 11 mission provided an excellent test of the DSN capabilities when the network successfully supported the Saturn Encounter navigation of the spacecraft outside and through the ring-plane and utilizing an arrayed antenna technique to provide increased sensitivity and good quality data for our first close view of Saturn and several of its moons.

Of the older Pioneer spacecraft, Pioneer 10 is over 2.9 billion kilometers from Earth and is proceeding on a path that will take it beyond the solar system. Pioneer 10 continues to be the most distant human made object communicated with and each time data is received, a new communications record is established.

The Pioneer 11 spacecraft, some 1.5 billion kilometers from Earth, is being tracked as it proceeds on a path taking it out of the solar system. The Pioneer 6-9 spacecraft are provided support during solar conjunctions. The two Helios missions are continuing their orbit about the Sun as they gather data on the solar plasma. The two Viking spacecraft continue to gather science data from Mars.

To take advantage of a rare alignment of the outer planets Jupiter, Saturn, and Uranus, Voyagers 1 and 2 were launched in 1977. Preparations are underway in the DSN to provide coverage of the Voyagers' encounters with Saturn in November 1980, and August 1981. As is typical of planetary missions, the two Voyager spacecraft will require support for several years during their flight to Saturn and Uranus.

The DSN facilities are also used on a noninterference basis for ground-based measurements in support of experiments in planetary radar mapping and in the field of radio astronomy. The ultrasensitive network antennas are being used in an attempt to learn more about the mysterious pulsar high energy sources, quasars, black holes, and other interstellar phenomena.

In addition to the Voyager missions, the upcoming DSN workload also includes preparation for support of the International Solar Polar and Galileo missions. These support preparations require thorough and complex testing, training, engineering and software effort, and compound the difficulty of overall support planning and execution since such preparations must be carried out at the same time that the network is supporting the extensive and continuous on-going workload described above.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The net decrease of $6.1 million is due to the transfer of funding for Jet Propulsion Laboratory engineering effort associated with specific projects from the operations budget to the systems implementation budget. This transfer provides for improved management visibility by budgeting for specific projects in one program area. A portion of the transfer for engineering effort was offset by increased cost escalation, particularly for operations at the Madrid station.

BASIS OF FY 1981 ESTIMATE:

The DSN operations funds provide for the maintenance and operations of the network facilities, control center, and the support and engineering effort associated with the operation of the network. The funds requested for FY 1981 are based upon the on-going workload, including the Voyager missions, the Pioneer 6-11 missions, the Pioneer-Venus extended mission, and the Viking Lander extended mission.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Aeronautics and Sounding Rocket Support Operations.....	4,516	4,800	5,300	5,500

OBJECTIVES AND STATUS:

Instrumentation systems are maintained and operated for the sounding rocket, balloon, small satellite, and aeronautical programs conducted by the Wallops Flight Center (WFC) and the aeronautical flight research programs of the Dryden Flight Research Center (DFRC). These instrumentation systems include general purpose tracking, telemetry, data handling, and communications systems, as well as special purpose optical equipment.

The Sounding Rocket Program continues to be very active, with over 300 launches last year, ranging from the smaller meteorological rockets to the larger Scout rockets. The majority of these sounding rocket launches are conducted at the WFC. This workload is expected to remain at approximately the same level in FY 1981. In addition to the continuing sounding rocket, balloon, and aeronautical program activities, the WFC will provide specialized tracking, evaluation, and calibration services for the launch phases of the Shuttle orbital flight tests.

The Dryden Flight Research Center (DFRC) operates the Aerodynamics Test Range facilities. These facilities are composed of precision radar tracking, telemetry, and communications equipment, which are used to monitor and control high performance aircraft research and development programs of both NASA and the Air Force. Various aircraft research and technology projects are supported by the Aerodynamics Test Range. Aircraft flown in these flights include the F-111, F-104, F-15, F-8, F-14, and remotely piloted vehicles, including Highly Maneuverable Aircraft Technology (HiMAT). Tracking and data acquisition support of the Shuttle orbital flight tests is planned at the DFRC for FY 1980 and 1981.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase of $500 thousand in the FY 1980 level provides for operational communications in support of the tilt rotor program and Shuttle at the Dryden Flight Research Center and to provide rehabilitation of heavy mechanical subsystems for the radar and antenna pedestals at Wallops Flight Center.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 funding requirements support the sounding rocket launches and the Aerodynamics Test Range activities. The request also includes funding to support the initial Shuttle orbital flight test landings at the Dryden Flight Research Center.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Communications Operations	34,027	39,800	37,700	39,300

OBJECTIVES AND STATUS:

NASA's global communications network (NASCOM) interconnects by means of leased voice and data circuits the tracking and data acquisition facilities which support all flight projects. NASCOM also links together such facilities as launch areas, test sites, and mission control centers. The Goddard Space Flight Center operates the NASCOM and serves as its major switching control point. In the interest of economy, reliability, and full utilization of trunk circuitry, subswitching centers have been established at key domestic and overseas locations.

To an increasing extent, the NASA flight projects are requiring the transfer of vast amounts of data between the mission control centers and the tracking sites because of the increased need for real time control of the spacecraft and on-board experiments. In addition, there is a requirement to provide increasing amounts of experiment data more quickly to the users for analysis.

In order to meet high data transfer rate requirements, NASA is increasing its utilization of digital techniques in providing communications support. The availability of this technology allows for a greater amount of data to be sent over conventional communication circuits. Also, circuits capable of transferring data at increasingly higher rates are becoming available from the common carriers at reasonable costs. Consequently, the techniques of sending data directly from a spacecraft, through a tracking station without manipulation, to a mission or project control center has become economically attractive. This approach, referred to in the communications field as a "bent pipe" mode, simplifies the data handling systems at the tracking stations, thereby minimizing the operation and maintenance activities at those locations. As a result, the trend toward the direct transfer of data from the spacecraft to the control center via high data rate communications links is expected to continue.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The decrease of $2.1 million in the FY 1980 funding level resulted from two factors: (1) the delay in the Shuttle orbital flight test schedule which, in turn, allowed for a delay in ordering up the wideband and video communications circuits required for Shuttle support; and (2) lower than originally estimated prices for some overseas wideband circuits.

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BASIS OF FY 1981 ESTIMATE:

The FY 1981 funding requirements for communications operations will provide for the circuits and services required to operate and maintain the NASCOM. International communications satellites will permit the extension of additional digital wideband services to all overseas tracking stations. These services will provide for the near real-time transfer of data for all on-going flight programs.

The major reason for the increased requirements in FY 1981 is due to the support requirements for the Shuttle flights. This project requires a full year of wideband communications circuits throughout virtually the entire network of stations. Wideband service will also be initiated to support the Tracking and Data Relay Satellite System (TDRSS) facility testing phase.

The operation of the switching centers and technical control facilities is a continuing function assuring high reliability and efficiency in the use of the various types of communications services available to NASCOM from the common carriers.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Data Processing Operations.....	33,260	34,400	35,600	38,000

OBJECTIVES AND STATUS:

Information received in the form of tracking and telemetry data from the various spacecraft must be processed into a useable form before transfer to control centers and experimenters. This transformation and computation process is performed as part of the data processing function and applies to a wide variety of programs, ranging from the small Explorer satellites to large and complex Solar/Astronomical Observatories and the Landsat satellites.

Tracking data are processed to provide orbital information which is used to compute spacecraft position. This is essential for the real-time control of spacecraft, for determining when the spacecraft will be passing over the stations so data can be acquired, and for providing precise information that can be used by the scientific experimenters to determine where in the trajectory of the spacecraft the scientific measurements were made. Telemetry data must be processed to: (a) separate the information obtained from various scientific experiments aboard the spacecraft; (b) consolidate information from each experiment; (c) determine spacecraft attitude; and (d) correlate these measurements with the position data. Processed data are the primary product of the spacecraft missions and it is through reductions and analyses of these data by the experimenters that the planned objectives are achieved.

In addition to the actual processing of the data, upcoming projects require extensive prelaunch orbit analysis including spacecraft position and attitude predictions. Analyses are also required to develop operational sequences and procedures to be used during the actual operation of these complex spacecraft.

In addition to the tracking and positional data processing described above, there is also a great deal of data processing required on the information received from the on-board experiments. Two facilities, the Image Data Processing Facility (IDPF) and the Telemetry On-Line Processing System (TELOPS) have been established at the Goddard Space Flight Center to process different types of experimental data.

The IDPF, initially established to handle imagery data of the Earth Resources Technology satellite (Landsat-1), now supports the second and third Landsat spacecraft. These spacecraft are supported with a new all-digital system using computer compatible tapes which, when completely operational, will reduce the time required to provide data to users. The operational requirement for this facility is expected to continue through the next several years for support of the currently operational and/or approved programs, including Nimbus 7, Synchronous Meteorological satellites, Heat Capacity Mapping Mission, and the upcoming Solar Maximum Mission.

The Telemetry Processing Facility which handles the conventional, nonimagery data was reconfigured in FY 1978 as the Telemetry On-Line Processing System. This reconfiguration resulted in a change from a tape-oriented system to an automated on-line electronic mass storage system. TELOPS receives satellite data in digital form from the tracking stations via NASCOM communication lines and is able to store up to six months of telemetry data on-line, thus, eliminating most of the tape and tape handling operations within the old processing facility.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase of $1.2 million in the FY 1980 funding level resulted from greater that expected costs associated with bringing the new all-digital IDPF into full operation and the implementation of a domsat terminal for rapid handling of Landsat data.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 budget requirements include funds to operate the IDPF and the TELOPS to process data from currently orbiting satellites, as well as data from the satellites scheduled to be launched during the period. The scientific requirements for the acquisition and processing of data from the older satellites are under continuing review and support for older missions is terminated or curtailed as mission objectives are achieved or when the experiment data is no longer useful or cost effective to acquire and process.

Software procurement activities have been initiated for support of upcoming space science and applications spacecraft such as the Space Telescope and Dynamics Explorer, as well as Spacelab. The activities cover spacecraft orbit and attitude control and related data processing requirements which require additional funding for FY 1981. Software effort is also required to develop the necessary programs to accommodate the Tracking and Data Relay Satellite System/free-flyer mode of operation.

BASIS OF FUND REQUIREMENTS:

SYSTEMS IMPLEMENTATION

The objectives of the NASA tracking and data systems implementation program are to maintain the existing ground support capability at a high level of proficiency and reliability in order to meet the aggregate support needs of the many and varied space missions, and to provide augmentation to this capability, as necessary, to meet the special requirements of individual flight projects. These ground support systems consist of the tracking and communications networks, control centers, data processing facilities and aeronautics and sounding rocket instrumentation.

The system implementation program encompasses the engineering, design and procurement of the necessary equipment, subsystems, and systems in response to the requirements of the various flight missions and other research projects. It also includes related documentation and basic software, the provisioning of large module spares, and the acceptance testing, integration and checkout of equipment.

FY 1981 funding is needed to maintain the required level of operational proficiency and reliability of network systems through the replacement of obsolete and worn out equipment. Modification and augmentation of existing systems are also necessary to maintain compatibility with changes in associated on-board spacecraft communications systems and to improve the utilization and efficiency of network systems. In addition, FY 1981 funds are also required to continue the implementation of new capabilities for upcoming missions, including the International Solar Polar Mission, Galileo, Space Telescope, Gamma Ray Observatory, Shuttle, and Spacelab programs.

Funds are also included to initiate long lead time items for the consolidation of the remaining STDN core stations with the DSN stations. The consolidated network, under the management of the Jet Propulsion Laboratory, is keyed to the mid-1980's.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate	Page No.
		(Thousands of Dollars)			
Spaceflight tracking and data network	14,085	17,000	17,000	22,600	RD 12-13
Deep space network	10,115	15,100	22,400	23,100	RD 12-15
Aeronautics and sounding rocket support	4,052	3,700	4,000	7,100	RD 12-17
Communications	4,815	3,700	4,400	5,600	RD 12-18
Data processing	7,430	6,900	9,500	17,800	RD 12-19
Total	40,497	46,400	57,300	76,200	
Spaceflight Tracking and Data Network Systems Implementation	14,085	17,000	17,000	22,600	

OBJECTIVES AND STATUS:

The Spaceflight Tracking and Data Network Systems Implementation program encompasses the procurement and implementation of systems and services necessary to sustain an effective capability for reliable support of ongoing scientific and applications satellite missions, to provide the network and control center capabilities required for efficient control, tracking, command, and data acquisition support of all NASA earth orbital missions, and to meet new support requirements for spacecraft to be launched in the near future. Implementation of these capabilities is vital to the success of NASA's spaceflight missions.

Employing systems implemented in past years, the network is currently supporting many missions with highly complex requirements for tracking, data acquisition, and command. Among these are the International Sun-Earth Explorers (ISEE-1, -2, and -3), the High Energy Astronomy Observatories (HEAO-2, and -3), Landsat-2 and -3, the Magnetic Field Satellite (MAGSAT), the Stratospheric Aerosol and Gas Experiment, Nimbus-5, -6, and -7, and the Laser Geodynamic Satellite (LAGEOS). Network and control center systems are in the final stages of implementation for upcoming new missions such as the Space Shuttle Orbital Flight Tests and Solar Maximum Mission. Plans and procurements are also underway to meet support requirements for future missions such as the Space Shuttle operational flights, Spacelab, Landsat-D, and the Space Telescope.

BASIS OF FY 1981 ESTIMATE:

Equipment modifications are required in the network and control centers in FY 1981 to maintain the required level of proficiency for support of a diverse and demanding workload and to assure the reliability of the network systems. Accordingly, funds are required for replacement of worn out systems with more reliable units, for equipment modifications to correct operational deficiencies, and for equipment to be used in operational

control of the network. The funds requested also provide for procurement of subsystem spares, for the provision and modification of test equipment, and for minor equipment modifications resulting from changes in support requirements from one mission to the next.

The operational flights of the Space Transportation System (STS) will employ the Tracking and Data Relay Satellite System (TDRSS) for orbital tracking and command and for data, television, and voice communications. A comprehensive capability for prelaunch testing and launch support of Shuttle and for compatibility testing of Shuttle and STS payloads with TDRSS is being installed at the Merritt Island, Florida, network station. Funds are requested in FY 1981 to complete the Merritt Island station TDRSS compatibility test capability and to complete the STS and STS payload telemetry and command monitoring systems at the TDRSS ground station at White Sands, New Mexico. Funds are also included for the continued implementation of mobile compatibility test vans to be used for prelaunch free-flyer spacecraft/TDRSS compatibility testing.

In addition, funds are requested to procure a spare transponder to ensure continuous operation of the TDRSS bilateration tracking systems. The bilateration tracking system is required to obtain precise position information on the TDRSS Precise position of the TDRSS spacecraft is necessary in order to calculate precise orbits of the spacecraft being tracked by TDRSS.

In FY 1981, effort will continue on the design and implementation of a new control center for the Space Telescope. This work will be conducted in concert with the development of the Science Institute (funded by the Office of Space Science) to minimize the design cost for both hardware and software systems as well as to facilitate testing and other operations.

In FY 1981, a new transportable station will be implemented at a foreign site to provide coverage to the Landsat-D spacecraft during those periods when the spacecraft is not in view of the TDRSS.

To efficiently and effectively meet the mission control workload in the 1980's, a new approach to control center design has been initiated. This approach involves techniques for rapid configuration of control center equipment to meet the requirements of a particular mission. The overall objective of the new design is to permit the sharing of resources to improve equipment utilization and to decrease the number of software and operations personnel. In FY 1981, the necessary complement of computers will be purchased and the integration of a "cluster" of control centers undertaken.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Deep Space Network Systems Implementation	10,115	15,100	22,400	23,100

OBJECTIVES AND STATUS:

The Deep Space Network is responsible for recovering science data from and providing the capability for remote operation of planetary and interplanetary spacecraft. In addition, after the Tracking and Data Relay Satellite System (TDRSS) becomes operational, the Deep Space Network will support highly elliptical earth orbital missions. The systems and facilities required to accomplish this are highly specialized and include Deep Space stations with their large aperture antennas (up to 64-meter diameter), ultrasensitive receivers, and high power transmitters. Advanced data handling systems are also required both at the stations and in the network control center.

The Deep Space Network Systems Implementation funding provides for the engineering and procurement of the systems and related services to be used in this network to assure that its capabilities keep pace with ongoing and upcoming approved planetary mission support requirements. It provides for the initiation of consolidation of the Deep Space and collocated near Earth stations into a single highly automated network that will provide enhanced capability while reducing overall maintenance and operations costs. Included is the replacement of obsolete equipment in order to improve the performance, reliability, and maintainability of the network. Overall, the equipment and techniques funded under this program are major contributors to: improvements in spacecraft navigation accuracy; the successful conduct of increasingly complex experiments; and the ability to receive increasing amounts of scientific information from planetary spacecraft at ever increasing distances from Earth. The need for dedicated network support during many time-critical mission events combined with the increasing communication distances and the demand for greater ground navigation precision, requires a continuing effort to extend network capabilities, performance, and reliability while at the same time reducing maintenance and operations costs.

Major efforts planned during FY 1981 include the start of a multiyear modification program to consolidate the Deep Space and collocated near Earth stations into a single network while providing support for the two Voyager Saturn encounters and implementation of a new high accuracy navigation technique.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

An increase of $7.3 million from the FY 1980 budget estimate resulted from the transfer of funding for the Jet Propulsion Laboratory engineering effort required for specific projects from the operations budget to the systems implementation budget. The purpose of this transfer is to consolidate the total funding requirements of specific projects in the systems implementation budget. This will provide for improved management visibility.

BASIS OF FY 1981 BUDGET:

Funding for FY 1981 provides for completion of a number of modifications and improvements required for the support of the second Voyager Saturn encounter. These include an operational digitally controlled uplink oscillator necessitated by an anomaly in the Voyager 2 onboard receiving system. It also provides for modifications to improve the sensitivity of the receiving antennas to increase the amount of scientific imagery data that can be returned during the Saturn encounter phase.

Implementation of an operational Very Long Baseline Interferometry (VLBI) tracking capability will also continue. This capability is necessary to meet current and future navigation requirements at the outer planets, particularly during periods when the spacecraft, in the vicinity of the planets, are viewed in the center of the plane of the ecliptic. An order of magnitude improvement in navigation accuracy is necessary in order for the spacecraft to achieve close satellite flybys and to provide the precision for gravity assist maneuvers as the spacecraft journey to subsequent planetary encounters. Missions requiring this accuracy level are Voyager at the Saturn and Uranus encounters and Galileo at the Mars and Jupiter encounters.

A phased consolidation of the Deep Space and collocated near Earth stations will begin in FY 1981 based on intensive system engineering design activities underway in FY 1980. Centralization of signal processing at each of the three Deep Space complexes (California, Spain, and Australia) by implementing data distribution equipment will reduce the amount of signal processing equipment per complex. This, together with ongoing modifications and replacement of obsolete data processing computers, will reduce the operations and maintenance costs. At the same time these modifications will increase network performance and flexibility by providing the capability to effectively array two or more antennas to increase sensitivity. Further reductions in maintenance and operations costs will be provided by automating much of the antenna front-end including the microwave and receiver equipment.

It is also planned to convert the 26-meter and 9-meter antennas to allow added reception at the X-band frequencies now being used by more recent and approved new spacecraft, while at the same time providing a greater potential for antenna arraying. The entire consolidation effort of antenna conversion, equipment automation, signal distribution and centralized processing is carefully sequenced to ensure that the network is capable of supporting current and planned future flight missions without interruption.

RD 12-16

Concurrent with these important engineering changes, FY 1981 funds will also be required to maintain the high level of reliability for support of the time critical maneuvers and planetary encounters. This will be accomplished through a continuing program of spares provisioning, major equipment refurbishment, and minor equipment and facility modification and maintenance to assure interface compatibility of existing equipment with the new system configurations being implemented in the network.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Aeronautics and Sounding Rocket Support Systems Implementation	4,052	3,700	4,000	7,100

OBJECTIVES AND STATUS:

The aeronautics, balloon, and sounding rocket programs are supported at the Wallops Flight Center in Virginia, and the Dryden Flight Research Center in California.

The aeronautics program at Wallops supports: (1) the investigation of major and minor airframe changes on stall, spin and recovery characteristics of light general aviation aircraft; (2) the development of advanced guidance and control concepts in general aviation aircraft; (3) the investigation of agricultural aircraft aerodynamics namely the effects on wake modifications, towing and cruise performance; (4) the development and demonstration of advanced airborne system concepts and problems such as noise, congestion, and adverse weather delays.

The sounding rocket programs supported by Wallops consist of payloads which range in weight from 12 to 1,200 pounds and are launched to altitudes from 70 to 700 km. They support atmospheric physics, plasma physics, solar physics and astronomy. Of considerable importance is the Environmental Observation Program which measures atmosphere dynamics parameters (temperature, winds, pressure, density) and selected constituents (ozone, nitric oxide and water vapor) within the field of view of earth observation satellites for intercomparison purposes. Wallops also hosts the international intercomparison project for the World Meteorological Organization is support of the Global Ozone Research and Monitoring Project.

Wallops provides fixed and mobile ground support equipment for instrumentation support to these programs. To maintain this equipment, spare and replacement parts must be acquired, as well as some nonrecoverable flight hardware such as on-board antennas and transponders. To meet specific test requirements, modifications and augmentations of selected telemetry, communications, tracking, command, and data handling systems are required. In addition, the mobile equipment must be periodically refurbished and modified to meet remote

site requirements such as the ongoing meteorological program in cooperation with several nations, including Argentina, Brazil, and Spain.

The aeronautical research technology programs supported by the Dryden Flight Research Center (DFRC) consist of high altitude and terminal area tests involving high performance aircraft such as the F-111, F-14, F-15, F-104, F-8, remote piloted vehicles including Highly Maneuverable Aircraft Technology (HiMAT) and other aircraft and helicopters. Dryden Flight Research Center was the site for the Approach and Landing Tests for the Shuttle Orbiter in 1977 and will support the Orbital Flight Tests beginning in 1980. Ground support equipment, located at the Dryden Flight Research Center, including the high precision radar, the telemetry data handling, and the associated timing, communications, and command systems, is maintained and modified to meet the changing requirements of the approved flight projects.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase of $300 thousand will provide for increased costs associated with upgrading of radar systems.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 funding requirements will provide the sustaining equipment and modifications to support the sounding rocket and aeronautics programs described above. In addition, it will provide funding for an impact prediction system for more reliable and downrange safety related support to the sounding rocket program. The present system is approximately 15 years old with the attendant problems of procuring spare parts, increased maintenance, and decreasing reliability.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Communications Systems Implementation.....	4,815	3,700	4,400	5,600

OBJECTIVES AND STATUS:

The objective of the Communications System Implementation program is to provide the necessary capability in NASA's global communications network (NASCOM) to meet new program support requirements, to increase the efficiency of the network, and to keep NASCOM at a high level of reliability for the transmission of data. NASCOM interconnects the tracking and data acquisition facilities which support all flight projects; it also links together such facilities as launch areas, test sites, and mission control centers.

The major efforts underway in the NASCOM are the implementation of a control and status system that can remotely control the configuration of the TDRSS multiplexing system at White Sands and the implementation of a 50 megabits per second transmission capability connecting the White Sands, Johnson Space Center and Goddard Space Flight Center for support of Spacelab missions and Landsat-D.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase of $700 thousand in the FY 1980 funding level resulted from greater than expected cost for the status and control system for the TDRSS multiplexer and the 50 megabits per second transmission capability for support of Spacelab and Landsat-D.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 funding requirements will provide the sustaining equipment and modifications to support the NASCOM Network and to continue effort on the automation of communications from the TDRSS ground station. Included also are the equipment and ground terminal to relay Landsat-D data in near real-time from the Indian Ocean area.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Data Processing Systems Implementation.....	7,430	6,900	9,500	17,800

OBJECTIVES AND STATUS:

The Data Processing Systems Implementation program provides for the procurement of equipment and related services for the large computer complexes at the Goddard Space Flight Center (GSFC) which support both the operational and payload requirements of space missions. To meet operational requirements these computer complexes, utilizing sophisticated software programs, determine spacecraft attitude and orbit, generate commands to the spacecraft and provide the status of onboard subsystems. In support of spacecraft payloads, the computer systems process the data from science and applications experiments for subsequent transfer to the experimenters.

Several significant activities in this program are underway at GSFC. The Telemetry On-Line Processing System (TELOPS), which became operational during 1978, is now routinely supporting a number of spacecraft, including the recently launched HEAO-3. The Image Processing Facility has been modified and is generating products for Landsat, Heat Capacity Mapping Mission, and Nimbus-7. Procurement is proceeding for a computer

replacement that will provide an improved central point for handling tracking data reception from the STDN. A centralized tracking data base is a continuing requirement for performing orbit computations. Implementation continues for a new system to process data from the numerous and varied experiments which comprise the payloads of early Spacelab missions.

CHANGES FROM FY 1980 BUDGET ESTIMATE:

The increase of $2.6 million in the FY 1980 funding level results from provision of redundant capability for critical parts of the Spacelab data processing system at the Goddard Space Flight Center to insure a reliable data processing capability.

BASIS OF FY 1981 ESTIMATE:

The FY 1981 budget request will provide continued funding for sequential replacement of the existing computer complex at the Goddard Space Flight Center which provides real-time support to the many NASA spacecraft. Included in the support are such critical activities as real-time attitude and orbit determination, memory management for onboard computers, and flight maneuver control. This computer complex is approximately 15 years old. Not only are hardware and software maintenance becoming more difficult and expensive, but the now frequent system outages are becoming a real threat to transmission of vital spacecraft commands. Further, system architecture requires greater software development to adapt to new missions. Funds are also necessary to augment and complete certain system procurements, including the Interim Spacelab Data Processing System and the Flight Maneuver Operations Control (FMOC) backup system. The Interim Spacelab Data Processing capability will be derived by augmenting and sharing the existing facility that currently processes free-flyer data. In particular, the old 1108 computers will be replaced with faster, more reliable systems, providing additional capacity that can be used for Spacelab missions as well as generally upgrading system performance for support of the free flyers.

There is also a continuing requirement to procure and maintain adequate supplies of spare parts to replace failure prone and high maintenance electronic modules, to provide test equipment and to undertake minor modifications and hardware fabrication associated with new equipment installation and reconfiguration.

BASIS OF FUND REQUIREMENTS:

ADVANCED SYSTEMS

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Advanced Systems	9,500	10,600	10,600	11,300

OBJECTIVES AND STATUS:

The Advanced Systems Program conducts studies and develops tracking and data acquisition systems and techniques required (1) to obtain new and improved capabilities for the networks and data facilities to meet the needs of approved missions and near term new starts, and (2) to improve the cost-effectiveness and optimize the reliability of the overall tracking and data acquisition support for the total mix of space flight missions. This includes investigations of required tracking and data acquisition support for upcoming missions and also flight/ground systems trade-off studies to determine, for example, which has the lowest lifecycle costs for operational support planning of future space missions.

BASIS OF FY 1981 ESTIMATE:

The Advanced Systems Program will continue to produce improvements in the techniques and the systems required for tracking and data acquisition. The capability of the Deep Space Network to track and accurately guide planetary spacecraft to their required planetary "window" or position relative to the target planet has improved by a factor of 10 every five years since 1964. The Galileo mission to Jupiter in 1984 requires continuation of this trend and new tracking technology is being developed for Galileo navigation during its Mars flyby.

The capability of the Deep Space Network to acquire telemetry data from planetary missions has also improved greatly. For example, it has improved over a million-fold since the Mariner IV in 1964 to the current receiving capability for Voyager, which is 115 kilobits per second from Jupiter nearly a billion kilometers away. Developments are now aimed at adding another factor of four improvement over the current Deep Space Network data acquisition capability to permit a corresponding increase in the scientific scope and value of future planetary missions.

The Earth satellite network in combination with the data handling and control facilities has increased its total data flow in support of all Earth orbital missions. From a workload level of approximately 200 million bits on a typical day in 1964 its capability is 1,000 times that amount today. To do this, major changes in techniques were necessary for mission control, digital data handling and image processing. New technology is

now underway for use during the upcoming TDRSS era when an additional factor of 10 in workload level will be reached. Here the prime objective is to seek significant improvements in overall support cost-effectiveness mainly for earth observational missions and Shuttle space operations. Studies are also being initiated to define the technology needs for a next generation TDRSS as experience is gained with the current generation of TDRSS.

Techniques for highly accurate measurement by the networks of parameters related to the space-time environment also play a vital role in support of NASA missions and experiments. The Advanced Systems program has of necessity remained at the forefront of this technology which includes, for example, laser ranging, frequency standards, worldwide time synchronization and baseline length measurement. Laser ranging systems used to support the LAGEOS satellite and to make geodetic measurements are now accurate to within 10 centimeters. Fieldworthy atomic frequency standards are being improved in accuracy by an order of magnitude every two years. These standards are probably the most accurate direct measuring instruments made by man, and they ultimately determine and limit our ability to track and navigate spacecraft and conduct experiments in areas such as gravitational physics and relativity. Vital also is our ability to synchronize two or more of these standards, currently to within one microsecond, and to measure baseline length to an accuracy of centimeters on a worldwide basis. To obtain greater accuracy required for each of the measurement techniques is an objective of the Advanced Systems Program.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

GENERAL STATEMENT

The Construction of Facilities (CoF) appropriation provides for contractual services for repair, rehabilitation and modification of existing facilities; the construction of new facilities; the acquisition of related facility equipment; the design of facilities projects and advance planning related to future facilities needs.

The funds requested for 1981 provide for: the continuation of prior years' endeavors in meeting the facilities requirements for the Space Shuttle and Space Shuttle payloads; construction and modification of aeronautical research and development facilities; repair, rehabilitation, and modification of other facilities to maintain, upgrade and improve the usefulness of the NASA physical plant; minor construction of new facilities; and facility planning and design activities.

The projects and amounts reflected in this budget estimate for Space Shuttle and Space Shuttle payloads are time sensitive to meet specific milestones. In addition, the program for 1981 includes the construction of a Man-Vehicle System Research Facility at the Ames Research Center and modification to the Aircraft Landing Dynamics Facility at the Langley Research Center.

The FY 1981 program continues to meet the objectives of preserving and enhancing the capabilities and usefulness of existing facilities and to ensure safe economical and efficient use of the NASA physical plant. This request continues the necessary Rehabilitation and Modification Program as in prior years and continues a Repair program. The purpose of the Repair program is to restore facilities to a condition substantially equivalent to their originally designed capability. The minor construction program continues to provide a means to accomplish smaller facility projects which accommodate changes in technical and institutional requirements. This program also includes projects which continue NASA efforts to reduce the consumption of energy.

Funds requested for facility planning and design cover advance planning and design requirements for potential future projects, master planning, facilities studies, engineering reports and studies and the preparation of facility project design drawings and bid specifications.

The request for FY 1981 is $120,000,000, a decrease of $36,100,000 below the appropriation for FY 1980. Outlays are estimated to be $163,000,000 in FY 1981, an increase of $7,800,000 over the estimate for FY 1980.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED APPROPRIATION LANGUAGE

CONSTRUCTION OF FACILITIES

For construction, repair, rehabilitation and modification of facilities, minor construction of new facilities and additions to existing facilities, and for facility planning and design not otherwise provided, for the National Aeronautics and Space Administration, and for the acquisition or condemnation of real property, as authorized by law, [$156,100,000] *$120,000,000*, to remain available until September 30, [1982] *1983: Provided*, That, notwithstanding the limitation on the availability of funds appropriated under this head by this appropriation Act, when any activity has been initiated by the incurrence of obligations therefor, the amount available for such activity shall remain available until expended, except that this provision shall not apply to the amounts appropriated pursuant to the authorization for repair, rehabilitation and modification of facilities, minor construction of new facilities and additions to existing facilities, and facility planning and design. *(42 U.S.C. 2451, et. seq.; Department of Housing and Urban Development—Independent Agencies Appropriation Act, 1980; additional authorizing legislation to be proposed.)*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

Program and Financing (in thousands of dollars)

Identification code 80-0107-0-1-999	Budget plan (amounts for construction of facilities actions programed)			Costs and obligations		
	1979 actual	1980 est.	1981 est.	1979 actual	1980 est.	1981 est.
Program by activities:						
Direct program:						
1. Space transportation systems	31,070	27,750	10,100	41,029	43,600	29,700
2. Scientific investigations in space		4,250	1,617	5,215	2,800	3,400
3. Space and terrestrial applications				2,225	800	500
4. Space research and technology				116		
5. Aeronautical research and technology	76,530	62,500	45,291	43,047	69,800	61,300
7. Supporting activity	39,900	61,600	62,992	45,366	48,800	58,400
Total direct program	147,500	156,100	120,000	136,998	165,800	153,300
Reimbursable program:						
1. Space transportation systems	251	12,000	2,000	251	3,636	7,700
5. Aeronautical research and technology	1,550	1,600	4,000	5	2,030	2,000
7. Supporting activity	923	3,400	5,000	5,034	4,934	3,500
Total reimbursable program	2,724	17,000	11,000	5,290	10,600	13,200
Total program costs, funded				142,288	176,400	166,500
Change in selected resources (undelivered orders)				4,658	2,000	−10,600
10.00 Total	150,224	173,100	131,000	146,946	178,400	155,900
Financing:						
11.00 Offsetting collections from Federal funds	−2,724	−17,000	−11,000	−2,724	−17,000	−11,000
21.40 Unobligated balance available, start of year: For completion of prior year budget plans:						
Direct				−93,356	−95,501	−88,601
Reimbursable				−823	−2,676	−4,276
22.40 Unobligated balance transferred from other accounts				−680		
24.40 Unobligated balance available, end of year: For completion of prior year budget plans:						
Direct				95,501	88,601	65,201
Reimbursable				2,676	4,276	2,776
25.00 Unobligated balance lapsing				63		
Unobligated balance restored				−103		
40.00 **Budget authority (appropriation)**	**147,500**	**156,100**	**120,000**	**147,500**	**156,100**	**120,000**
Relation of obligations to outlays:						
71.00 Obligations incurred, net				144,222	161,400	144,900
72.40 Obligated balance, start of year				128,061	139,535	146,035
74.40 Obligated balance, end of year				−139,535	−146,035	−127,935
77.00 Adjustments in expired accounts				−32		
90.00 Outlays				132,716	154,900	163,000

Note.—Reconciliation of budget plan to obligations:

	1979 actual	1980 estimate	1981 estimate
Total budget plan	150,224	173,100	131,000
Deduct portion of budget plan to be obligated in subsequent years	62,885	54,200	32,400
Add obligations of prior year budget plans	59,607	59,500	57,300
Total obligations	146,946	178,400	155,900

SUM 3

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

SUMMARY OF BUDGET PLAN BY LOCATION

Location	FY 1979	FY 1980 (In Dollars)	FY 1981
Ames Research Center	9,770,000	2,900,000	13,180,000
Goddard Space Flight Center	5,640,000	---	---
Jet Propulsion Laboratory	4,630,000	---	3,500,000
Lyndon B. Johnson Space Center	---	1,760,000	---
John F. Kennedy Space Center	---	2,810,000	760,000
Langley Research Center	6,500,000	7,980,000	22,756,000
Lewis Research Center	6,140,000	5,720,000	12,355,000
George C. Marshall Space Flight Center	---	3,540,000	---
Michoud Assembly Facility	---	3,100,000	4,582,000
Wallops Flight Center	---	1,100,000	---
Large Aeronautical Facilities	56,100,000	45,900,000	---
Various Locations	---	---	2,150,000
Space Shuttle Facilities	31,070,000	27,750,000	10,100,000
Space Shuttle Payload Facilities	---	4,250,000	1,617,000
Repair	---	12,000,000	15,000,000
Rehabilitation and Modification	12,800,000	19,790,000	20,000,000
Minor Construction	4,200,000	3,500,000	4,000,000
Facility Planning and Design	10,650,000	14,000,000	10,000,000
Total Plan	147,500,000	156,100,000	120,000,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

	FY 1979	FY 1980 (In Dollars)	FY 1981
SUMMARY OF BUDGET PLAN BY COGNIZANT OFFICE			
Office of Space Transportation Systems	31,070,000	27,750,000	10,100,000
Office of Space Science	---	4,250,000	1,617,000
Office of Aeronautics and Space Technology	76,530,000	62,500,000	45,291,000
Office of Space Tracking and Data Systems	---	---	2,150,000
Office of Management Operations	7,620,000	---	---
Office of the Comptroller	32,280,000	61,600,000	60,842,000
Total Plan	147,500,000	156,100,000	120,000,000
SUMMARY OF BUDGET PLAN BY SUBFUNCTION			
Code No. Title			
253 Space Flight	31,070,000	27,750,000	10,100,000
254 Space Science, Applications and Technology	---	4,250,000	1,617,000
255 Support Space Activities	39,900,000	61,600,000	62,992,000
(250) Subtotal, General Science, Space and Technology	70,970,000	93,600,000	74,709,000
402 Air Transportation	76,530,000	62,500,000	45,291,000
Total	147,500,000	156,100,000	120,000,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

BUDGET PLAN BY LOCATION AND PROJECT

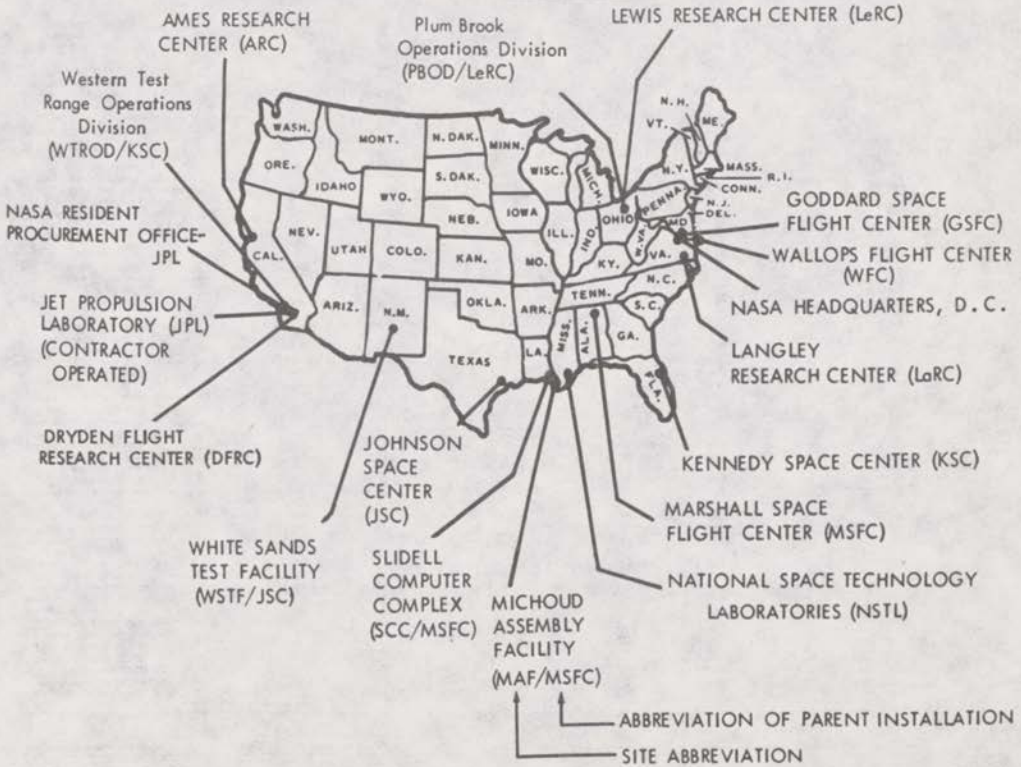
Cognizant Office	Budget Activity	Subfunction Code	Installation and Project	FY 1979 (In thousands of	FY 1980 dollars)	FY 1981	Page No.
			Ames Research Center	9,770	2,900	13,180	
AST	5	402	Construction of Man-Vehicle Systems Research Facility	---	---	7,480	CF 1-1
AST	5	402	Modification of Steam Ejector System and Thermal Protection Laboratory (N-234)	---	---	2,300	CF 1-9
AST	5	402	Modification of the Unitary Plan Wind Tunnel (N-227)	5,390	---	3,400	CF 1-17
AST	5	402	Modification of Static Test Facility (N-249)	---	2,900	---	
AST	5	402	Modification of 3.5-Foot Wind Tunnel	1,870	---	---	
AST	5	402	Modification of 12-Foot Pressure Wind Tunnel	2,510	---	---	
			Goddard Space Flight Center	5,640	---	---	
MGMT OPS	7	255	Modifications and Additions for Logistic and Supply Functions	5,640	---	---	
			Jet Propulsion Laboratory	4,630	---	3,500	
COMP	7	255	Modifications to Various Buildings for Energy Conservation	---	---	1,500	CF 2-1
COMP	7	255	Modifications to Various Buildings for Seismic Protection	1,570	---	2,000	CF 2-6
COMP	7	255	Modifications and Addition to the Space Flight Operations Facility	3,060	---	---	
			Lyndon B. Johnson Space Center	---	1,760	---	
COMP	7	255	Rehabilitation and Modification of Flight Operations Facilities, Ellington AFB	---	1,760	---	

Cognizant Office	Budget Activity	Subfunction Code	Installation and Project	FY 1979	FY 1980	FY 1981	Page No.
				(In thousands of dollars)			
			John F. Kennedy Space Center	---	2,810	760	
COMP	7	255	Rehabilitation of High Temperature Hot Water System, Zone 2, Industrial Area	---	---	760	CF 3-1
COMP	7	255	Modifications to the Central Instrumentation Facility	---	1,260	---	
COMP	7	255	Modifications to the Operations and Checkout Building	---	950	---	
COMP	7	255	Rehabilitation of Roof, Launch Control Complex	---	600	---	
			Langley Research Center	6,500	7,980	22,756	
AST	5	402	Modifications for Avionics Integration Research Laboratory (1220)	---	---	5,756	CF 4-1
AST	5	402	Modifications to Aircraft Landing Dynamics Facility (1257)	---	---	15,000	CF 4-8
AST	5	402	Rehabilitation and Modification of Gas Dynamics Laboratory (1247)	---	3,600	2,000	CF 4-17
AST	5	402	Modifications of Model Support System 8-Foot High Temperature Structures Tunnel (1265)	---	1,410	---	
AST	5	402	Modification of Transonic Dynamics Tunnel	---	970	---	
AST	5	402	Modifications to 8-Foot Transonic Pressure Tunnel (640)	---	2,000	---	
MGMT OPS	7	255	Modifications for Utility Control System	1,980	---	---	
AST	5	402	Rehabilitation of Unitary Plan Wind Tunnel	4,520	---	---	
			Lewis Research Center	6,140	5,720	12,355	
COMP	7	255	Decommissioning of Plum Brook Station Reactor Facility	---	---	3,000	CF 5-1
AST	5	402	Modifications to Central Air System, Various Buildings	---	5,720	7,655	CF 5-10
AST	5	402	Rehabilitation of Electrical Switchgear, Engine Research Building (5)	---	---	1,700	CF 5-21
AST	5	402	Construction of Research Analysis Center	6,140	---	---	

Cognizant Office	Budget Activity	Subfunction Code	Installation and Project	FY 1979	FY 1980	FY 1981	Page No.
				(In thousands of dollars)			
			George C. Marshall Space Flight Center	---	3,540	---	
COMP	7	255	Modifications to Various Buildings	---	2,640	---	
COMP	7	255	Rehabilitation of Roofs, Various Buildings	---	900	---	
			Michoud Assembly Facility	---	3,100	4,582	
COMP	7	255	Rehabilitation of Roof, Phase II, Building 103	---	---	3,800	CF 6-1
COMP	7	255	Rehabilitation of Chilled Water System	---	---	782	CF 6-6
COMP	7	255	Rehabilitation of Roof, Phase I, Building 103	---	3,100	---	
			Wallops Flight Center	---	1,100	---	
COMP	7	255	Construction of Facilities Operations Shop Building	---	1,100	---	
			Various Locations	---	---	2,150	
ST&DS	7	255	Modification of 26-Meter Antenna, DSS-44, Canberra, Australia (JPL)	---	---	1,200	CF 7-1
ST&DS	7	255	Replacement of Azimuth Radial Bearing, DSS-14, Goldstone, CA (JPL)	---	---	950	CF 7-5
			Large Aeronautical Facilities at Various Locations as Follows:	56,100	45,900	---	
AST	5	402	Construction of National Transonic Facility (LaRC)	24,500	12,000	---	
AST	5	402	Modification of 40- by 80-Foot Subsonic Wind Tunnel (ARC)	31,600	33,900	---	
			Space Shuttle Facilities at Various Locations as Follows:	31,070	27,750	10,100	
STS	1	253	Modification of Manufacturing and Final Assembly Facilities for External Tanks (MAF)	13,980	6,900	5,400	CF 8-4
STS	1	253	Modifications to Solid Rocket Motor Manufacturing and Assembly Facilities, Thiokol Plant, Wasatch, Utah	1,920	---	2,700	CF 8-14

Cognizant Office	Budget Activity	Subfunction Code	Installation and Project	FY 1979	FY 1980	FY 1981	Page No.
				(In thousands of dollars)			
			Space Shuttle Facilities at Various Locations as Follows: (Cont'd)				
STS	1	253	Minor Shuttle-Unique Projects (Various Locations).....	1,600	2,500	2,000	CF 8-28
STS	1	253	Modifications to Crawler Transporter Maintenance Facility (KSC).....	---	1,250	---	
STSA	1	253	Modifications to Launch Complex 39 (KSC).....	13,570	17,100	---	
			Space Shuttle Payload Facilities at Various Locations as Follows:	---	4,250	1,617	
SS	2	254	Rehabilitation and Modification for Payload Ground Support Operations (KSC).....	---	2,610	1,617	CF 9-1
SS	2	254	Modification of an Addition to Materials Sciences Laboratory (N-240) (ARC).....	---	1,640	---	
COMP	7	255	Repair of Facilities at Various Locations, Not in Excess of $500,000 per Project.....	---	12,000	15,000	CF 10-1
COMP	7	255	Rehabilitation and Modification of Facilities at Various Locations, Not in Excess of $500,000 per Project.....	12,800	19,790	20,000	CF 11-1
COMP	7	255	Minor Construction of New Facilities and Additions to Existing Facilities at Various Locations, Not in Excess of $250,000 per Project.....	4,200	3,500	4,000	CF 12-1
COMP	7	255	Facility Planning and Design.....	10,650	14,000	10,000	CF 13-1
			TOTAL.....	147,500	156,100	120,000	

LOCATION OF NASA MAJOR AND COMPONENT INSTALLATIONS



SUM 10

RECORDED VALUE OF CAPITAL TYPE PROPERTY
IN-HOUSE AND CONTRACTOR-HELD
AS OF SEPTEMBER 30, 1979
(IN THOUSANDS)

Reporting Installation	Real Property							Grand Total
	Land	Buildings	Other Structures and Facilities	Leasehold Improvements	Total	Equipment	Fixed Assets in Progress	
Ames Research Center	$ 2,928	$ 213,479	$ 9,374	-0-	$ 225,781	$ 165,781	$ 56,247	$ 447,809
ARC-Moffett Field, Ca.	2,928	213,479	9,374	-0-	225,781	160,997	56,247	443,025
Various Locations (a)	-0-	-0-	-0-	-0-	-0-	4,784	-0-	4,784
Dryden Flight Research Center	-0-	14,447	6,804	-0-	21,251	63,564	3,095	87,910
DFRC - Edwards AFB, Ca.	-0-	14,447	6,804	-0-	21,251	60,059	3,095	84,405
Various Locations (a)	-0-	-0-	-0-	-0-	-0-	3,505	-0-	3,505
Goddard Space Flight Center	1,706	101,711	58,174	-0-	161,591	511,020	19,555	692,166
GSFC-Greenbelt, Md.	1,353	85,994	16,939	-0-	104,286	241,690	14,224	360,200
Tracking Stations (Networks)	353	15,716	41,190	-0-	57,259	233,344	5,331	295,934
Various Locations (a)	-0-	1	45	-0-	46	35,986	-0-	36,032
Jet Propulsion Laboratory	1,188	89,871	67,578	534	159,171	233,821	19,408	412,400
JPL - Pasadena, Ca.	1,188	78,461	11,840	534	92,023	155,360	19,408	266,791
Deep Space Network	-0-	11,410	55,738	-0-	67,148	78,461	-0-	145,609
Johnson Space Center	9,107	195,875	61,925	-0-	266,907	442,347	24,623	733,877
JSC - Houston, Tx.	5,537	160,127	35,389	-0-	201,053	373,547	19,701	594,301
White Sands Test Facility								
WSTS-Las Cruces, N.M.	-0-	9,455	20,979	-0-	30,434	20,149	-0-	50,583
Various Locations (a)	3,570	26,293	5,557	-0-	35,420	48,651	4,922	88,993
Kennedy Space Center	71,345	349,073	330,677	-0-	751,095	967,416	117,914	1,836,425
KSC - Cape Canaveral, Fal.	71,345	349,073	330,677	-0-	751,095	962,507	117,914	1,831,516
Western Test Range Operations Div.								
WTROD - Lompoc, Ca.	-0-	-0-	-0-	-0-	-0-	3,820	-0-	3,820
Various Locations (a)	-0-	-0-	-0-	-0-	-0-	1,089	-0-	1,089
Langley Research Center	162	147,434	217,582	-0-	365,178	183,710	17,665	566,553
LARC - Hampton, Va.	156	133,034	217,506	-0-	350,696	169,476	17,665	537,837
Various Locations (a)	6	14,400	76	-0-	14,482	14,234	-0-	28,716
Lewis Research Center	2,330	209,128	76,377	136	287,871	143,194	17,971	449,036
LERC - Cleveland, Oh.	316	132,778	57,963	136	191,193	113,452	17,971	322,816
Plumbrook Operations Division								
PBOD - Sandusky, Oh.	1,914	76,350	18,414	-0-	96,678	15,238	-0-	111,916
Various Locations	-0-	-0-	-0-	-0-	-0-	14,504	-0-	14,504
Marshall Space Flight Center	7,157	200,979	130,147	-0-	338,283	396,707	3,522	738,512
MSFC - Huntsville, Al.	-0-	124,910	62,888	-0-	187,798	268,770	3,522	460,090
Michoud Assembly Facility								
MAF - New Orleans, La.	7,092	66,918	54,540	-0-	128,550	25,863	-0-	154,413
Slidell Computer Complex								
SCC-Slidell, La.	65	5,004	2,041	-0-	7,110	11,208	-0-	18,318
Various Locations (a)	-0-	4,147	10,678	-0-	14,825	90,866	-0-	105,691
National Space Technology Labs.								
NSTL - NSTL Station, Ms.	18,061	68,629	194,294	-0-	280,984	29,296	-0-	310,280
Wallops Flight Center	1,305	26,585	52,899	-0-	80,789	56,015	5,083	141,887
WFC - Wallops Island, Va.	1,305	26,585	52,899	-0-	80,789	53,929	5,083	139,801
Various Locations (a)	-0-	-0-	-0-	-0-	-0-	2,086	-0-	2,086
NASA Headquarters	-0-	-0-	-0-	-0-	-0-	17,807	6,644	24,451
Washington, D. C.	-0-	-0-	-0-	-0-	-0-	4,555	6,644	11,199
Various Locations (a)	-0-	-0-	-0-	-0-	-0-	13,252	-0-	13,252
TOTAL	$ 115,389	$1,617,211	$ 1,205,831	$ 670	$ 2,938,901	$3,210,678	$291,727	$6,441,306

(a) Includes Property in possession of Contractors at Various Locations

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1961 ESTIMATES

SUMMARY

AMES RESEARCH CENTER

	Amount	Page No.
Office of Aeronautics and Space Technology:		
Construction of Man-Vehicle Systems Research Facility	7,480,000	CF 1-1
Modification of Steam Ejector System and Thermal Protection Laboratory (N-234)	2,300,000	CF 1-9
Modification of the Unitary Plan Wind Tunnel (N-227)	3,400,000	CF 1-17
Total	13,180,000	

AMES RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
CONSTRUCTION OF MAN/VEHICLE SYSTEMS RESEARCH FACILITY
LOCATION PLAN

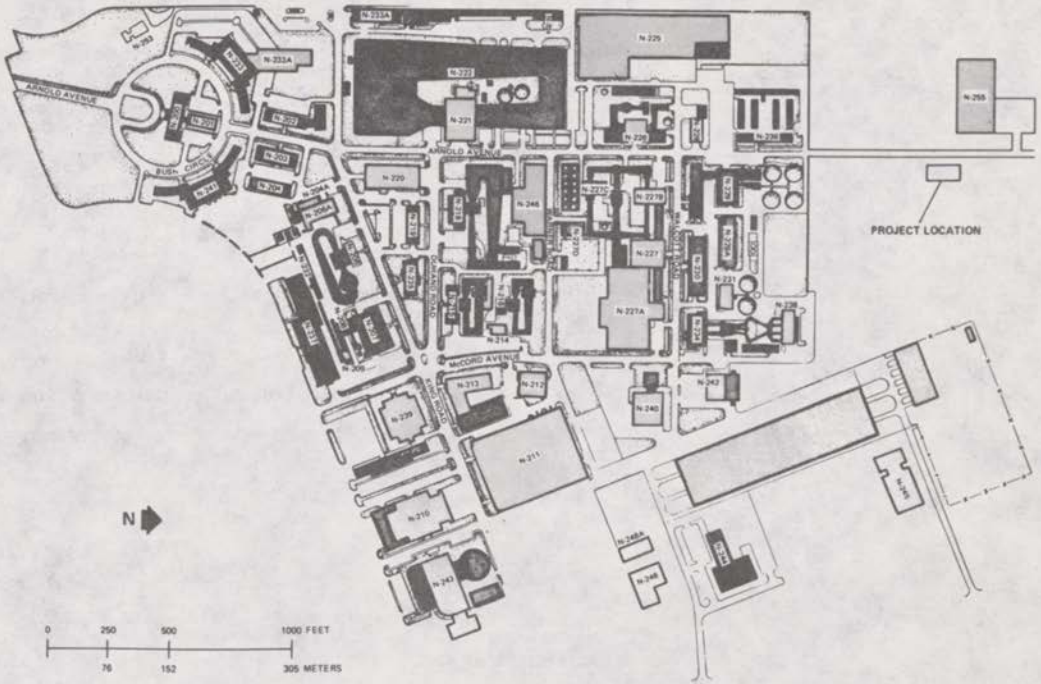


FIGURE 1

CF 1-1

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Construction of Man-Vehicle Systems Research Facility

INSTALLATION: Ames Research Center

FY 1981 CoF ESTIMATE: $7,480,000

LOCATION OF PROJECT: Ames Research Center

COGNIZANT HEADQUARTERS OFFICE: Office of Aeronautics and Space Technology

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF Funding	700,000	---	700,000
Capitalized Investment	N/A	---	---
Total	700,000	---	700,000

SUMMARY PURPOSE AND SCOPE:

Construction of the Man-Vehicle Systems Research Facility at Ames Research Center (ARC) will provide a vital research capability which will satisfy a national requirement for aeronautical human factors research. It will be the only such facility that will provide ground test simulation of multiple aircraft (two with full crews), terminal area Air Traffic Control (ATC), air crew interactions, and advanced technology cockpit displays technology representative of future generations of aircraft and all within the full-mission context. By providing a high degree of operational fidelity, the facility will permit meaningful research on critical human factors such as fundamental analytical models for the functional and physical characteristics of both the air crew and the ground crew; the formulation of design criteria and principles, from the human factors perspective

appropriate to flight systems and operational environments of the future; the integration of new subsystems and procedures such as electronic displays, and automated avionics and controls into contemporary flight and traffic control scenarios; and, new training methodologies and principles which will be required by the introduction of increasing levels of systems automation and integration.

PROJECT JUSTIFICATION:

It is estimated that human error is responsible for or a contributing factor in 60-80% of all domestic aircraft accidents. Aviation is on the verge of a revolution in air and ground operations which with adequate human factors research input has the potential for eliminating many causes of these human errors. This proposed facility will significantly contribute to the design and operational use of cockpits of future generations of domestic aircraft and to the overall aviation system.

In the near future, based on current technology trends, aircraft cockpits will be very different from those in use today. The new cockpits will have integrated electronic displays instead of the individual electromechanical displays now used. These displays will be capable of providing the air crew with much more information concerning the air traffic in the immediate vicinity than present instruments. They will be more automated and are likely to be designed for specific members of the flight crew instead of being duplicated, as at present, for the pilot and copilot. New technology will provide the air crew with more information and control for maintaining positive separation from other aircraft. Research is required to determine the potential impact of this new technology on the total aviation system from the perspective of human information processing and cockpit/ground interactions.

The Federal Aviation Administration (FAA) has requested that NASA give special attention to the integration of advanced technology systems into the cockpit. The Air Transport Association (ATA) also has requested that NASA undertake a major program to examine advanced cockpit displays. In addition, the Congressional Subcommittee on Transportation, Aviation and Weather, in its final report #98-796, dated November 1977, from the hearings on "The Future Needs and Opportunities in the Air Traffic Control System", recommended a ". . . joint effort between the FAA and NASA in examining the capabilities and limitations of cockpit displays of traffic information. . . (and in) examining human factors problems related to distributive management concepts." It also recommended that ". . . NASA conduct a study directed toward identifying which of the pilot functions can and should be automated."

More recently, the Secretary of Transportation and the Administrator of the Federal Aviation Administration announced a wide ranging air-safety program that includes near term implementation of new equipment and air traffic control procedures for many of the Nation's airports and air routes. Also projected were future studies of both hardware and procedural protocols that may significantly affect air-to-air and air-to-ground

interactions. Research facilities, such as the one requested here, are needed to fully develop and evaluate these concepts under demanding but controlled conditions.

The Man-Vehicle Systems Research Division at ARC has been involved in a wide variety of research activities that are related to these issues. Among these are studies of control and monitoring behavior, head-up display utilization, cockpit displays of traffic information, the Aviation Safety Reporting System, resource management training, work load measurement and full-mission simulations. A recent full-mission simulation has shown that performance of crew members may deteriorate under high work load and abnormal flight conditions in ways that are not predictable from normal operating conditions and conditions of reduced workload. This has emphasized the need for high fidelity in simulation and for the capability to conduct full-mission simulations of relevant aircraft operations. These requirements are particularly compelling for the human factors research including (1) information requirements for all-electronic advance displays, (2) interaction and distribution of responsibility between aircrew and ground controllers, and (3) the automation of pilot and aircrew functions.

IMPACT OF DELAY:

Human error is responsible for or a contributing factor in 60-80 percent of all domestic aircraft accidents. Because no facility currently exists to integrate all of the critical human factor research involved in aircraft control, it is essential that this project be started as soon as possible.

PROJECT DESCRIPTION:

Building

The building will consist of a high bay portion housing simulator, controls, shop support and mechanical equipment room; and an adjoining one-story wing containing computer rooms, support space, conference room, programming area, toilets and janitor room. The entire structure encloses an area of 11,000 square feet (1,022 square meters) plus an additional 2,300 square feet (214 square meters) at mezzanine level in the high bay portion (Figure 1). The building will be structural steel framing with first floor slab on grade (slab depressed at computer floor areas), and second floor (mezzanine) and roof to be steel decking with a concrete fill.

Advanced Technology Aircraft Cockpit

The advanced technology aircraft cockpit consists of four basic elements: cab, in-flight controls, flight displays and visual scene. The advanced technology cab will be representative of future generations of transport aircraft. The cab will be a totally enclosed shell and will accommodate a pilot, copilot, flight engineer, and an observer. This cab will also be equipped with a visual scene generator capable of depicting both day

and night scenes, other aircraft and special visual conditions representative of fog, clouds, and other meteorological conditions. This visual system will allow the experimenter to recreate and control visual as well as operational workload which is a capability of particular importance in many of the proposed research applications. The cockpit will be provided with a full complement of panels, switches and controls to provide fully outfitted positions for a crew of three.

Current Technology Cockpit

The current technology cockpit will consist of a cab, the frame and shell of which will be identicial to that of the advanced technology cockpit, but equipped to represent the current generation wide-body aircraft with a flight engineer's station and flight display and control systems virtually identical to those of a representative operational aircraft. This cab will be equipped with a visual display system.

Terminal Area Air Traffic Control Facility

A functional representation of an Air Traffic Control (ATC) facility will comprise an important element in the overall facility. An existing ATC system will be coupled with a new dedicated computer system to provide long duration, full-mission simulation studies. This project will provide a new dedicated mini-computer to perform overall functions of terminal air traffic modeling and traffic generation in support of this existing ATC system (Figure 2).

Other Equipment and Capability

The facility will include audio, video and intercommunication systems so that realistic speech and cockpit noise environments can be recreated for the flight and ground crews. These systems will also make it possible for the experimenters and simulator operators to communicate efficiently with one another and with flight and ground crews. Experimenters' stations for the control and monitoring of the simulation will be provided, as will be a computer-controlled equipment test system. This latter system, which will test and monitor all the major facility systems, is necessary to ensure a level of system reliability high enough to satisfy the requirements of full mission research.

57-166 O - 80 - 32

PROJECT COST ESTIMATE:

This cost estimate is based on a Preliminary Engineering Report.

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	1,200,000
Site development and utilities (outside of 5' line)	LS	---	---	210,000
Structural/architectural	SF	13,300	43.20	575,000
Mechanical/electrical	SF	13,300	31.20	415,000
Equipment	---	---	---	6,280,000
Advanced technology aircraft cockpit	LS	---	---	2,825,000
Current technology cockpit	LS	---	---	1,870,000
Terminal area air traffic control station	LS	---	---	325,000
Other equipment	LS	---	---	1,260,000
Audio, video, intercommunication equipment	LS	---	---	(625,000)
Simulation test and control stations	LS	---	---	(635,000)
Fallout Shelter (not feasible)	---	---	---	---
Total				7,480,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Equipment Layout

OTHER EQUIPMENT SUMMARY:

No other equipment is required to complete this project.

FUTURE COF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

Additional visual equipment and a fundamental human factors research area for part task, part mission investigations not requiring full mission simulation are under study for future year requirements.

AMES RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
CONSTRUCTION OF MAN/VEHICLE SYSTEMS
RESEARCH FACILITY

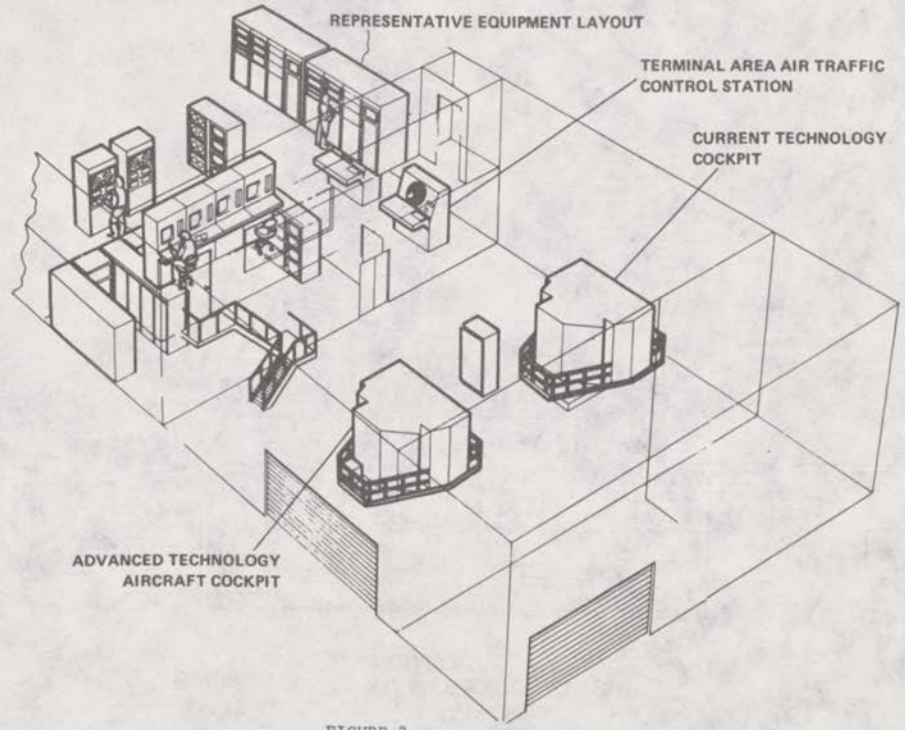


FIGURE 2

CF 1-8

AMES RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
MODIFICATION OF STEAM EJECTOR SYSTEM
LOCATION PLAN

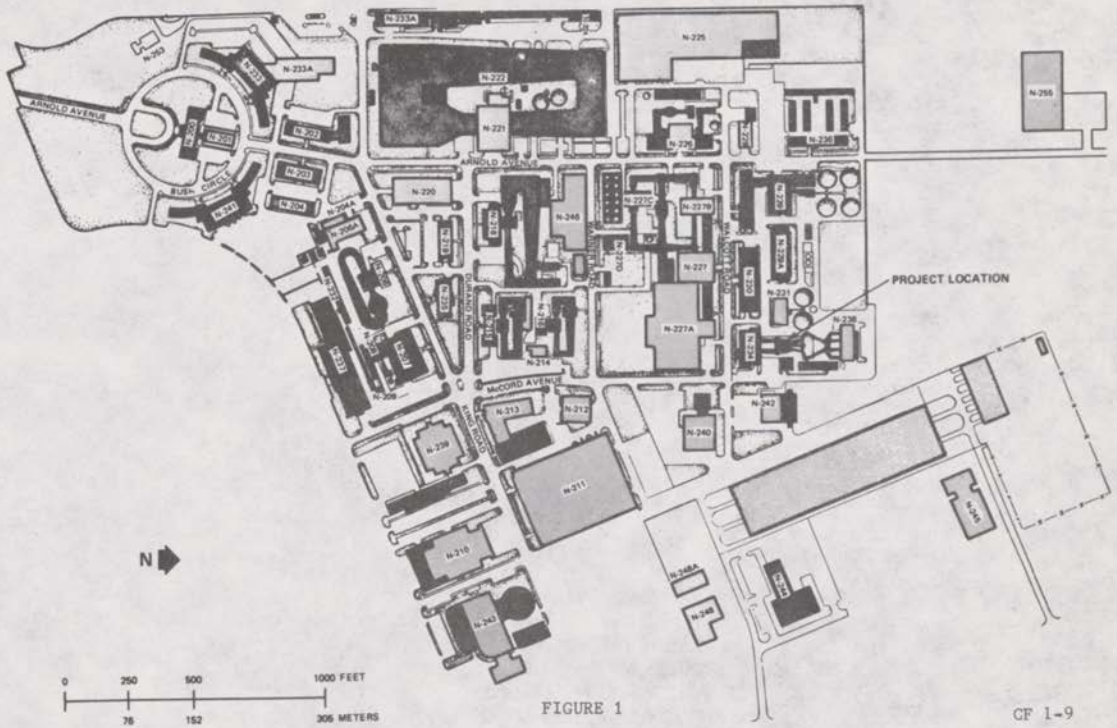


FIGURE 1

CF 1-9

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE:	Modification of Steam Ejector System and Thermal Protection Laboratory (N-234)
INSTALLATION:	Ames Research Center
FY 1981 CoF ESTIMATE:	$2,300,000

LOCATION OF PROJECT: Moffett Field, Santa Clara County, California

COGNIZANT HEADQUARTERS OFFICE: Office of Aeronautics and Space Technology

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	234,000	1,040,000	1,274,000
Capitalized investment	N/A	*17,927,426	17,927,426
Total	234,000	18,967,426	19,201,426

*Value for N-234 and N-238

SUMMARY PURPOSE AND SCOPE:

This project will provide modifications to the Steam Ejector System which serves the Thermal Protection Laboratory, N-234, and Arc Jet Facility, N-238, at Ames Research Center (ARC) (Figure 1). The project consists of three tasks: (1) replacement of the fifth stage steam ejector with a mechanical/electrical vacuum pump for energy conservation; (2) modifications to the steam boiler for energy conservation; and (3) repair and modification of components and support systems of the Arc Jet and Thermal Protection Laboratory facilities. The energy conservation portions of this project will enable savings of over 60,000,000 cubic feet (1,700,000

cubic meters) of natural gas annually. The related project payback for this work is approximately three years. The modification and repair portions will insure continued reliable operation of the laboratory facilities.

PROJECT JUSTIFICATION:

The Steam Ejector System (Figure 2) at ARC provides the high vacuum required for aerodynamic investigation, design and qualification testing of the thermal protection systems of both the Thermal Protection Laboratory, N-234, and Arc Jet Facility, N-238. The Thermal Protection Lab began operation in 1962 and the Arc Jet Facility began operation in 1973. Both facilities have been in continous use since their initial operation. This facility complex provides testing capability for research and development activities such as for the Space Shuttle tiles, the leading edge thermal protection system testing, the materials testing of planetary entry heat shields and the aerodynamic heating investigations of vehicles in planetary atmospheres.

The Steam Ejector System consists of a natural gas-fired steam generating plant, a five-stage steam ejector vacuum pumping system, cooling towers, and high pressure water and exhaust storage equipment. This vacuum system provides the necessary discharge condition for each of the various test facilities of the complex.

The Thermal Protection Lab is comprised of the 1 x 5-inch Supersonic Turbulent Flow Duct, the Heat Transfer Wind Tunnel, the High Power Gasdynamic Laser, the 2 x 9-inch Supersonic Turbulent Flow Duct, and the Aerodynamic Heating Wind Tunnel. The Arc Jet Facility includes the 20 and 60 Megawatt Interaction Heating facilities, the High Enthalpy Entry Facility, the High Pressure Turbulent Flow Facility, and the Giant Planet Entry Facility.

The first project task replaces the fifth stage steam ejector with a mechanical vacuum pump for energy conservation. The energy savings for the first year of operation (FY 1982) is approximately 45,400,000 cubic feet (1,285,600 cubic meters) of natural gas. This savings is partially offset by the approximately 390,000 kWh required to operate the mechanical pumps. However, there will still be a net savings of approximately $250,000 per year.

The second task modifies the steam boiler which was originally designed as a ship's boiler and has been in constant operation at its present location since 1962. Over the years, its 220-tube economizer has frequently been repaired by removing or sealing tubes. Consequently, now one out of five economizer sections is inoperative which reduces the boiler efficiency. The project also provides for an exhaust gas oxygen analyzer and insulation of hot water tankage and equipment to improve efficiency. Finally, through the addition of a heat exchanger to the waste hot water side of the condenser, the boiler make-up water to the deaerator can be preheated. The combined fuel savings achieved by these modifications amounts to approximately 16,500,000 cubic feet (467,000 cubic meters) of natural gas per year valued at $95,000 per year during the first year of operation.

The third task is modifications and repairs to support systems such as the cooling water system, the gas supply system, the flow control system, the model support system, heat exchangers, the data acquisition system, and the diffuser section. This work is required to insure continued reliable and efficient operation of this research facility complex.

IMPACT OF DELAY:

If this project is delayed, significant energy will be needlessly wasted. The combined net savings of this project will result in a payback of about 3 years. In addition, the modification and repair items must be done to insure future facility reliability and needed flexibility.

PROJECT DESCRIPTION:

Replacement of Fifth Stage Ejector

The last (fifth) stage of the Thermal Protection Laboratory's Steam Ejector System will be replaced with mechanical/electrical vacuum pumps. To accomplish this, two vacuum pumps and motors operating in parallel are required. The project also includes all piping, valving controls and electrical modifications necessary to install the new fifth stage. Surplus 600 horsepower (447 kilowatts) electric motors will be installed to drive the vacuum pumps.

Modification to the Steam Boiler

Modifications to the boiler include the installation of new tubes in the economizer, and improvements to related equipment. This work also includes the installation of an oxygen analyzer and combustion air controls to improve the operational efficiency. Three inches (7.6 centimeters) of fiberglass insulation are to be applied to the bare steel tank saddles, supporting steel work, adjacent valves, and to the deaerator tank. Also included is the installation of a heat exchanger to preheat the boiler makeup water.

Modification and Repair of Various Components

a. Repair of Support Systems. The following support systems for the Arc Jet and Thermal Protection Lab facilities will be repaired or replaced in-kind.

- The cooling water system which consists of seven large capacity water pumps, 500 horsepower (373 kilowatt) drive motors and system valves will be overhauled.

- The Gas Supply System repairs include the replacement of a deteriorated and failing Nitrogen Storage System, replacement of a storage tank, pump valves and manifolding, and refurbishment of valves, manifolds, and other support items for helium/hydrogen gas and carbon monoxide systems.

- The Flow Control System repairs include replacement of obsolete and worn flow control drives such as differential pressure transmitters, gages and other central panel instruments.

- The Model Support System repair will replace the debilitated model support system for the Aerodynamic Heating tunnel.

- The downstream heat exchanger of the 2- x 9- Turbulent Flow Duct of the lab will be replaced.

b. Modification of Thermal Protection Lab Data Acquisition System. This modification consists of replacing the existing data acquisition system and wiring in Building N-234 with a newly acquired computer controlled Data Acquisition/Processing system and associated wiring.

c. Modifications of the Aerodynamics Heating Facility. The existing 4-foot (1.2 meter) diameter diffuser section of the Aerodynamic Heating Facility will be replaced with a 6-foot (1.8 meter) in diameter section. This diffuser pipe will pass through the north wall of Building N-234 and requires the present opening to be enlarged to accommodate the larger diameter diffuser pipe. Included in this revision will be a new 6-foot (1.8 meter) diameter vacuum valve with a valve shield mechanism. The existing diffuser entrance, diffuser pipe, water jacket and expansion joint will be replaced. Modifications will also be made to the test section box, plenum and cooling water piping.

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PROJECT COST ESTIMATE:

This cost estimate is based on a Preliminary Engineering Report.

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	2,300,000
Site development	---	---	---	---
Replacement of fifth stage steam ejector	---	---	---	765,000
Vacuum pump	EA	---	---	(505,000)
Piping, valves and electrical	LS	---	---	(260,000)
Modification to steam boiler	LS	---	---	400,000
Modification and repair of various components	---	---	---	1,135,000
Repairs of support systems	LS	---	---	(480,000)
Modification of thermal protection lab data acquisition system	LS	---	---	(455,000)
Modification of aerodynamic heating facility diffuser	LS	---	---	(200,000)
Fallout Shelter (not feasible)	---	---	---	---
Total				2,300,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Schematic Diagram

OTHER EQUIPMENT SUMMARY:

No additional equipment is required for this project.

FUTURE CoF ESTIMATED FUNDING TO COMPLETE THIS PROJECT:

There are no anticipated future funding requirements necessary to complete this project.

AMES RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
MODIFICATION OF STEAM EJECTOR SYSTEM
SCHEMATIC DIAGRAM

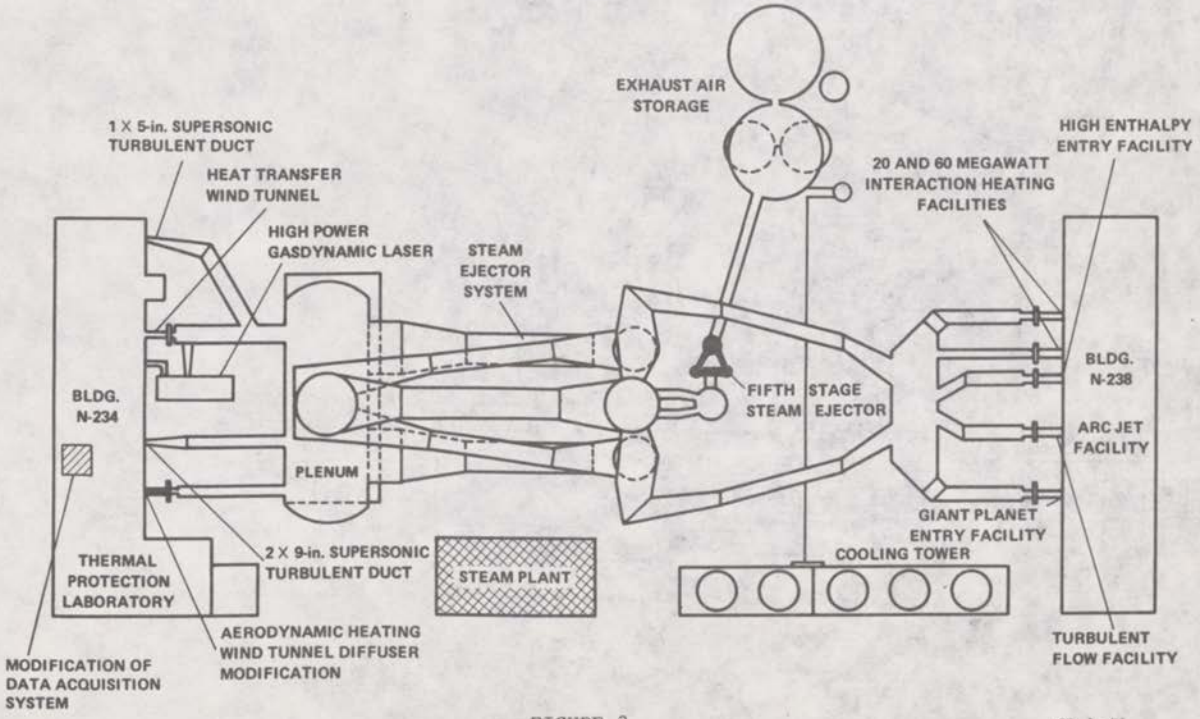


FIGURE 2

CF 1-16

AMES RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
MODIFICATION OF THE UNITARY PLAN WIND TUNNEL
LOCATION PLAN

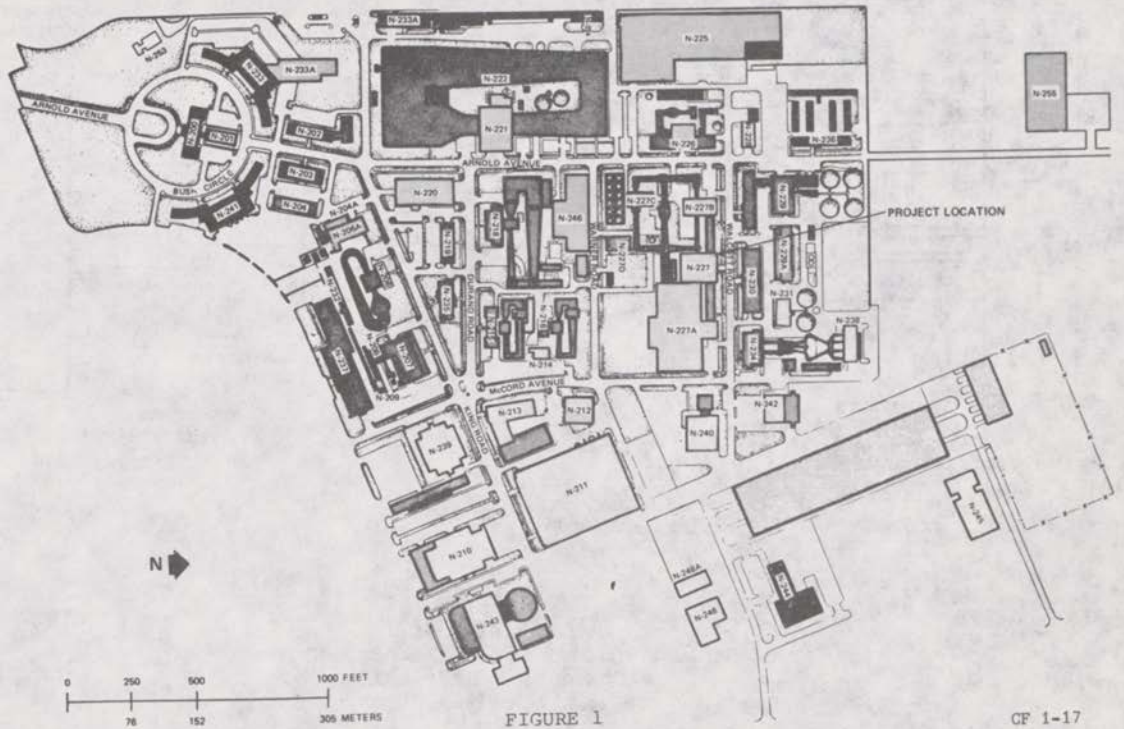


FIGURE 1

CF 1-17

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Modification of the Unitary Plan Wind Tunnel (N-227)

INSTALLATION: Ames Research Center

FY 1981 CoF ESTIMATE: $3,400,000

LOCATION OF PROJECT: Moffett Field, Santa Clara County, California

COGNIZANT HEADQUARTERS OFFICE: Office of Aeronautics and Space Technology

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	415,000	7,522,000	7,937,000
Capitalized investment	N/A	35,316,298	35,316,298
Total	415,000	42,838,298	43,253,298

SUMMARY PURPOSE AND SCOPE:

This project modifies the Unitary Plan Wind Tunnel (UPWT), Ames Research Center (ARC) (Figure 1), Moffett Field, California, for energy conservation improvements and to maintain an efficient operation of this testing complex. The energy conservation modifications will save approximately 20,000,000 kilowatt-hours of electricity annually with an estimated savings of $540,000 per year beginning in FY 1982. This project also includes modifications to the model buildup shops as well as repairs to the cooling coils, flow control valves and other equipment.

PROJECT JUSTIFICATION:

The UPWT complex consists of three separate wind tunnel circuits and test sections; the 11- X 11-Foot Transonic with a Mach number range of 0.4 to 1.4, the 9- X 7-Foot Supersonic with a Mach number range of 1.5 to 2.5, and the 8- X 7-Foot Supersonic with a Mach number range of 2.5 to 3.5 (Figure 2). All three circuits are powered by a common set of drive motors. Therefore, only one wind tunnel can be operated at a time. The Unitary facility has been in continuous operation since completion of construction in 1955, and is a National Facility.

Experimental investigations conducted in the UPWT facilities include projects requested by: the Department of Defense (DOD) for advanced aircraft and missiles; the aircraft industry for commercial transports; ARC in-house researchers for advanced NASA aerodynamic programs; and other NASA centers and government organizations for a broad range of advanced aircraft and aerospace projects.

Because this facility is heavily used and plays an important role in the Nation's aeronautical research programs, it is imperative that these improvements be made. The energy conservation measures, needed modifications and repair work will assure its continued operation, at minimum cost and maximum efficiency.

Four of the five tasks comprising this project are required to reduce the operating energy consumption of the UPWT. This work includes: modifying the 11- X 11-Foot leg compressor to enable control of the wind tunnel flow speed by adjusting the inlet guide vanes instead of the drive motors; installing bypass switchgear and eliminating the rheostat losses for maximum speed operation; reducing the electrical power usage of the 11- X 11-Foot test section diffuser region; and automation of the start up, on line adjustment, and shutdown sequencies of the wind tunnel's pressurization and compressor lubrication systems. Approximately 20,000,000 kilowatt-hours per year will be saved by these modifications. The estimated amortization period for this energy investment is less than 4 1/2 years.

The other modification and repair work is required to maintain and improve the operating condition of the UPWT complex. Modifications to the model buildup shops are needed to allow complete assemblies of model-balance-sting instrumentation for checkout before installation in the wind tunnel test section. Because modern models and instrumentation are becoming more complex, buildup and checkout of these assemblies is best performed outside the tunnel test section. This will provide better tunnel utilization and a more manpower efficient checkout environment. Acoustic treatment of the 9-X 7-Foot Wind Tunnel is needed to reduce the noise level in the test chambers from 117 dba, which does not meet OSHA standards, to under 85 dba which is acceptable for continuous work areas.

The repair work is needed for continued efficient operation of the facility. The existing cooling spray canopy is corroded and cooling coils are subjected to thermal stresses from imprecise control of the cool-down

cycle during shutdown of the facility. The coils and control valves of the 11-X 11-Foot Wind Tunnel after cooler and compressor lubrication system heat exchangers are old and unreliable. These systems need frequent repair and always leak, allowing moisture to enter the wind tunnel. This problem can only be eliminated by complete replacement of these components. Both the vibration and temperature monitoring systems are worn out and outdated. Reliable, low maintenance, state-of-the-art systems will replace these existing systems. These monitoring systems are essential to the wind tunnel operation because either excessive bearing temperature or compressor rotor vibration can lead to catastrophic failures.

IMPACT OF DELAY:

If this project is delayed, significant potential energy savings will not be realized. The UPWT uses approximately 46 percent of ARC's electrical energy. This project will save approximately nine percent of the Center's utilities energy consumption as compared to 1978. Consequently, it is a critical element in ARC's program to reduce energy consumption and improve efficiency of large energy users. In addition, if the necessary modification and repair items are delayed, more frequent shutdowns for maintenance and repair could occur. This will result in an ever increasing backlog of testing in this key research and development facility.

PROJECT DESCRIPTION:

The five project tasks are described below:

Modification of Compressor 11- X 11-Foot Leg

The compressor of the 11- X 11-Foot leg of the UPWT consists of 3 stages of fixed (stator) and rotating (rotor) blades as well as fixed inlet and exit guide vanes. Modifications will replace the fixed inlet guide vanes of the compressor with motorized camber inlet guide vanes, and adjust the first, second, and third stage stator blades, and exit guide vanes to optimized fixed positions. This will permit the control of the wind tunnel flow speed by adjusting the variable camber inlet guide vanes rather than through the present method of changing the drive motors speed. Presently, the speed of the drive motors is reduced by increasing the amount of resistance in the motor secondary circuit resulting in heat energy losses. The purpose of the variable camber inlet guide vanes is to introduce the correct amount of swirl to the flow upstream of the first compressor stage.

Modification of Drive Motor Control

Presently, liquid rheostats provide the varying resistance for speed control of the four 45,000 HP (33,500 kW) compressor drive motors. At maximum speeds, these resistors introduce a loss of about 4 percent into the circuit. Unlike the 11- X 11-Foot circuit, the 8- X 7-Foot and 9- X 7-Foot circuits normally operate at maximum speed. The proposed bypass switchgear will eliminate these rheostat losses at maximum speed operation by permitting the bypass switching of the resistors out of the circuit. The switchgear will be of the outdoor, weatherproof enclosed type, rated for 5,000 volts and 6,000 amps, and will be positioned close to the Auxiliary Equipment Building.

Modification of Plenum Bleed System

This modification work involves the use of 9 boundary layer ejectors to significantly increase the efficiency of the tunnel diffuser which is the highest energy loss segment of the tunnel circuit. This ejector system consists of an array of 104 nozzles installed around the periphery of the downstream end of the test section. It will remove air around the test section and re-introduce the air further downstream from the test section, thereby increasing the flow efficiency. Piping and controls required to supply air to these nozzles from an existing compressor are also part of this project.

Automation of the Make-Up Air (MUA) System

The project will provide a system which will permit a controller, acting through electrical relays, to automatically operate the make-up air system. The controller will consist of input/output sensors to activate electric valve motors, receive valve position and pressure sensor data; a computer processor capable of storing alternate operation and sequences data and monitoring system status; operator displays and manual override equipment; and sensors for system monitoring.

Modification and Repair of Various Components and Systems

This portion of the project consists of the following:

a. Modification of Model Build-up Shops. Installation of support systems such as an overhead crane, high pressure air supply, electric power, and data system connections to provide improved model buildup capability in these shops.

b. Acoustic Treatment of 9- X 7-Foot Wind Tunnel Diffuser and Test Chamber. The wind tunnel will be enclosed with a fiberglass sound wall in the Test Chamber area. This will acoustically isolate the wind tunnel from the work area adjacent to the tunnel.

c. Cooling System Modification. The existing spray canopy will be replaced and enlarged. Control valves and a control system will be provided to allow automatic cool-down when the facility is shutdown. Cooling tower drift eliminators and fire protection sprinklers will be repaired/replaced to save water and provide proper protection.

d. Cooling Coils and Flow Control Valves. The coils and control valves of the 11- X 11-Foot Wind Tunnel after-cooler and compressor lubrication system heat exchangers will be replaced in kind with new components.

e. Vibration and Temperature Monitoring Equipment. Existing equipment will be replaced with modern components to provide adequate monitoring of both temperature and vibration of the wind tunnel compressors.

PROJECT COST ESTIMATE:

This cost estimate is based on a Preliminary Engineering Report.

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	3,400,000
Modification of compressor	LS	---	---	730,000
Modification of drive motor control	LS	---	---	820,000
Modification of plenum bleed system	LS	---	---	300,000
Automation of make-up air system	LS	---	---	650,000
Modification & repair of various components systems	---	---	---	900,000
Modification of model buildup shops	LS	---	---	(47,000)
Acoustic treatment of 9- X 7-foot wind tunnel	LS	---	---	(162,000)
Cooling system modification	LS	---	---	(211,000)
Cooling coils and flow control valves	LS	---	---	(300,000)
Vibration and temperature monitoring equipment	LS	---	---	(180,000)
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total				3,400,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Isometric View

OTHER EQUIPMENT SUMMARY:

No other equipment is required for this project.

FUTURE COF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

As presently planned, there are no anticipated future funding requirements necessary to complete this project.

AMES RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
MODIFICATION OF THE UNITARY PLAN WIND TUNNEL

ISOMETRIC VIEW

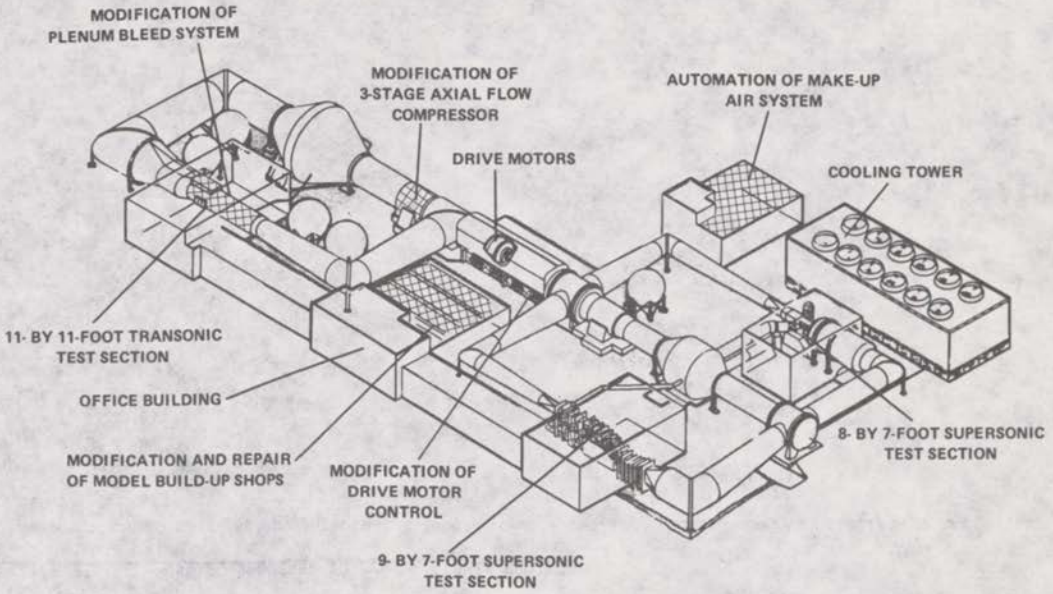


FIGURE 2

CF 1-25

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

SUMMARY

JET PROPULSION LABORATORY

	Amount	Page No.
Office of the Comptroller:		
Modifications to Various Buildings for Energy Conservation.....	1,500,000	CF 2-1
Modifications to Various Buildings for Seismic Protection.....	2,000,000	CF 2-6
Total.....	3,500,000	

JET PROPULSION LABORATORY
FISCAL YEAR 1981 ESTIMATES
MODIFICATIONS TO VARIOUS BUILDINGS FOR ENERGY CONSERVATION

LOCATION PLAN



FIGURE 1

CF 2-1

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Modifications to Various Buildings for Energy Conservation

INSTALLATION: Jet Propulsion Laboratory

FY 1981 CoF ESTIMATE: $1,500,000

LOCATION OF PROJECT: La Canada-Flintridge, Los Angeles County, California

COGNIZANT HEADQUARTERS OFFICE: Office of the Comptroller, Facilities Division

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	115,000	---	115,000
Capitalized investment	N/A	16,355,161	16,355,161
Total	115,000	16,355,161	16,470,161

SUMMARY PURPOSE AND SCOPE:

This project provides for modifications to mechanical and electrical systems in various Jet Propulsion Laboratory (JPL) buildings to improve efficiency of operation and reduce energy consumption. The air-conditioning systems in thirteen buildings will be modified to reduce wasteful, chilled air-reheat mechanical systems capacities to more closely match the loads in the buildings (Figure 1). This will reduce the energy needed to satisfy the space conditioning requirements. These modifications will reduce electrical consumption by approximately 6,000,000 kilowatt hours of electricity and 27,000,000 cubic feet of natural gas per year. These energy reductions will enable JPL to operate these buildings using less energy, and reduce the total

laboratory energy consumption by almost 8 percent compared to FY 1978 levels. The estimated first year's operational savings is about $380,000. This project is very cost-effective with a simple payback period of four years.

PROJECT JUSTIFICATION:

The mechanical and electrical systems for these buildings were designed and installed when energy consumption was not a major consideration. At that time, a low initial cost system that satisfied the building requirements was the criterion. The existing constant air volume systems waste significant amounts of energy because of their inability to vary the energy input as loads inside the building change or outside air conditions change. The existing controls are inadequate and unreliable. The existing chilled water and hot water systems are energy inefficient. The general office lighting levels in Building 180 are much higher than needed. Conversion of constant air volume systems to variable air volume (VAV) systems (Figure 2); replacement of inefficient motors and installation of economizers; modification of the HVAC system to allow the main system to shutdown during off-hours; and decreasing the lighting levels of office areas in Building 180 will improve operating efficiencies and save energy. The chilled water and hot water systems will be rebalanced to more closely match the building loads and use outside air to the maximum extent.

IMPACT OF DELAY:

Delay in accomplishing these modifications to the mechanical and electrical systems will result in unnecessary expenditure of funds for energy, continued waste of natural gas and delay a significant increment of JPL's overall energy reductions.

PROJECT DESCRIPTION:

This project provides for the modification to the existing HVAC systems of some 370,000 square feet (34,370 square meters) of space in Buildings 125, 144, 150, 158, 180, 190, 197, 198, 200, 201, 244, 245, 248. The work includes installation of new control systems, conversion of existing constant air volume systems to variable air volume (VAV) systems, rehabilitation of chilled water and hot water systems, and rebalancing the air distribution systems in the thirteen buildings. Additionally, replacement of motors, provision of economizers, and minor duct changes will be included. It is also planned to reduce the general office lighting in Building 180 from over 5 watts per square foot to 3 watts per square foot. Provisions will be made to connect these buildings to the Utility Control System at JPL, so that night set-back and system optimization can be achieved.

PROJECT COST ESTIMATE:

The basis of this cost estimate is a Preliminary Engineering Report.

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	1,500,000
Demolition	LS	---	---	90,000
Structural modifications	LS	---	---	70,000
Electrical modifications	LS	---	---	290,000
Mechanical modifications	LS	---	---	1,050,000
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total				1,500,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Typical HVAC Modifications

OTHER EQUIPMENT SUMMARY:

There is no other equipment required to be used with this facility project.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

There are no known future requirements to complete this project.

JET PROPULSION LABORATORY
FISCAL YEAR 1981 ESTIMATES
MODIFICATIONS TO VARIOUS BUILDINGS FOR ENERGY CONSERVATION

TYPICAL HVAC MODIFICATIONS

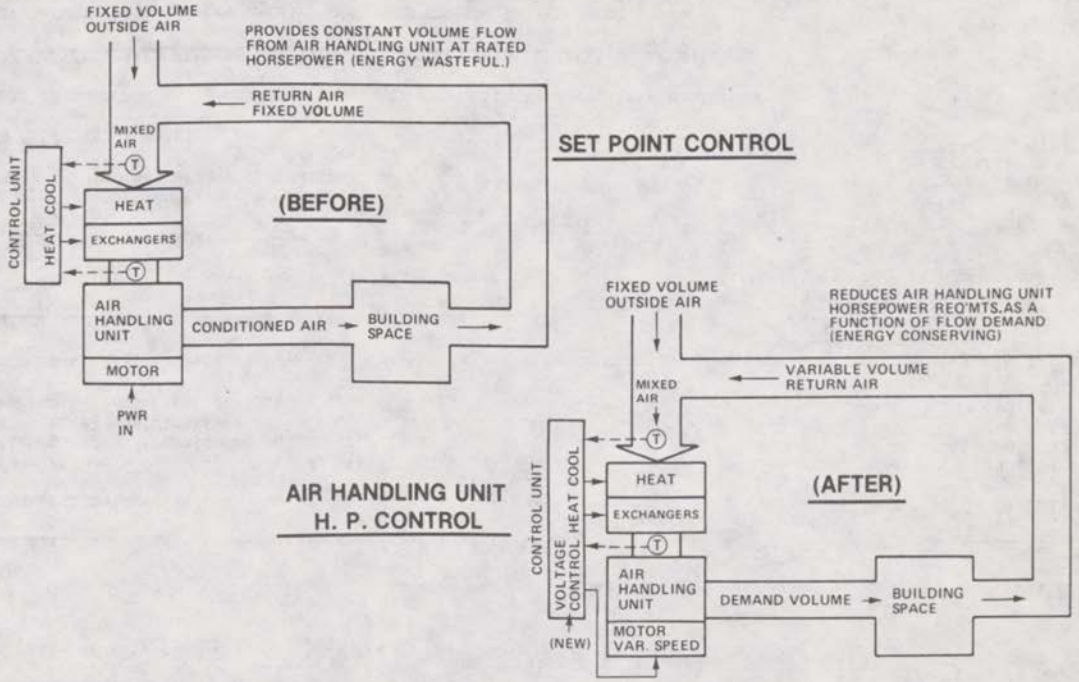


FIGURE 2

CF 2-5

JET PROPULSION LABORATORY
FISCAL YEAR 1981 ESTIMATES
MODIFICATIONS TO VARIOUS BUILDINGS FOR SEISMIC PROTECTION

LOCATION PLAN

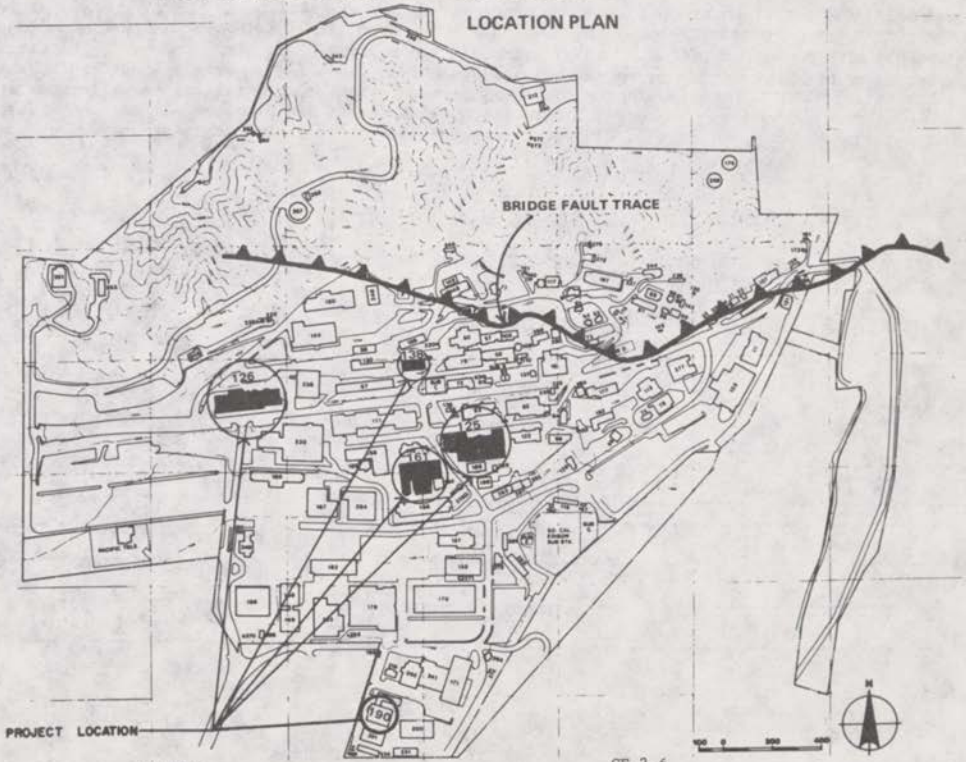


FIGURE 1

CF 2-6

PROJECT TITLE: Modifications to Various Buildings for Seismic Protection

INSTALLATION: Jet Propulsion Laboratory

FY 1981 CoF ESTIMATE: $2,000,000

LOCATION OF PROJECT: La Canada-Flintridge, Los Angeles County, California

COGNIZANT HEADQUARTERS OFFICE: Office of the Comptroller, Facilities Division

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	605,000	5,070,000	5,675,000
Capitalized investment	N/A	5,035,300	5,035,300
Total	605,000	10,105,300	10,710,300

SUMMARY PURPOSE AND SCOPE:

The purpose of this project is to provide seismic reinforcement necessary to minimize human fatalities at five Jet Propulsion Laboratory (JPL) Buildings that are susceptible to collapse in the event of a major earthquake. This reinforcement work will meet current seismic code standards. Structural, architectural, mechanical and electrical systems will be improved in accordance with the JPL Seismic Safety Plan to minimize fatalities and provide for the safe exit of personnel. FY 1978 and 1979 seismic protection projects provided for comparable efforts in some 20 major JPL buildings as well as the JPL water storage system. Further analysis of the earthquake probabilities and associated risks has identified these additional buildings which require

strengthening to upgrade resistance to seismic forces for protection of buildings' occupants during major earthquakes. This project includes improvements to buildings (125, 126, 138, 161, and 190) which have serious deficiencies. These facilities will be used through the 1980's and, therefore, these modifications are necessary and prudent.

PROJECT JUSTIFICATION:

This project is necessary to minimize potential high fatality seismic risks caused by the seismic hazard at JPL. Structural modifications to the buildings will prevent collapse even in the event of irreparable structural damage. Other modifications will minimize injuries from hazards within buildings, such as falling ceilings, partitions or hardware; broken water and natural gas lines; failure of elevator hoistways; and blockage of stairways. Since the average seismic hazard for the JPL site is high, this work should be accomplished as soon as possible.

JPL is located in rugged topography at the base of the San Gabriel Mountains (Figure 1). The northern portion of the site is steep and mountainous. The lower portion is a decomposed granite alluvial fan with slopes of about 14 percent. After the 1971 San Fernando earthquake, geologic investigations located a thrust-type fault running east and west across the northern end of the site. The fault, named the "JPL Bridge Fault", is related to the San Gabriel fault zone that produced the San Fernando earthquake and is considered potentially active (Figure 2).

JPL initiated seismic studies on a priority basis soon after the 1971 San Fernando earthquake. Over the past several years, the seismic hazard and the earthquake resistance of a significant number of JPL facilities have been investigated. In summary, these studies included: (1) determination of local and regional geology and seismicity; (2) studies of foundation materials; (3) determination of earthquake probabilities and the nature of resultant earth shaking; (4) development of seismic design criteria; (5) design checks of numerous suspect facilities with the guidance of new codes; (6) dynamic analyses of several buildings; (7) identification of unsafe facilities or structural elements; (8) cost estimates for upgrading facilities; and, (9) cost estimates for replacement of facilities. Results of these studies were used to develop the JPL Seismic Safety Plan, which was the basis for the FY 1978 and FY 1979 projects as well as this funding request. Facilities at JPL were designed in accordance with codes applicable at the time of construction, but are now assessed as having inadequate earthquake resistance in view of the present seismic hazard knowledge and the latest building codes. The facilities to be rehabilitated are the remaining minor facilities at JPL considered to be high potential fatality seismic risks. The FY 1978 and FY 1979 projects addressed the major facility requirements at JPL.

IMPACT OF DELAY:

Delay in providing for these modifications will result in the continuation of unacceptable high seismic risk to the occupants of these buildings. The five buildings in this project do not conform to minimum criteria for protection against seismic hazards caused by a major earthquake and are high potential fatality risks.

PROJECT DESCRIPTION:

The project includes structural modifications to prevent the collapse of the walls and floors in five buildings, and other nonstructural modifications to minimize hazards from architectural, electrical and mechanical failures. Structural modifications include adding reinforced concrete shear walls, guniting and reinforcing existing walls and columns, and provisions for anchoring roofs and floors to masonry walls. Nonstructural modifications include elevator hoistway bracing; adding battery powered fire alarm and light systems; strengthening stairways; anchoring heating, ventilating and air-conditioning (HVAC) equipment; providing automatic shutoff valves on water and natural gas pipelines; and providing building utility pipeline and powerline flexibility.

The following facilities, with a cumulative occupancy of approximately 1,085 people, are included in this project:

Facility Number	Facility Title	Avg. No. of Occupants
125	Electronics Laboratory	311
126	Systems Division Office Building	255
138	Engineering Office	53
161	Telecommunications Laboratory	337
190	Procurement Office/Cafeteria	129

PROJECT COST ESTIMATE:

The basis of this cost estimate is a detailed Preliminary Engineering Report supported by related studies.

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	2,000,000
Modifications to building 125	LS	---	---	495,000
Modifications to building 126	LS	---	---	470,000
Modifications to building 138	LS	---	---	320,000
Modifications to building 161	LS	---	---	415,000
Modifications to building 190	LS	---	---	300,000
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total				2,000,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Geological Fault Map of Los Angeles County

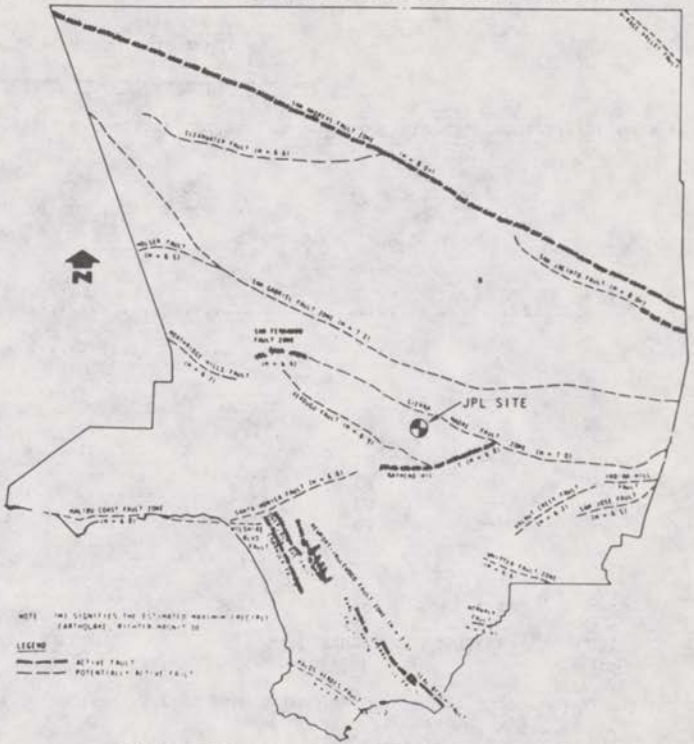
OTHER EQUIPMENT SUMMARY:

There is no known additional equipment, either collateral or noncollateral, required for this project.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT

No future funding is required to complete this project.

JET PROPULSION LABORATORY
FISCAL YEAR 1981 ESTIMATES
MODIFICATIONS TO VARIOUS BUILDINGS FOR SEISMIC PROTECTION



GEOLOGICAL FAULT MAP OF LOS ANGELES COUNTY
FIGURE 2

CF 2-11

57-166 O - 80 - 34

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

SUMMARY

JOHN F. KENNEDY SPACE CENTER

	Amount	Page No.
Office of the Comptroller:		
Rehabilitation of High Temperature Hot Water System, Zone 2, Industrial Area	760,000	CF 3-1

JOHN F. KENNEDY SPACE CENTER
FISCAL YEAR 1981 ESTIMATES
REHABILITATION OF HIGH TEMPERATURE
HOT WATER SYSTEM, ZONE 2,
INDUSTRIAL AREA
LOCATION PLAN

CF 3-1

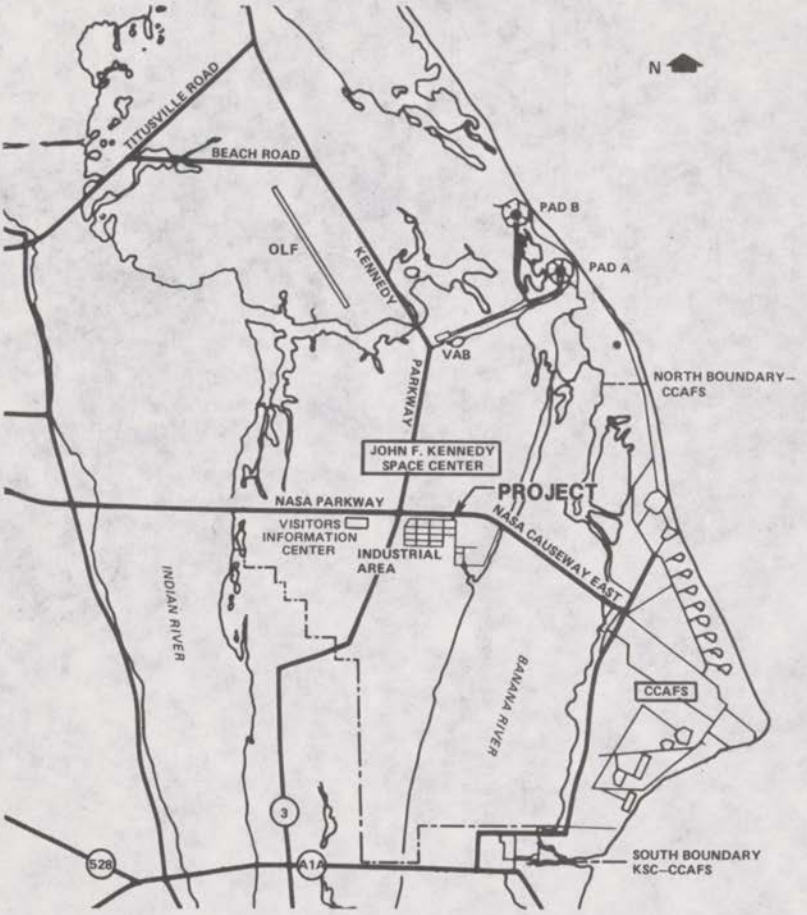


FIGURE 1

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Rehabilitation of High Temperature Hot Water System, Zone 2, Industrial Area

INSTALLATION: John F. Kennedy Space Center

FY 1981 CoF ESTIMATE: $760,000

LOCATION OF PROJECT: John F. Kennedy Space Center, Brevard County, Florida

COGNIZANT HEADQUARTERS OFFICE: Office of the Comptroller, Facilities Division

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	51,000	---	51,000
Capitalized investment	N/A	4,459,000	4,459,000
Total	51,000	4,459,000	4,510,000

SUMMARY PURPOSE AND SCOPE:

This project will replace approximately 3,000 linear feet (914 meters) of 8-inch (20.3 centimeter) diameter and 2,000 feet (610 meters) of 6-inch (15.2 centimeter) diameter high temperature hot water (HTHW) pipe and appurtenances which are used for critical environmental control in the Operations and Checkout Building, M7-355; the Supply, Shipping and Receiving Building, M7-505; and the Flight Crew Support Building, M7-409 at the Kennedy Space Center (KSC). The existing piping is located in a concrete trench which floods during heavy rains, causing deterioration of the insulation and corrosion of the pipe, valves and expansion joints. Approximately 3,100 linear feet (945 meters) of 8-inch pipe and 2,300 linear feet (701 meters) of 6-inch pipe

will be installed above grade in a grassed utility island (Figure 2) where it will not be subject to the destructive flooding and corrosive conditions. This project will assure the reliability of the system to support Shuttle Payloads, and will significantly reduce maintenance costs and fuel consumption. It will also eliminate potential safety hazards.

PROJECT JUSTIFICATION:

This project is the final increment of work for replacing an underground HTHW system with an above ground system. The rate of deterioration on this last portion of the below ground system has accelerated to the point where during a recent three-month period it was necessary to make emergency replacement of one 8-inch and two 6-inch expansion joints and repair a hole in a corroded 6-inch feeder to the Operations and Checkout Building. Because of the extremely adverse condition of the existing underground system there is a strong probability of increasingly frequent failures with the consequent loss of controlled environment in the critical Shuttle activity areas in the Supply, Shipping and Receiving Building, the Flight Crew Support Building, and especially in the Operations and Checkout Building. In this facility, environmentally sensitive Spacelab flight hardware is located, and temperature and humidity critical payloads are to be tested and checked out. The present system provides no means of supporting the buildings with high temperature hot water in the case of a failure. A minimum of 24 hours is required to cool down the system to accomplish repairs and bring it up to operating temperature again.

On several occasions, because of this advancing deterioration, sections of the system have literally disintegrated (usually at the expansion joints), throwing off the heavy steel trench covers and spraying a jet of scalding water in a heavily used automobile parking area.

The net energy loss resulting from the wet, deteriorated insulation is estimated to average 1,190,000 BTU per hour, resulting in a waste of approximately 55,000 gallons (208,000 liters) of fuel oil a year at a cost in current dollars of $25,000 a year. Records indicate that the maintenance cost (labor and materials) for keeping this portion of the system operational is approximately $10,000 a year.

IMPACT OF DELAY:

Delay of this project increases the risk of impacting the test control and checkout of Spacelab and horizontal processed payloads which are dependent on precise temperature and humidity. The potential hazard to personnel and equipment in the parking area will continue. High maintenance costs will continue as repairs to the below ground system increase and approximately 55,000 gallons of fuel oil will be wasted during each year of delay.

PROJECT DESCRIPTION:

This project will replace approximately 3,000 linear feet of 8-inch diameter pipe and 2,000 linear feet of 6-inch diameter pipe and appurtenances located in a concrete trench. This is the final portion of the high temperature hot water distribution system which is being replaced incrementally. Approximately 3,100 linear feet of 8-inch diameter pipe and 2,300 linear feet of 6-inch pipe will be located above ground in a grassed utility island. The new pipe will have the same capacity as the existing pipe and will be covered with a 4-inch (10.2 centimeter) cellular glass insulation and wrapped with ultraviolet resistant polyvinyl chloride jacketing.

The construction of the new system will take place without interfering with the use of the present system. The outage for the final tie-in of the new system will be scheduled to avoid interruption of essential operations.

PROJECT COST ESTIMATE:

This cost estimate is based on a Preliminary Engineering Report and related studies.

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	760,000
Sitework	LS	---	---	26,000
Pipe and fittings	LF	5400	30.43	164,000
Valves	EA	53	138.72	8,000
Pre-fab pipe-in-conduit	LF	415	177.30	74,000
Pipe insulation and jacket	LF	5400	28.31	153,000
Pipe supports, etc	LS	---	---	335,000
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total				760,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Site Plan

OTHER EQUIPMENT SUMMARY:

There is no other equipment required to be used with this facility project.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

There is no future funding required for this facility project.

JOHN F. KENNEDY SPACE CENTER
FISCAL YEAR 1981 ESTIMATES
REHABILITATION OF HIGH TEMPERATURE HOT WATER, ZONE 2, INDUSTRIAL AREA
SITE PLAN

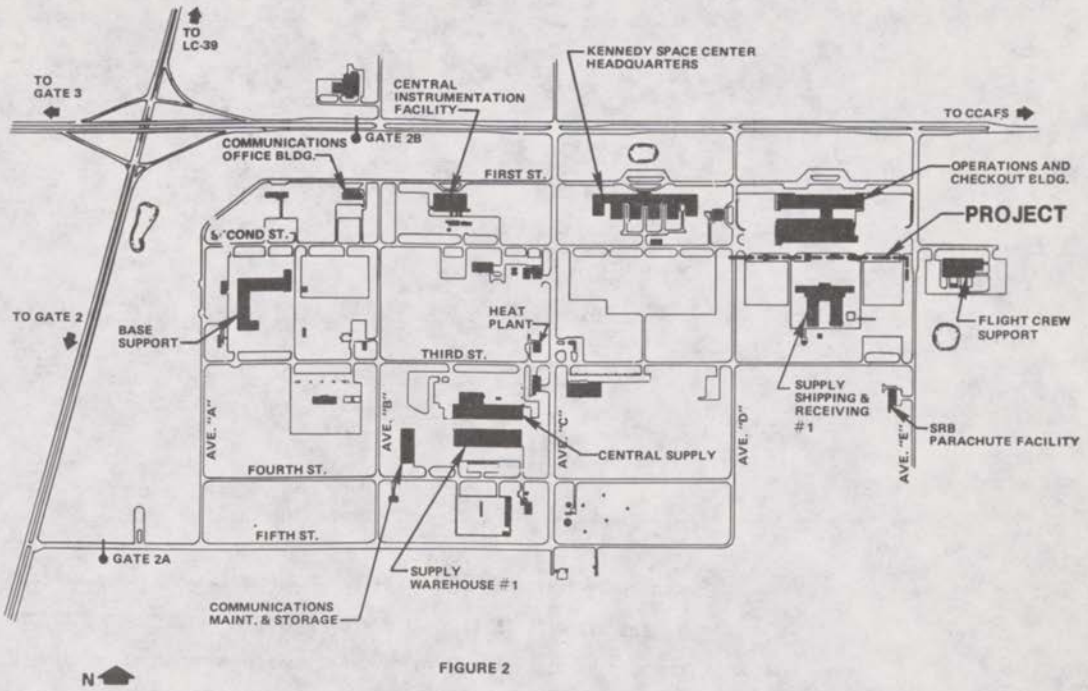


FIGURE 2

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

SUMMARY

LANGLEY RESEARCH CENTER

	Amount	Page No.
Office of Aeronautics and Space Technology:		
Modifications for Avionics Integration Research Laboratory (1220).....	5,756,000	CF 4-1
Modifications to Aircraft Landing Dynamics Facility (1257).....	15,000,000	CF 4-8
Rehabilitation and Modification of Gas Dynamics Laboratory (1247).....	2,000,000	CF 4-17
Total.....	22,756,000	

LANGLEY RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
MODIFICATIONS FOR AVIONICS INTEGRATION RESEARCH LABORATORY, BUILDING 1220
LOCATION PLAN

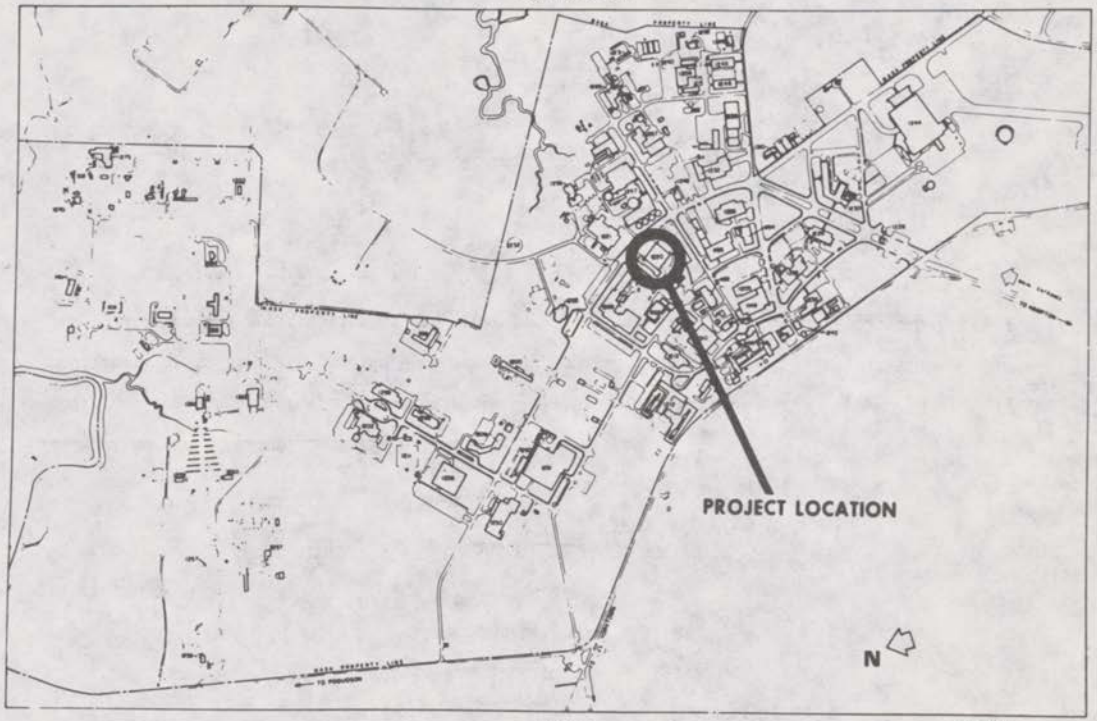


FIGURE 1

CF 4-1

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Modifications for Avionics Integration Research Laboratory, Building 1220

INSTALLATION: Langley Research Center

FY 1981 CoF ESTIMATE: $5,756,000

LOCATION OF PROJECT: Hampton, Virginia

COGNIZANT HEADQUARTERS OFFICE: Office of Aeronautics and Space Technology

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	570,000	---	570,000
Capitalized investment	N/A	2,629,313	2,629,313
Total	570,000	2,629,313	3,199,313

SUMMARY PURPOSE AND SCOPE:

Modifications for the Avionics Integration Research Laboratory (AIRLAB) at Langley Research Center (LaRC) will provide capability to conduct avionics integration research to formulate, study, and design automated avionics systems for future aircraft. This research will be broadly applicable to General Aviation, Vertical/Short Take-Off and Landing (V/STOL), and Conventional Take-Off and Landing (CTOL) aircraft. The facility will be used to perform research in advanced aircraft control systems, avionic data distribution

systems, highly reliable fault tolerant avionic systems, sensors, and actuators. In addition, it will be used to study and evaluate full systems integration of new technology concepts for cockpit display and flight management. There is no facility that can provide this vital research capability.

PROJECT JUSTIFICATION:

This facility is required to support LaRC's assigned roles and missions for aeronautical avionics and control programs. AIRLAB will simulate an entire aircraft avionics system. This comprenensive simulation capability will permit realistic assessment of new technology in a safe ground test environment, and encourage timely development and use of potentially high benefit (cost and performance) technology in future aircraft designs. The facility will be used to study advanced integrated avionics systems through the use of actual flight hardware, microprogrammed simulators, unique logic emulators, and analytical modeling. AIRLAB will provide a capability, which does not exist, for bringing together advanced technology avionics and control elements into configurations which can be assessed and optimized. While complex avionic systems are readily conceived at this time, practical development and testing is limited. AIRLAb will be the catalyst and driving influence for assessment and safety assurance of fault tolerant fully integrated systems.

Projections of future aircraft development point to more complex design requirements dictated by economics, noise control, energy efficiency, increased air traffic and control, stringent reliability, maintainability, and safety factors. These growing design complexities lead to a greater dependency on avionic systems for safe flight. The traditional method of flight testing these critical systems is unacceptable because of risks to aircraft and crew, as well as the aircraft fuel consumption and other operating costs resulting from the extremely long test times needed to gather performance and reliability data on advanced avionics systems.

Alternate approaches using existing facilities have been determined marginally suitable. The NASA-Johnson Space Center's Shuttle Avionics Integration Laboratory (SAIL) facility is dedicated to the Space Shuttle and would require extensive technological reconfiguration to pursue the activities proposed for AIRLAB. Air Force and Navy facilities are heavily scheduled and dedicated to tactical military problems including weapon delivery and, therefore, involve trade-offs not germane to the civil sector. None of the above facilities are dedicated to obtaining basic research data to guide development of advanced avionics and controls systems.

Research results from AIRLAB will be of keen interest to industry, the Department of Defense, the Federal Aviation Administration and the engineering community at large, as well as NASA. Industry and university on-site involvement in research is basic to the concept of AIRLAB. The research that will be performed in AIRLAB is required before the full benefits of advanced aircraft design concepts and future air traffic control systems and operational procedures can be realized. Advanced technology resulting from the use of this laboratory

should be developed, validated, and made available for designers by the late 1980's. Because of the lead time necessary to bring this laboratory into operation and to accomplish the required research, it is imperative that this project be funded in FY 1981.

IMPACT OF DELAY:

This facility is needed to support development and evaluation of advanced avionics and controls technology. This technology is necessary for complementary research in areas such as crew-system integration and advanced aircraft control concepts. Without this facility, research analysis of advanced experimental avionic and control components cannot be effectively accomplished in a comprehensive, fully integrated, efficient manner.

PROJECT DESCRIPTION:

The AIRLAB will be a single story structure located within an existing high-bay area in the Simulation Research Facility, Building 1220 (Figures 1 and 2). The proposed modifications include construction of gypsum board walls, a ceiling, a raised removable-type computer room floor, and installation of air-conditioning. Existing primary electrical service is adequate for supplying the needed power for the new power distribution panels to be installed within AIRLAB. The equipment supporting the advanced avionics integration and interfacing research activities will be divided into eleven work areas within the AIRLAB facility. Nine of the eleven work areas are equipped with a minicomputer, disk mass-memory, a control console with keyboard and cathode ray tube (CRT) display, a printer-plotter, experimental control and graphics display unit, analog data recording equipment, and a laboratory-to-experimental systems interface rack. Each of the nine areas ("stations") will have the capability (through software) to not only simulate completely, or in part, an appropriate research function, but also to control experiments (fault insertions, performance monitoring, etc.) and retrieve, reduce, and display engineering data. One of the two remaining work areas will function as a research coordination control, and data acquisition center for conducting advanced avionics systems integration and interfacing experiments, and also as the interface to external systems such as those at the LaRC Data Reduction Center. This equipment includes: a digital data link interface to the Data Reduction Center, a minicomputer with disk mass-storage, a highspeed printer-plotter, analog data recorders, magnetic tape recorders, and a test control and display console. The remaining work area, the Digital Avionics Design and Reliability Analyzer, will be a computer and system diagnostic emulator consisting of a computer, disk and tape mass-storage, computer control and display equipment, and emulation experiment controllers and graphics display consoles.

PROJECT COST ESTIMATE:

The project cost estimate is based on a completed Preliminary Engineering Report.

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	823,000
Architectural/structural	SF	7,600	57.50	437,000
Mechanical	SF	7,600	22.50	171,000
Electrical	SF	7,600	28.30	215,000
Equipment	---	---	---	4,933,000
Research support stations	EA	9	342,000	3,078,000
Research coordination, control and data acquisition center	LS	---	---	647,000
Digital avionics design and reliability analyzer	LS	---	---	1,208,000
Fallout Shelter (not feasible)	---	---	---	---
Total				5,756,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Site Plan

OTHER EQUIPMENT SUMMARY:

No additional equipment is required.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

No future funding is required to complete this project.

LANGLEY RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
MODIFICATIONS FOR AVIONICS INTEGRATION RESEARCH LABORATORY, BUILDING 1220
SITE PLAN

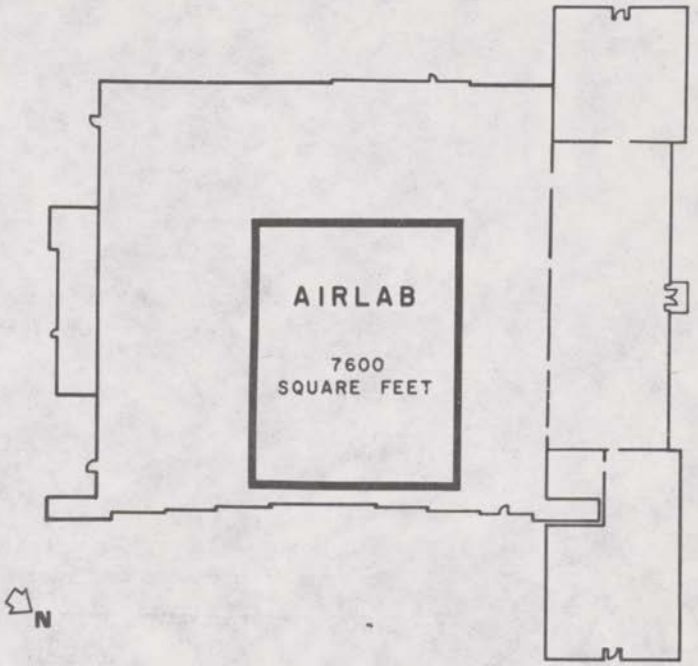


FIGURE 2

57-166 O - 80 - 35

LANGLEY RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
MODIFICATIONS TO AIRCRAFT LANDING DYNAMICS FACILITY BUILDING 1257
LOCATION PLAN

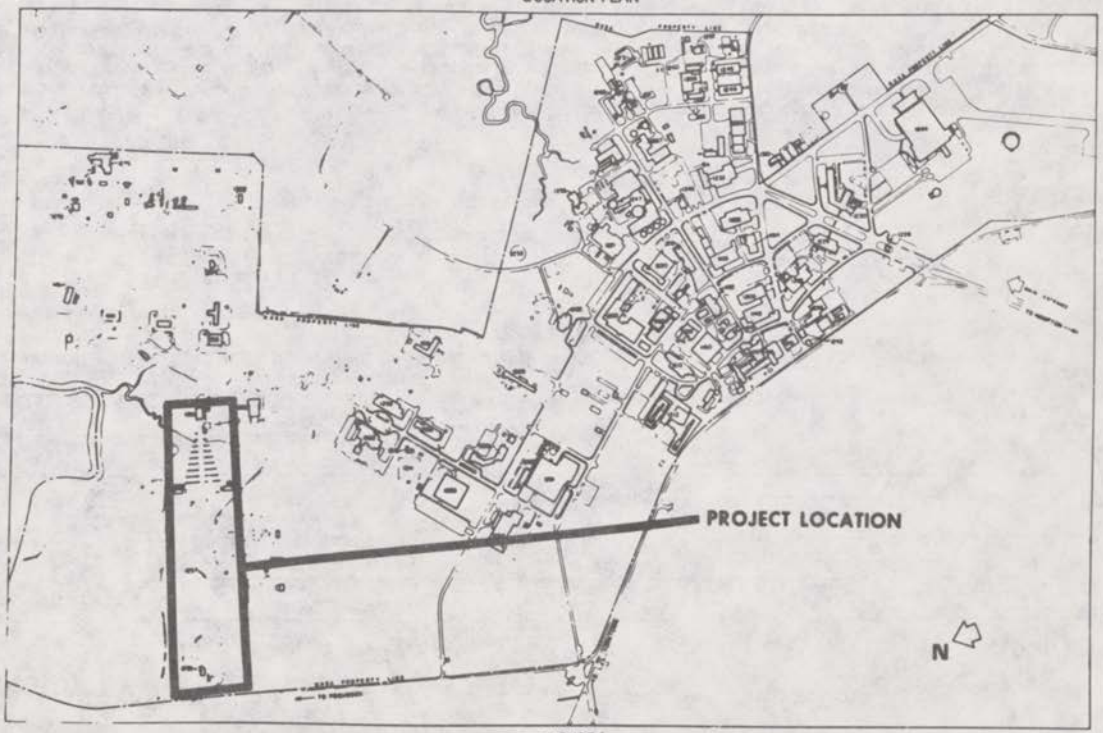


FIGURE 1

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Modifications to Aircraft Landing Dynamics Facility (1257)

INSTALLATION: Langley Research Center

FY 1981 CoF ESTIMATE: $15,000,000

LOCATION OF PROJECT: Hampton, Virginia

COGNIZANT HEADQUARTERS OFFICE: Office of Aeronautics and Space Technology

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	1,440,000	---	1,440,000
Capitalized investment	N/A	5,401,305	5,401,305
Total	1,440,000	5,401,305	6,841,305

SUMMARY PURPOSE AND SCOPE:

The purpose of this project is to increase the test speed capability of the Aircraft Landing Dynamics Facility, located at the Langley Research Center (LaRC), from 110 to 220 knots to provide a facility capable of meeting current and anticipated needs for aircraft landing gear research. This research pertains to the solution of current operational and safety problems associated with landing gear systems of existing aircraft, as well as the development of technology for future aircraft and space vehicles. The carriage propulsion system will be modified to provide the increased thrust necessary to achieve the higher test speed capability; the present test track will be extended approximately 600 feet (183 meters) to increase the length of the test section;

and an improved, higher capacity carriage arresting system will be installed downstream of the lengthened test section. Also included is a new test carriage that will withstand the increased catapult and arrestment loads and which will feature an open bay area to accommodate larger landing gear test specimens. Service and storage space for the new carriage and the existing carriages will also be provided.

The modified facility will simulate landing speeds of existing and proposed aircraft as well as explore ground operations problems. It will also provide capability for testing the newer multiwheel landing gear. When modified the facility will duplicate actual flight conditions (loads and speeds) for identifying causes of landing gear failures. This significantly improved test capability will lead to implementation of corrective actions for preventing failures that could cause loss of lives and multimillion dollar aircraft.

PROJECT JUSTIFICATION:

Most research on runway grooving, braking and steering performance, slush drag and tire hydroplaning has been accomplished at the NASA Langley Aircraft Landing Dynamics Facility. The need for continued research is exemplified by the 25 landing gear related accidents experienced by commercial airlines in 1978. Three of these involved fatalities and all resulted in significant property damage. During the past two years, nearly 300 test runs were conducted at the Aircraft Landing Dynamics Facility. These tests included braking tests on blown tires and simulation of the catastrophic DC-10 accident at Los Angeles to support the National Safety Transportation Board (NSTB) investigations. However, the simulations were limited by the speed capabilities of the existing facility. Also tested during this period were several antiskid braking systems for slippery runways, a new "air cushion" landing gear concept, and the shimmy characteristics of the Space Shuttle nose gear. Tests are also scheduled for early 1980 to investigate F-4 and F-15 landing gear and runway interaction problems.

Another major concern to airlines and aircraft manufacturers is the high maintenance costs for landing gear, brakes and tires. This facility will provide the capability to analyze stresses for optimizing design and performance and to achieve reduced operation and maintenance costs.

The present Landing Dynamics Facility became operational in 1956. At that time, 100 knot landing speeds were standard for propeller driven aircraft. After the facility became operational, jet aircraft development pushed landing speeds up to 120 to 160 knots. Current aircraft operating speeds have increased to 160 knots at touchdown and nearly 200 knots at take-off, necessitating the development of improved tires, braking systems, and landing gear shock absorbers. Aircraft have grown in size such that multiwheel landing gear systems are required to reduce surface bearing pressure levels to within the load bearing capacities of the existing runways. Such landing gear present many design and performance problems which have not been adequately

researched. In addition, tire-runway interface characteristics require better definition, especially those affected by water, snow, or ice. Research testing in the upgraded facility is essential to improve such distributed load landing systems for aircraft of the future.

A major area of emphasis for commercial transport development is all-weather landing systems and a means for metering and spacing aircraft to increase runway utility, especially during inclement weather. A part of this research includes the exploration of high speed turnoffs and taxiway maneuvering. Such high speed ground operations are necessary to avoid simply moving the congestion from the final glide path to the runway. The Terminally Configured Vehicle (TCV) will be subjected to flight and landing experiments which must be accompanied by controlled high speed tests in this facility. Data from such testing will also provide engineering criteria for landing dynamics simulators. These complementary research activities should be conducted concurrently to realize the maximum benefits of fully integrated research.

Capability does not exist for conducting full-scale tests on landing gear systems for future space vehicles returning from orbit. Normal Space Shuttle landing speeds are expected to be in the 160 to 200 knot range. Pad-abort landing speeds may approach 220 knots. With the increased capability provided by this facility, ground tests on flight hardware can be conducted under actual flight operating conditions with no risk to personnel or the space vehicles. Unconventional landing gear concepts, such as the skids used on the X-15, are promising candidates for future space vehicle applications and can be developed using this facility.

IMPACT OF DELAY:

This project must be accomplished now to provide increased capability for developing technology required for upgrading and modifying landing gear systems on existing civil and military aircraft. The existing facility, with its current test limitation of 110 knots, can only explore about 60 percent of the safety and operating problems of current and proposed aircraft. No capability exists for testing high speed conditions which currently present very complex engineering design problems. Without capability for full-scale testing of future landing gear systems under simulated take-off and landing conditions, advancements in landing system technology will be limited. For example, safe operation in all-weather environments, which appears achievable from the standpoint of approach and landing systems and avionics and controls, demands high speed operating capabilities for landing gear systems. Along with safety considerations, economic factors important to efficient operations are served by improvements in landing gear systems. Additionally, future space vehicle landing gear design and development must include full-scale tests before actual operations in order to reduce risks to crews and vehicles.

PROJECT DESCRIPTION:

The following facility modifications will be made: (1) necessary site development; (2) extend the present track by approximately 600 feet (183 meters); (3) construct a carriage service building at the rear of existing Building 1262 (Office Building), and relocate Building 1261 (Track Shop) and Building 1261-B (Tire Storage Building) now located at the end of the existing track; (4) construct a high speed, open bay test carriage; (5) increase the thrust capability of the carriage propulsion system; (6) install an improved higher capacity carriage arrestment system; and, (7) make minor modifications to the support systems.

Site Development

The perimeter road will be extended approximately 600 feet (183 meters) and the tow path will be extended approximately 600 feet (183 meters); utilities relocated; surface drainage rerouted; an earthen berm provided for protection of neighboring facilities; and electric power provided.

Track Extension

The current track is 2,200 feet (671 meters) long and consists of a 400-foot (122-meter) carriage acceleration section, a 1,200-foot (367-meter) test section, and a 600-foot (183-meter) carriage arrestment section. The present track will be extended by approximately 600 feet (183 meters) to provide an 1,800-foot (549-meter) test section.

Carriage Service Building, Track Shop, and Tire Storage Building

A 14,000-square foot (1,338-square meter) Carriage Service Building will be constructed as an addition to Building 1262 to store and service all carriages, and to also provide an area for fabricating the new high speed carriage. The dimensions of this building will be approximately 180 feet (55 meters) long, 80 feet (24 meters) wide, 45 feet (14 meters) high. Building 1261 (Track Shop) and Building 1261-B (Tire Storage Building) will be relocated at the end of the new track extension to provide temporary on-track carriage storage and test tire storage.

High Speed, Open Bay Test Carriage

A new test carriage designed for forces to accelerate it to 220 knots will be constructed. The carriage will feature a large internal open bay area to accommodate bulky landing gear test specimens. The carriage will be approximately 72 feet (22 meters) long, 40 feet (12 meters) wide and 30 feet (9 meters) high, with an open area approximately 20 feet (6 meters) wide and 40 feet (12 meters) long. A model drop system capable of

loading test gear to 50,000 pounds (22,700 kilograms) will be provided. The carriage design will be of the same general character as the existing landing gear test carriage, and will be compatible with the existing test facility.

Carriage Propulsion System

The present carriage propulsion system will be replaced with a new, larger L-shaped pressure vessel, quick opening valve and exit nozzle system for rapidly ejecting high pressure water at increased thrust levels. The foundation for the present L-shaped vessel will be modified to accommodate the higher thrust loads of the new system. These modifications will produce sufficient thrust to accelerate an 85,000 pound (38,590 kilogram) carriage to 220 knots.

Carriage Arresting System

The new arresting system, installed along the lengthened test section, will be capable of absorbing more energy and of accommodating higher engagement speeds than the present system. However, the present system will remain operational to permit testing while the track is being extended, and to arrest the carriages during low speed tests and for high speed hydrodynamic tests which employ the water tank that parallels the track.

Modifications to Support Systems

Modifications to the support systems will include update of the catapult control system; overhaul of the valves to the air storage tanks; update of the hydraulic controls for the quick opening valve; modification of the liquid nitrogen tank, pump and converter; and, repair and extension of the existing runway test surface.

PROJECT COST ESTIMATE:

This project cost estimate is based on a Preliminary Engineering Report.

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	5,570,000
Site development	LS	---	---	1,050,000
Track extension	LS	---	---	2,460,000
Carriage service building, track shop, and tire storage building	LS	---	---	2,060,000
Equipment	---	---	---	9,430,000
High speed, open bay carriage	EA	1	---	2,180,000
Carriage propulsion system	EA	1	---	5,170,000
Carriage arresting system	EA	1	---	1,910,000
Modifications to support systems	EA	1	---	170,000
Fallout Shelter (not feasible)	---	---	---	---
Total				15,000,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Plan View

OTHER EQUIPMENT SUMMARY:

No additional equipment is required for this project.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

No additional future CoF funding is required for this project.

LANGLEY RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
MODIFICATIONS TO AIRCRAFT LANDING DYNAMICS FACILITY, BUILDING 1257
PLAN VIEW

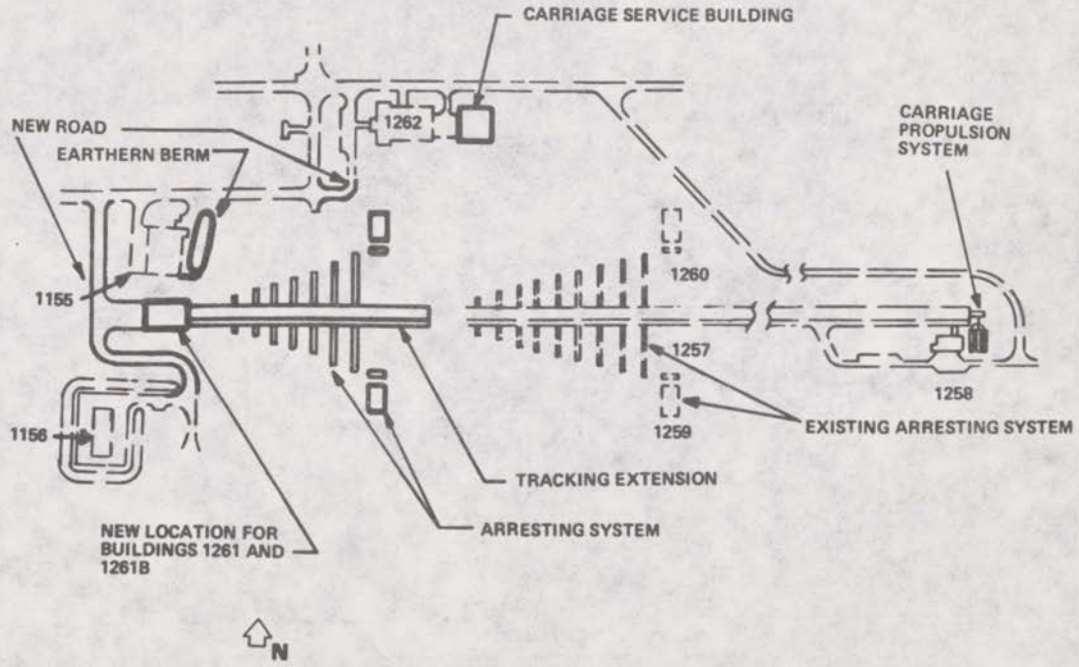


FIGURE 2

LANGLEY RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
REHABILITATION AND MODIFICATION OF GAS DYNAMICS LABORATORY, BUILDING 1247
LOCATION PLAN

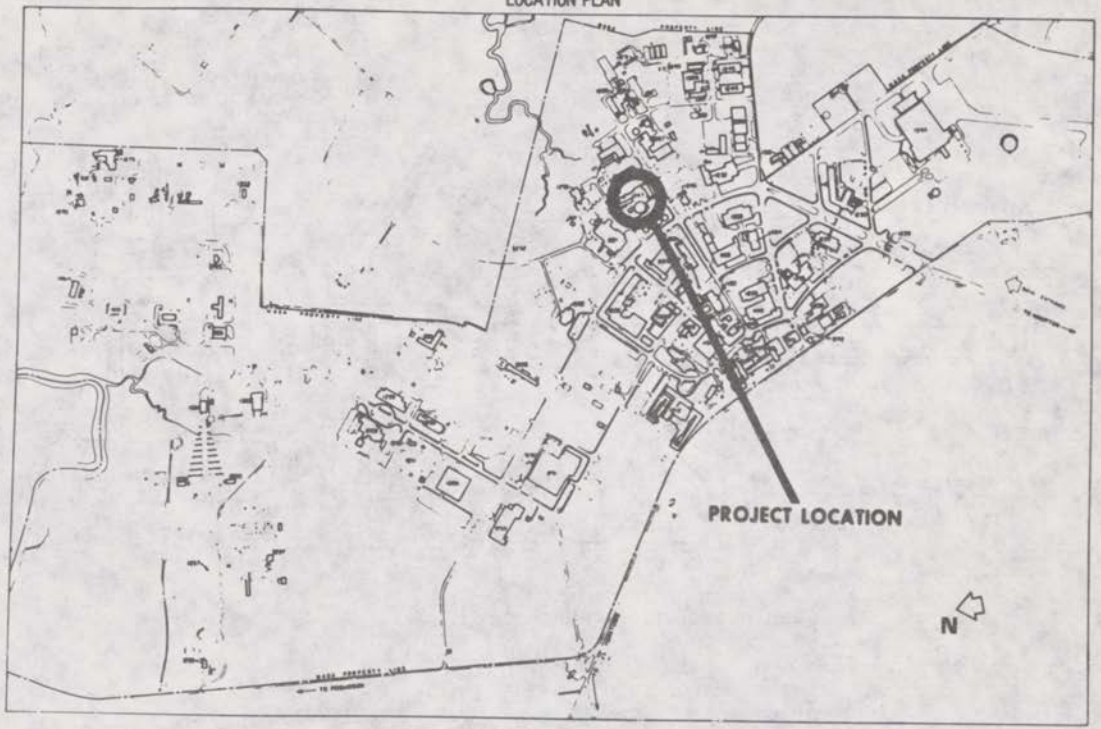


FIGURE 1

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Rehabilitation and Modification of Gas Dynamics Laboratory (1247)

INSTALLATION: Langley Research Center

FY 1981 CoF ESTIMATE: $2,000,000

LOCATION OF PROJECT: Hampton, Virginia

COGNIZANT HEADQUARTERS OFFICE: Office of Aeronautics and Space Technology/Office of the Comptroller, Facilities Division

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	512,948	3,600,000	4,112,948
Capitalized investment	N/A	18,232,850	18,232,850
Total	512,948	21,832,850	22,345,798

SUMMARY PURPOSE AND SCOPE:

This project provides for the second and final phase of two phases of rehabilitation and modification of offices, laboratories and support equipment in the Gas Dynamics Laboratory (Figure 1) at the Langley Research Center (LaRC). The work is principally located in Building 1247A (High-Speed Aerodynamics Division Laboratory offices), 1247B (Scramjet Test Facility), 1247E (Compressor Building), and 1247H (High Reynolds Number Helium Tunnel Complex (Figure 2). Building 1247D (Hypersonic Blowdown Tunnels) is being rehabilitated and modified by the FY 1980, Phase I project. This project includes overhauling, upgrading and modernizing as necessary

to meet safety, energy, and performance requirements related to wind tunnel control, wind tunnel flow, data acquisition, and noise abatement. Research in this facility complex supports many high priority NASA research programs such as laminar flow control, turbulent drag reduction, advanced supersonic transports, sonic boom alleviation, advanced space transportation systems (follow-on Shuttle), airbreathing launch vehicles, planetary entry probes, civil and military hypersonic aircraft, and hypersonic missiles.

PROJECT JUSTIFICATION:

The Gas Dynamics Laboratory is a 28-year-old facility composed of several types of wind tunnels and test apparatus. New tunnels and facility equipment have been added over the years in response to changes in research emphasis. However, none of the older equipment has either been rehabilitated or received a major overhaul. This rehabilitation project completes the work initiated with the Phase I FY 1980 project on overhaul, upgrading, and modernizing which is necessary to assure future operations meeting safety, energy, and performance requirements.

The Building 1247 complex is critical to research testing from subsonic through hypersonic speeds. Its testing capabilities are particularly important in the Mach 3 to 8 speed range in which the next generation of advanced supersonic transports, hypersonic aircraft and missiles will fly. This laboratory of several small wind tunnels can test inexpensive, readily installed and easily modified models over a wide range of Mach numbers. Each of the facilities has at least one special experimental feature that makes its testing capability unique. Examples of such special features are high speed model injection mechanisms, laser-doppler velocimeter systems, Raman radiation instrumentation, electron beam flow visualization, varying Reynolds Numbers, and various flow media including air, nitrogen, and helium.

Interconnecting the vacuum systems of the east and west wings of the Gas Dynamics Laboratory by this project will provide approximately 500 percent more run time for five different facilities in Building 1247. The additional capacity will result in a cost savings of nearly $48,000 per year and a payback of just over six years. This is based on a $475 energy savings per test run resulting from less energy being used to pump down the connected vacuum systems than is used to pump up the gas storage system which operates the ejectors. The increased capacity will permit the long run times needed for both pressure distribution and boundary layer surveys for such programs as laminar flow control and turbulent drag reduction.

IMPACT OF DELAY:

Many of the components of this facility have been in existence since 1951 and have not had a major overhaul. If this facility is to continue to provide reliable research and testing capabilities, the necessary rehabilitation and modification work to maintain and improve the equipment and facility must be performed now.

If this project is delayed, failure of key components of this facility will severely impact critical ongoing and planned aerodynamic research work.

PROJECT DESCRIPTION:

The building structure and support equipment are virtually the same as originally constructed 28 years ago. Continuous use over the years has caused significant building and equipment deterioration and ever increasing maintenance workloads. This project addresses the following seven major areas of concern:

Rehabilitation of Buildings 1247B and 1247H

These buildings enclose floor areas of approximately 33,350 square feet (3,100 square meters), occupied by nine test cells and a small shop area. Also included are various control rooms, lavatory facilities, and a full basement. This structure was erected in 1951, except for a small addition (1247H) which was constructed in 1962. A new central air-conditioning system is needed to cool large quantities of electronic data gathering and signal conditioning equipment, and electronic control systems. The building roof and masonry walls will receive substantial repair work. Additionally, new windows will be installed, plumbing fixtures will be replaced as necessary, and the fire alarm system will be upgraded to present-day standards.

Rehabilitation Building 1247A

Building 1247A is a three-story office structure constructed in 1951. Its total floor area is approximately 17,300 square feet (1,607 square meters), plus a full basement. New air-conditioning will be provided, using the same central system as for Buildings 1247B, 1247D, and 1247H. The elevator will be modernized, the fire alarm system will be upgraded, and fire emergency egress will be improved by having one-hour rated enclosures installed on two existing stairwells. New lighting fixtures and windows will be installed. Offices will be equipped with suspended ceilings, and wall surfaces will be rehabilitated. Exterior masonry and roofing repairs as well as modifications for access by handicapped persons will also be provided.

72-Inch Vacuum Duct

A vacuum duct will be installed connecting the 100-foot (30.4-meter) vacuum sphere to the north vacuum system (Figure 2). This will consist of approximately 100 linear feet (30.4 meters) of 72-inch (183-centimeter) duct from the vacuum sphere to the roof of Building 1247D, where it will connect to an additional 100 feet (30.4 meters) of 36-inch (91-centimeter) duct being installed to connect, through an isolation valve, to the north vacuum pumping system.

Steam Ejector Muffler

A steam ejector is essential to the operation of the Scramjet Test Facility because of the possibility of hydrogen detonation from conventional mechanical vacuum pumping sources. This ejector produces ground level sound intensities in excess of 100 dBA for continuous periods of up to six hours. A muffler will be installed to reduce this noise to acceptable levels for personnel working outside and within the adjacent office building.

Mach 10/20 Tunnel Controls

The Mach 10 and Mach 20 legs of the High Reynolds Number Helium Tunnel are operated by programmable control systems which sequence events such as tunnel flow and model injection. Existing electronics are from the vacuum tube technology era. Work on these controls includes installation of solid state amplifier modules in all power supplies and controllers to provide greater reliability, less maintenance, and generally improved operating efficiencies and characteristics.

Air Storage Field Valve Installation

The 5,000-psi (3,515,000 Newtons/meter) air storage field at Building 1247E is divided into four sections, each having a 6-inch (15-centimeter) discharge line through a utility tunnel to the Gas Dynamics Laboratory. The existing manually operated, obsolete isolation valves are at the Laboratory end of the utility tunnel. These valves leak and are physically difficult to operate. This is an unsafe condition for such high pressure lines. The replacement valves will be installed at the storage field and will be motorized for fast, efficient and safe operation. The addition of these three valves will provide isolation capability for the whole or any section of the bottle field for safety and maintenance requirements, and will offer the flexibility and economies of using air at different storage pressures as required for research testing.

22-Inch Tunnel Supply Valves

There are two sets of valves, three per set, used for sectionalizing the helium storage tank system from the supply line to the 22-Inch (58-centimeter) Tunnel system. During runs, a valve operator in radio contact with the tunnel operators must be stationed outside the building to operate these valves manually. These valves will be replaced by motorized valves, related motor control centers and necessary structural supports. The new valves will be remotely operated and monitored from inside the building by tunnel operators.

PROJECT COST ESTIMATE:

This project cost estimate is based on a Preliminary Engineering Report.

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	1,260,000
Rehabilitation (1247B, and 1247H)	SF	33,350	13.00	430,000
Rehabilitation (1247A)	SF	17,300	48.00	830,000
Equipment	---	---	---	740,000
72-inch vacuum duct	LS	---	---	300,000
Steam ejector muffler	LS	---	---	100,000
Mach 10/20 tunnel controls	LS	---	---	70,000
Air storage field valve installation	LS	---	---	120,000
22-inch tunnel supply valves	LS	---	---	150,000
Fallout Shelter (not feasible)	---	---	---	---
Total				2,000,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Site Plan

OTHER EQUIPMENT SUMMARY:

There is no additional equipment required for this project.

FUTURE CoF ESTIMATED FUNDING TO COMPLETE THIS PROJECT:

There is no additional funding required for this project.

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LANGLEY RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
REHABILITATION AND MODIFICATION OF GAS DYNAMICS LABORATORY, BUILDING 1247
SITE PLAN

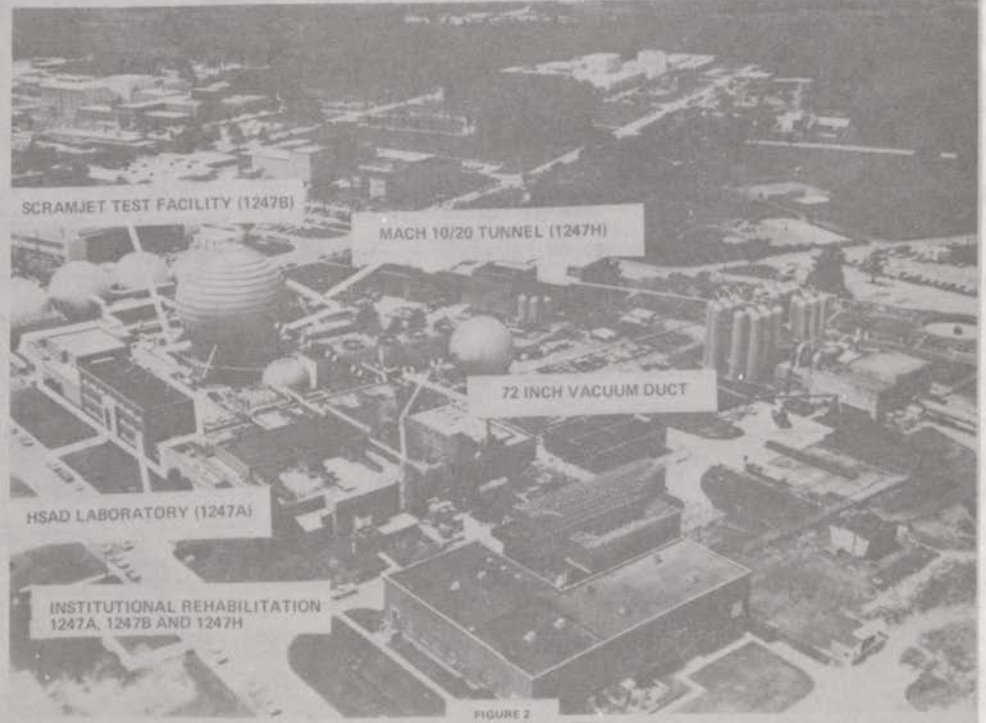


FIGURE 2

CF 4-24

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

SUMMARY

LEWIS RESEARCH CENTER

	Amount	Page No.
Office of the Comptroller:		
Decommissioning of Plum Brook Station Reactor Facility	3,000,000	CF 5-1
Office of Aeronautics and Space Technology:		
Modifications to Central Air System, Various Buildings	7,655,000	CF 5-10
Rehabilitation of Electrical Switchgear, Engine Research Building 5	1,700,000	CF 5-21
Total	12,355,000	

LEWIS RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
DECOMMISSIONING OF PLUM BROOK STATION REACTOR FACILITY
LOCATION PLAN

PROJECT LOCATION

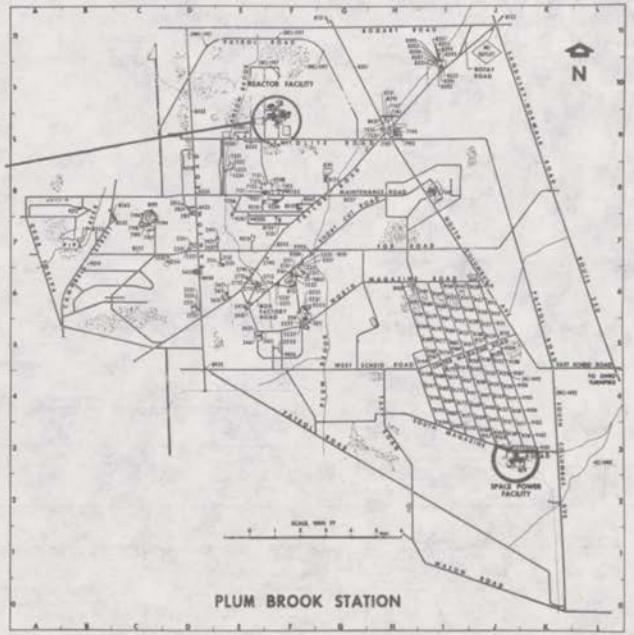


FIGURE 1

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE:	Decommissioning of Plum Brook Station Reactor Facility
INSTALLATION:	Lewis Research Center
FY 1981 CoF ESTIMATE:	$3,000,000

LOCATION OF PROJECT: Plum Brook Station, Sandusky, Ohio

COGNIZANT HEADQUARTERS OFFICE: Office of the Comptroller, Facilities Division

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	180,000	---	180,000
Capitalized investment	N/A	18,591,000	18,591,000
Total	180,000	18,591,000	18,771,000

SUMMARY PURPOSE AND SCOPE:

This project is the first of five phases of work estimated to cost $15 million for decommissioning the Lewis Research Center's (LeRC) Plum Brook Station Reactor Facility (Figures 1 and 2). Because of work constraints associated with radiation safety, decommissioning of this facility will require approximately five years of effort. The work included in this project is all that can reasonably be accomplished in FY 1981. Included is the removal of radioactive pipe and paving from the site ditches (Figure 3) and the removal of all

radioactive materials from the containment vessel in Building 1111 (Figure 4). All work will be in strict accordance with Nuclear Regulatory Commission (NRC) requirements and other applicable safety and health standards.

PROJECT JUSTIFICATION:

Research operation of the Reactor Facility was terminated in January 1973 and the facility was subsequently placed in standby status. Because radioactive materials are still present at the site, it is necessary to maintain this facility in its standby status until it can be decommissioned.

This 60 megawatt reactor facility was originally built for nuclear irradiation testing of nuclear fueled and unfueled experiments for space applications. Construction was started in 1956 and full power operation was achieved in April 1963. The reactor operated continuously at nearly 60 megawatts until operations were discontinued in 1973. During the period from January 1973 to July 1973, the entire facility was prepared for placement in standby status. At that time all nuclear fuel and fissionable materials were removed. It has now been determined that this facility will never be reactivated.

Currently, LeRC is under three NRC licenses. These include one for possession but not operation of the 60 megawatt test reactor, one for possession but not operation of a small mock-up reactor, and one for possession of radioactive materials. To meet the requirements for these licenses, LeRC must maintain the facility, provide adequate security and general surveillance, and provide quarterly radiological monitoring. In addition to maintaining the integrity of the buildings, building locks, and fences, LeRC must also maintain electrical power and designated temperature levels in the facility and cathodic protection of the reactor containment vessel. A continuous nitrogen gas purge through the reactor vessel, an alarm system, emergency lights, and telephone service must also be maintained. A communication center that is manned 24 hours per day and an administrative staff are required to fulfill all of these NRC requirements. The cost of maintaining this facility in standby status is approximately $300,000 per year in terms of 1981 dollars. This "holding" activity cost will continue until the radioactive materials are removed from the facility. A study has shown that the other options for decommissioning this facility, all of which involve delayed dismantling, would cost between $35 million and $45 million in terms of 1981 dollars. Prompt decommissioning will avoid these higher long term costs.

IMPACT OF DELAY:

Maintaining this unneeded facility in a standby status is costly and a continuing liability to NASA. Delay in performing this decommissioning work will unnecessarily extend these standby maintenance activities and their costs.

PROJECT DESCRIPTION:

This first phase of the total work for decommissioning the 60 megawatt Plum Brook Station Reactor Facility includes removal of all radioactive material from the containment vessel in Building 1111 and the removal of radioactive material from the site ditches (Figures 3 and 4). This includes removal of contaminated and irradiated equipment from the four experiment quadrants, the dry annular area, and Canal E of the containment vessel. Contaminated equipment will be decontaminated if possible. Also included is the decontamination of all containment vessel surfaces. Additionally, the concrete piping and asphaltic paving material in the site ditches will be removed and decontaminated.

Decontamination of radioactive equipment requires the reactivation of the existing decontamination equipment at the Reactor Facility. This includes the clothing laundry equipment and the equipment for reducing contaminated liquids to radioactive sludge. These reactivation tasks are included in this project.

Radioactive wastes, including irradiated equipment and radioactive materials accumulated during decontamination operations, will be disposed of by transfer to Nuclear Regulatory Commission approved burial sites.

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PROJECT COST ESTIMATE:

This cost estimate is based on an evaluation study and a completed Preliminary Engineering Report.

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	---
Demolition	---	---	---	3,000,000
Removal of contaminated and irradiated equipment	LS	---	---	715,000
Decontamination of containment vessel	LS	---	---	560,000
Decontamination of contaminated equipment	LS	---	---	570,000
Removal and decontamination of site ditch piping and paving	LS	---	---	280,000
Disposal of radioactive wastes	LS	---	---	80,000
Support services	LS	---	---	795,000
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total				3,000,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Aerial Photograph of Reactor Facility
Figure 3 - Site Plan
Figure 4 - Reactor Building (1111) Plan

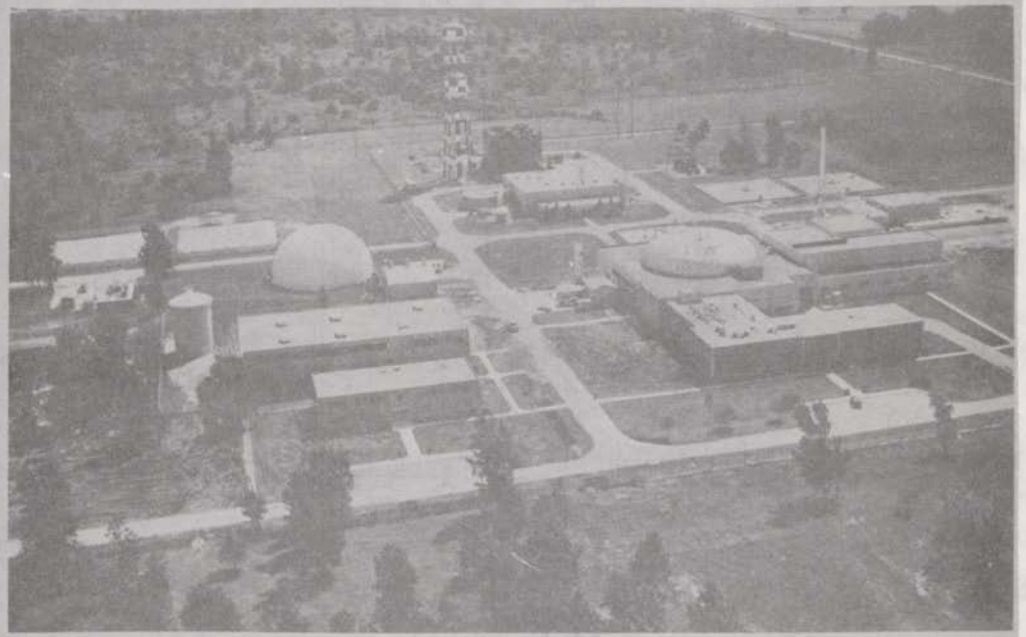
OTHER EQUIPMENT SUMMARY:

No other equipment is required.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

It is estimated that an additional $12 million will be required to complete decommissioning of this facility. Current planning indicates that approximately $3 million per year for the next four years (FY 1982 - 1985) will be required to adequately support this effort.

LEWIS RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
DECOMMISSIONING OF PLUM BROOK STATION REACTOR FACILITY



AERIAL PHOTOGRAPH OF REACTOR FACILITY

FIGURE 2

CF 5-7

LEWIS RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
DECOMMISSIONING OF PLUM BROOK STATION REACTOR FACILITY
SITE PLAN

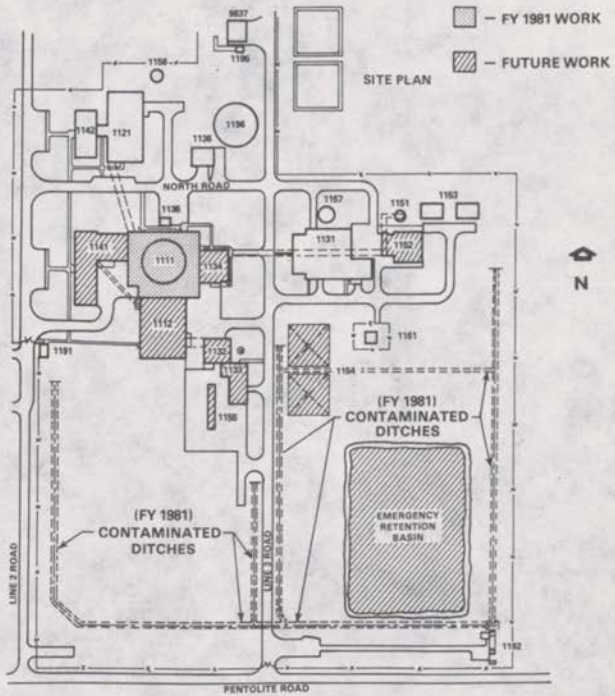
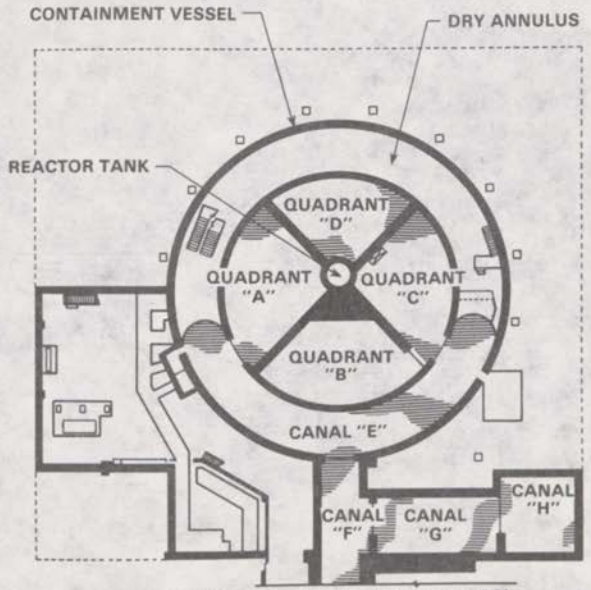


FIGURE 3

CF 5-8

LEWIS RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
DECOMMISSIONING OF PLUM BROOK STATION REACTOR FACILITY



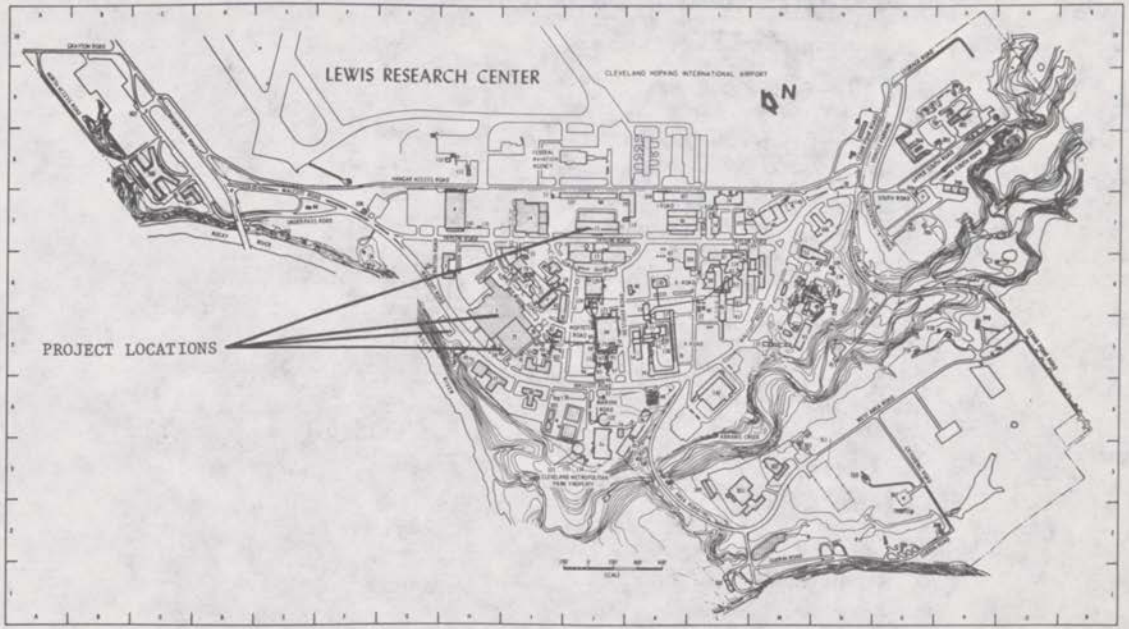
REACTOR BUILDING (1111)
PLAN

FIGURE 4

LEWIS RESEARCH CENTER

FISCAL YEAR 1981 ESTIMATES

MODIFICATIONS TO CENTRAL AIR SYSTEM, VARIOUS BUILDINGS



LOCATION PLAN

FIGURE 1

CF 5-10

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Modifications to Central Air System, Various Buildings

INSTALLATION: Lewis Research Center

FY 1981 CoF ESTIMATE: $7,655,000

LOCATION OF PROJECT: Cleveland, Cuyahoga County, Ohio

COGNIZANT HEADQUARTERS OFFICE: Office of Aeronautics and Space Technology

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	1,859,000	6,172,000	8,031,000
Capitalized investment	N/A	37,271,000	37,271,000
Total	1,859,000	43,443,000	45,302,000

SUMMARY PURPOSE AND SCOPE:

This project completes modifications to the Central Air System at Lewis Research Center (LeRC) begun with FY 1980 funding. These modifications provide for centralized operation of the Central Air System equipment located in the Engine Research Building complex (Buildings 5, 23, 37, and related areas). In addition, it centralizes the air and electrical services dispatching and utility control functions, and provides for replacement of the aging high pressure air system compressor (Figure 1). This project completes the overall upgrading of the Central Air System's outdated control and data acquisition systems started with the FY 1980 project.

The Central Air System provides essential compressed air and exhaust services to the majority of research test setups at the Center. The research supported is primarily aeronautical propulsion testing. Research programs include improvements in engine performance, durability, and efficiency and have as a goal the reduction of engine fuel consumption and polluting exhaust emissions.

The obsolete manual controls and data acquisition systems being upgraded by this project are unreliable. They are also inadequate for efficient support of research operations. Efficiency is also degraded by having the air and electrical power dispatching functions in two different locations. A failure of the high pressure air compressor would seriously disrupt research programs at LeRC. The modifications provided by this project will substantially increase the reliability and efficiency of the research support provided by the Central Air System.

PROJECT JUSTIFICATION:

The Central Air System provides vital compressed air and exhaust services for the operation of over 100 different research test setups. Equipment concentrated at the Propulsion Systems Laboratory and the Engine Research Building complexes is connected to various test areas throughout the Center by a complex distribution piping system (Figure 2). The 20-30 year old Propulsion Systems Laboratory equipment primarily serves the larger research activities where tests of full scale gas turbine engines or other tests requiring high flow rates are conducted. The 30-35 year old Engine Research Building equipment primarily serves the smaller research activities where engine component tests and other tests with low flow rate requirements are conducted. This modification project for the Engine Research Building equipment and for the Central Air Dispatch, Electrical Power Dispatch and Utility Control System functions is fully integrated with the previously funded FY 1980 work in the Propulsion Systems Laboratory. This requested funding will provide for continuity and orderly, implemented improvement to the overall Central Air System.

The Engine Research Building equipment was installed in the 1940's. Although the basic air handling equipment is in good operating condition, the control systems are obsolete. These systems are pneumatically operated and are manually adjusted at control stations near the operating equipment (Figure 3). They are worn out and replacement parts are no longer available. Even when they were in satisfactory operating condition, these controls were too sluggish to respond to sudden changes in flow rate demands of the research test setups. The new control systems provided by this project will be electro-hydraulic systems for fast response to changing conditions and will be remotely operated from the new control area provided by the FY 1980 project.

The present data acquisition system also is inadequate. It consists of locally mounted gages near the operating equipment. Monitoring of the equipment is mostly by visual inspection and requires experienced operators to detect potential problems. The new data acquisition system provided by this project will monitor

critical equipment parameters and air flow conditions. It will also improve safety conditions by providing alarms when abnormalities and system shutdown occur, and allowable operating limits are reached. For efficient remote monitoring, all data displays and hard copy printout equipment will be located in the new control area.

Current operations are inefficient because Engine Research Building equipment operators are scattered in many locations. The Central Air Dispatch function is in yet another Engine Research Building location (Figure 5), and the Electrical Power Dispatch function is in Building 21 (Figure 6). Relocation of these functions to one central control room will greatly improve the operating efficiency of the Central Air System.

The current trend in gas turbine engine research is to higher pressures and temperatures to improve operating efficiencies. The 450 pounds per square inch (310 Newtons per square centimeter) high pressure air system supplies air for this research. This system consists of only one high pressure compressor. This compressor is now over 30 years old. Replacement parts must be custom made and delivery times are long. The new compressor system provided by this project will have a 38 pounds per second (17 kilograms per second) flow capability which is equal to that of the existing compressor. The new system will be installed as the primary supply system and the existing compressor system will be maintained as a backup.

IMPACT OF DELAY:

This project must be implemented now to provide vitally needed control and data acquisition systems for the Engine Research Building equipment, to increase the reliability of the high pressure air system, and to realize the benefits of centralized operations for the entire Central Air System and the associated Electrical Power Dispatch function. Because this project includes integration with the control and data acquisition systems provided with the FY 1980 project, a comprehensive concurrent design of both projects is being used to maximize the design process efficiency and to eliminate the possibility of system incompatibilities. Continuation at this time with the planned improvements to the Central Air System, begun with the FY 1980 project, will provide for the orderly and expeditious completion of these modifications and will provide maximum uniformity of equipment.

PROJECT DESCRIPTION:

This project provides computer-based, automated control and data acquisition systems for the Central Air System equipment in Buildings 5, 23, and 37 of the Engine Research Building complex and in related areas. Operation of these new systems will be from consoles installed in the new control area provided by the FY 1980 project. This FY 1981 project also provides for the relocation of the Central Air Dispatch function, the Electrical Dispatch function, and the Utility Control System master station from presently dispersed locations

to the new control area. In addition, a new 450 pounds per square inch (310 Newtons per square centimeter) high pressure air compressor system will be acquired and installed.

Installation of the new control system includes replacement of the obsolete pneumatic local controls with electro-hydraulic controls, the installation of various remote operated air routing valves, and the installation of all necessary hydraulic components, including a high pressure oil supply system. Operators' consoles will be installed in the new control area and integrated with the systems installed with the FY 1980 project. For safety and simplicity, these consoles will include television screen type displays with which operators interact by means of a lighted pen or similar electronic device for selection of "on-off" operations.

The new data acquisition and display system will include extensive instrumentation, television type displays, and recording devices. These will be used to monitor and record the equipment performance and operating characteristics. This system will be installed in the new control area and integrated with the systems installed with the FY 1980 project.

Included in this control and data acquisition systems work is the installation of new controls and monitoring equipment for the Central Air Dispatch and Electrical Power Dispatch functions. The Central Air Dispatch function will be relocated from the Engine Research Building 5 to the new control area. Similarly, the Electrical Power Dispatch function and the Utility Control System master station will be relocated from Building 21 to the new control area.

The new high pressure air compressor system includes building modifications and installation of a new 450 pounds per square inch (310 Newtons per square centimeter) compressor and related piping.

57-166 O - 80 - 37

PROJECT COST ESTIMATE:

This cost estimate is based on a completed Preliminary Engineering Report and related studies.

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	465,000
Demolition and repair of vacated services dispatch areas	LS	---	---	80,000
Building modifications for high pressure air compressor system installation	LS	---	---	385,000
Equipment	---	---	---	7,190,000
Controls installation and integration	LS	---	---	2,900,000
Valve and hydraulic system component installation	LS	---	---	250,000
Data acquisition and display equipment installation and integration	LS	---	---	1,450,000
Transducer installation	LS	---	---	625,000
Multiplexer installation	LS	---	---	460,000
High pressure air compressor system installation	LS	---	---	1,505,000
Fallout Shelter (not feasible)	---	---	---	---
Total				7,655,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Aerial View of Piping Network
Figure 3 - Typical Local Compressor Controls
Figure 4 - Central Air Dispatch Control Room, Building 5
Figure 5 - Electrical Dispatch and Utility Control Master Station Control Room, Building 21

OTHER EQUIPMENT SUMMARY:

No other equipment is required to complete this project.

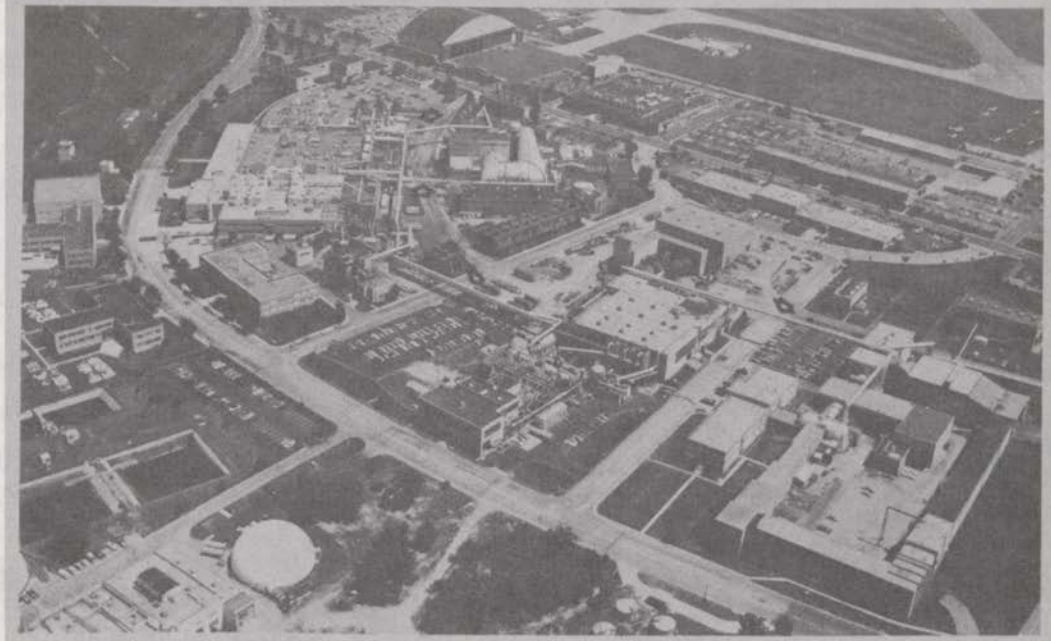
FUTURE CoF ESTIMATED FUNDING REQUIREMENTS TO COMPLETE THIS PROJECT:

No future CoF funding is required to complete this project.

LEWIS RESEARCH CENTER

FISCAL YEAR 1981 ESTIMATES

MODIFICATIONS TO CENTRAL AIR SYSTEM, VARIOUS BUILDINGS



AERIAL VIEW OF PIPING NETWORK

FIGURE 2

CF 5-17

LEWIS RESEARCH CENTER

FISCAL YEAR 1981 ESTIMATES

MODIFICATIONS TO CENTRAL AIR SYSTEM, VARIOUS BUILDINGS



TYPICAL LOCAL COMPRESSOR CONTROLS

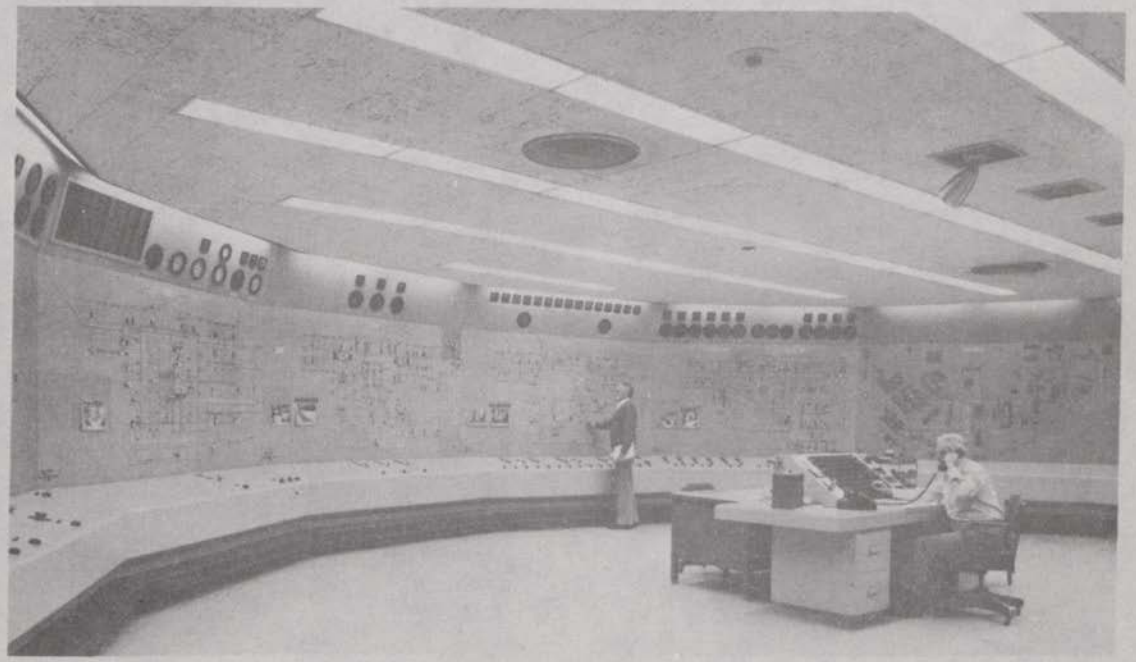
FIGURE 3

CF 5-18

LEWIS RESEARCH CENTER

FISCAL YEAR 1981 ESTIMATES

MODIFICATIONS TO CENTRAL AIR SYSTEM, VARIOUS BUILDINGS



CENTRAL AIR DISPATCH CONTROL ROOM, BUILDING 5

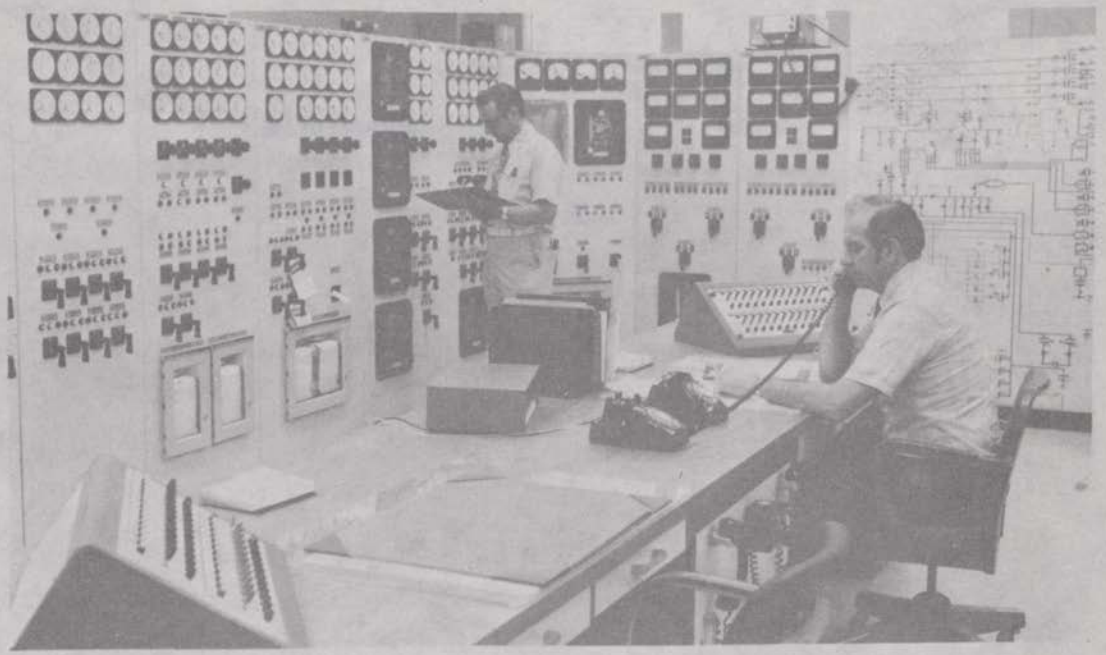
FIGURE 4

CF 5-19

LEWIS RESEARCH CENTER

FY 1981 CoF ESTIMATES

MODIFICATIONS TO CENTRAL AIR SYSTEM, VARIOUS BUILDINGS



ELECTRICAL DISPATCH AND UTILITY CONTROL MASTER
STATION CONTROL ROOM, BUILDING 21

FIGURE 5

CF 5-20

LEWIS RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
REHABILITATION OF ELECTRICAL SWITCHGEAR, ENGINE RESEARCH BUILDING 5
LOCATION PLAN

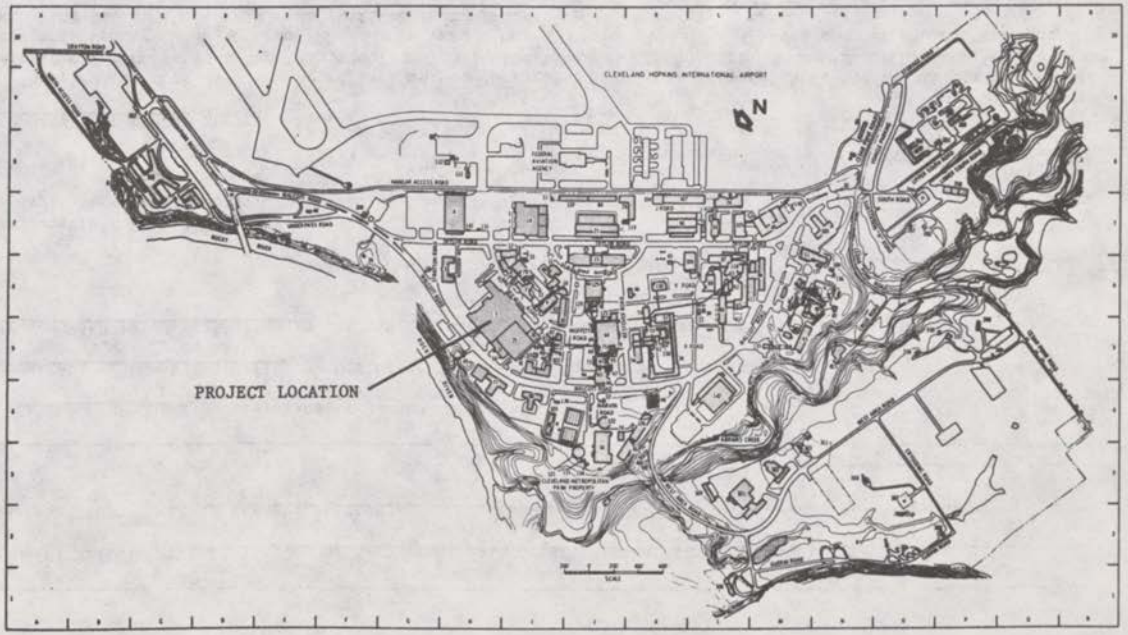


FIGURE 1

CF 5-21

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Rehabilitation of Electrical Switchgear, Engine Research Building 5

INSTALLATION: Lewis Research Center

FY 1981 CoF ESTIMATE: $1,700,000

LOCATION OF PROJECT: Cleveland, Cuyahoga County, Ohio

COGNIZANT HEADQUARTERS OFFICE: Office of Aeronautics and Space Technology

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	117,000	---	117,000
Capitalized investment	N/A	---	---
Total	117,000	---	117,000

SUMMARY PURPOSE AND SCOPE:

This project provides for the replacement of forty (40) obsolete and unreliable medium voltage oil-filled electrical circuit breakers (Figures 2 and 3) in the basement of the Engine Research Building 5, at the Lewis Research Center (LeRC) (Figure 1). Air or vacuum type circuit breakers and fused motor starters, which conform with the National Electric Code, will be installed.

A potential for an explosion of these breakers exists, and such an explosion and resulting fire would be a serious hazard to personnel and vital research support equipment located in the vicinity of this switchgear.

Also, the existing circuit breakers, which are an integral part of the electrical power distribution system in the Engine Research Building complex (Buildings 5, 23, 37, and 38), do not conform with the National Electric Code. The new switchgear provided by this project will eliminate this hazard, increase the reliability of the electrical power distribution system in the Engine Research Building complex, and comply with the National Electric Code standards.

PROJECT JUSTIFICATION:

The existing oil-filled circuit breakers are over 35 years old. The manufacturer of these units has derated their capacity on several occasions since original installation. Because of this derated capacity and the heavy duty required of them, these units are not adequate to successfully close during an electrical fault condition. Heat generated during a fault situation could be sufficient to cause an explosion of these circuit breakers. The oil in these units generally catches fire during such an explosion. If such an explosion and fire occurred, the hazard to nearby personnel and unique electrical and mechanical equipment, including many components of LeRC's Central Air System, would be great. In addition to these safety considerations, repair parts for these aging circuit breakers are no longer available and reliability of the breakers is decreasing.

The ability to test medium voltage electrical equipment under all conditions of operation has improved considerably since the existing switchgear was manufactured. As a result of improved testing, the manufacturer of the existing LeRC equipment has significantly reduced its ratings. The present rating of this equipment is being exceeded by 25 percent because the load approaches the full original rating. Although some margin of safety is usually incorporated in manufacturers' maximum ratings, adequate performance of this equipment at 25 percent above its maximum rating is a serious risk.

Twenty-four new circuit breakers provided by this project will replace the existing transformer main secondary circuit breakers and various feeder circuit breakers. These feeder breakers provide power to key LeRC research test facilities and critical research support equipment including the Central Air System service air compressors and altitude and atmospheric exhaust pumps, 250 volt direct current motor-generator sets, cooling water pumps, high speed variable voltage motor-generator sets, specialty transformers, and ventilation fans. The eleven motor starters provided in this project will replace 16 existing circuit breakers being used for this purpose. These starters will serve the drive motors for the Central Air System service air compressors and altitude exhaust pumps and the 250 volt direct current motor-generator sets. These motors range in power from 500 horsepower (373 kilowatts) to 2,150 horsepower (1,604 kilowatts).

IMPACT OF DELAY:

This work must be accomplished now to eliminate the hazards to personnel and equipment resulting from possible failures of existing switchgear. Extensive damage to critical research support equipment resulting from such a failure probably would also seriously impact research operations at LeRC. In addition, this work will substantially improve the overall reliability of the electrical power distribution system.

PROJECT DESCRIPTION:

This project provides for the replacement of forty (40) medium voltage, oil-filled, electrical circuit breakers and associated wiring located in the basement of the Engine Research Building 5 (Figures 2 and 3). Twenty-four of the existing circuit breakers which serve as 2,400 volt transformer secondary main and feeder circuit breakers will be replaced with air or vacuum type circuit breakers. The other 16 circuit breakers which are used as 2,400 volt motor starters and reduced voltage motor starters will be replaced with 11 fused air type motor starters. This equipment and installation will be in conformance with the National Electric Code and other applicable standards.

PROJECT COST ESTIMATE:

The project cost estimate is based on a completed Preliminary Engineering Report.

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	---
Equipment	---	---	---	1,700,000
Transformer main secondary circuit breakers installation	EA	4	70,000	280,000
Feeder circuit breaker installation	EA	20	43,300	866,000
Full voltage motor starter installation	EA	9	46,000	414,000
Reduced voltage motor starter installation	EA	2	70,000	140,000
Fallout Shelter (not feasible)	---	---	---	---
Total				1,700,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Typical Switchgear
Figure 3 - Switchgear Wiring

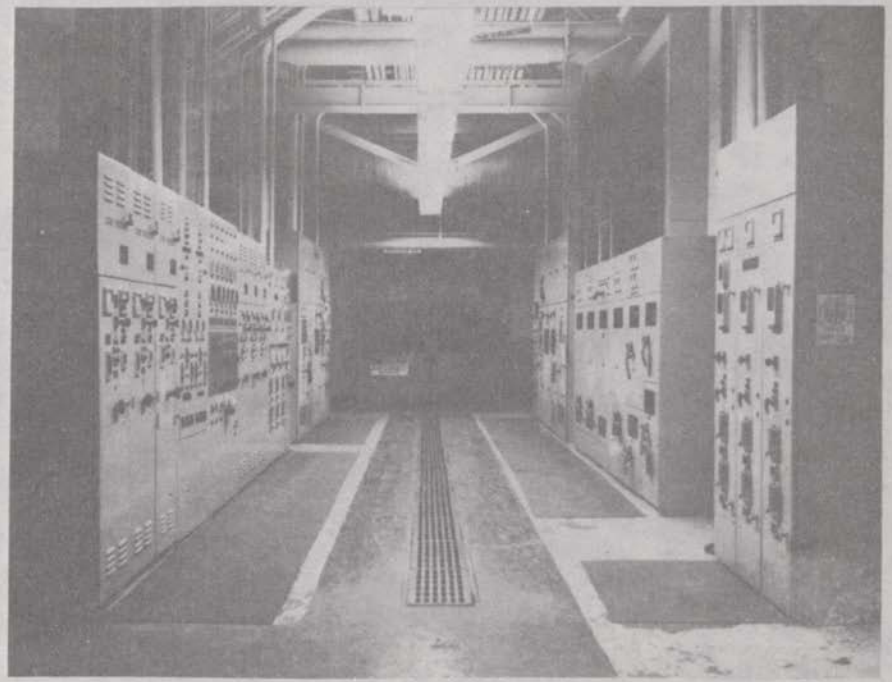
OTHER EQUIPMENT SUMMARY:

No other equipment is required to complete this project.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

No future CoF funding is required to complete this project.

LEWIS RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
REHABILITATION OF ELECTRICAL SWITCHGEAR, ENGINE RESEARCH BUILDING 5

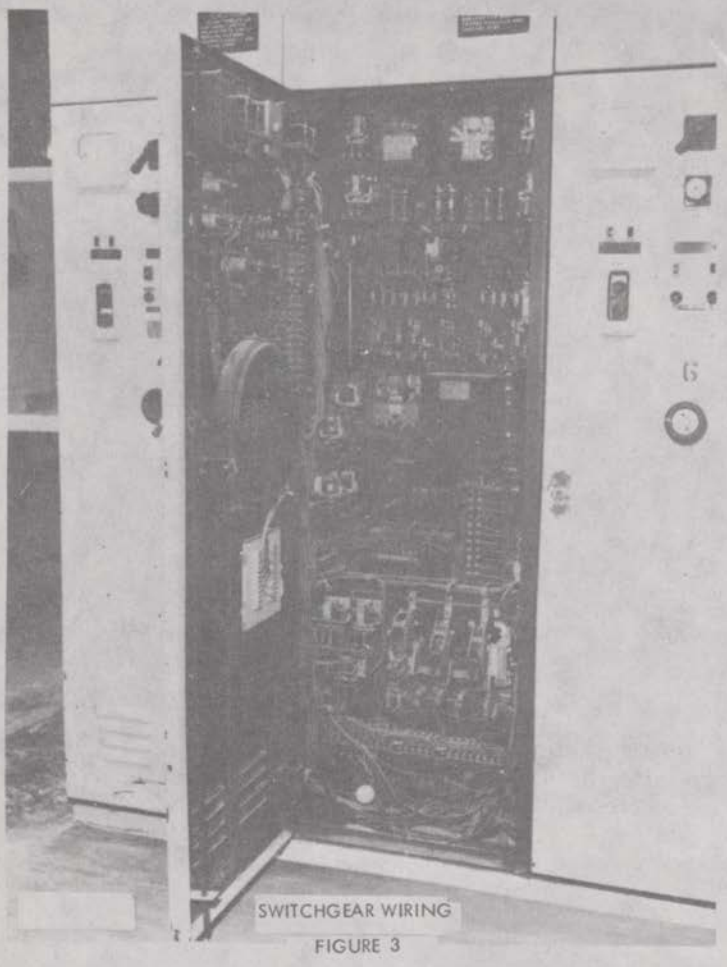


TYPICAL SWITCHGEAR
FIGURE 2

CF 5-27

LEWIS RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
REHABILITATION OF ELECTRICAL SWITCHGEAR, ENGINE RESEARCH BUILDING 5

CF 3-28



SWITCHGEAR WIRING

FIGURE 3

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

SUMMARY

MICHOUD ASSEMBLY FACILITY

	Amount	Page No.
Office of the Comptroller:		
Rehabilitation of the Roof, Phase II, Building 103	3,800,000	CF 6-1
Rehabilitation of Chilled Water System	782,000	CF 6-6
Total	4,582,000	

MICHOUD ASSEMBLY FACILITY
FISCAL YEAR 1981 ESTIMATES
REHABILITATION OF THE ROOF, PHASE II, BUILDING 103
LOCATION PLAN

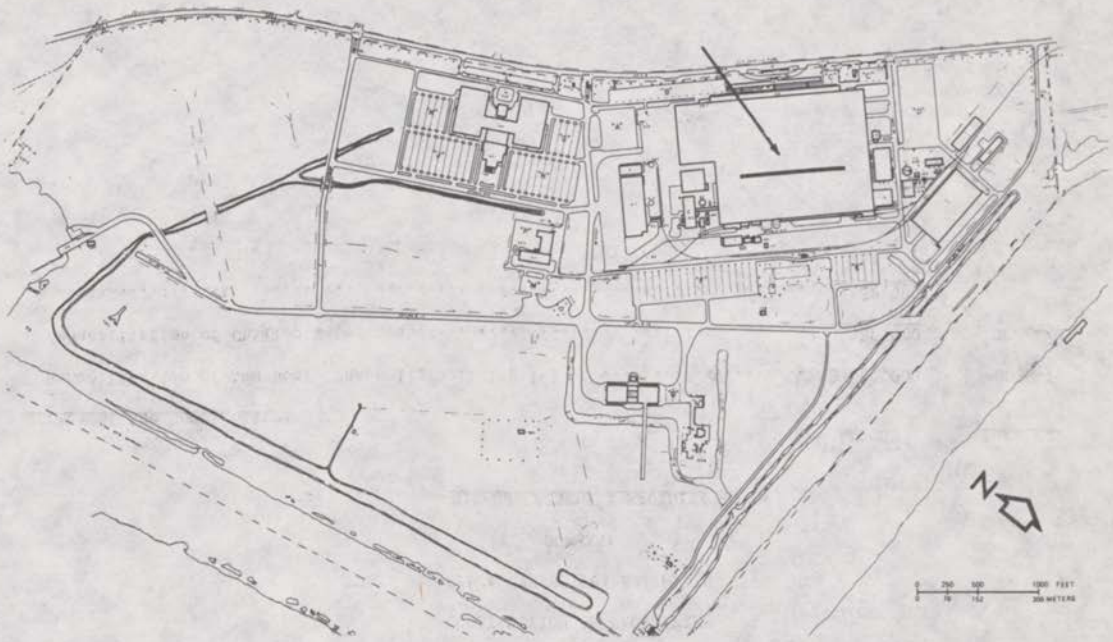


FIGURE 1

CF 6-1

57-166 0 - 80 - 38

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Rehabilitation of the Roof, Phase II, Building 103

INSTALLATION: Michoud Assembly Facility

FY 1981 CoF ESTIMATE: $3,800,000

LOCATION OF PROJECT: New Orleans, Orleans Parish, Louisiana

COGNIZANT HEADQUARTERS OFFICE: Office of the Comptroller, Facilities Division

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	491,000	3,100,000	3,591,000
Capitalized investment	N/A	---	---
Total	491,000	3,100,000	3,591,000

SUMMARY PURPOSE AND SCOPE:

This project will complete the rehabilitation of the roof of the Main Manufacturing Building (Building 103) at the Michoud Assembly Facility (Figure 1). The first phase was authorized in the FY 1980 program. The FY 1980 project provided for repair of approximately one half of the roof. This proposed work includes the removal of roofing not replaced during Phase I of the project and installation of an aggregate-surfaced, asphalt built-up roof over a concrete deck. It will reduce future maintenance costs and eliminate the possibility of damage from leaks to Space Shuttle external tank production equipment and materials.

PROJECT JUSTIFICATION:

Building 103 is the main manufacturing facility at the Michoud Assembly Facility (MAF), and is used exclusively for production of External Tanks for NASA's Space Shuttle Program. This building is the primary facility used for external tank manufacturing. Therefore, it is imperative that it be maintained at a level consistent with the programmatic manufacturing demands. This building was constructed in 1943 and was reroofed in 1963. There have been two major repair efforts since 1963: (1) after hurricane Betsy in 1963 damaged the SE corner of the roof; and (2) a project to repair roof valleys in 1972. The roof will be 18 years old in 1981. The estimated roof life in the New Orleans area is 12 years. Consequently, for the past several years, an ever increasing repair effort has been necessary to protect the structural integrity of the building and to prevent manufacturing interruptions due to leaks. During the period of September 1977 to December 1978, $252,000 was expended for roof repair. These repair efforts have not been able to keep pace with the rapidly deteriorating conditions. Currently, the roof has soft spots caused by saturated insulation, blisters caused by trapped moisture, valleys that are breaking down and causing leaks, and horizontal roof drains that have deteriorated to the point that they must be replaced. Roof traffic to service the many fan houses and other roof structures has also caused a breakdown in roof integrity. A Preliminary Engineering Report, prepared by an A-E consulting firm in 1978, concluded that the roof of Building 103 should be reroofed immediately due to the "very deteriorated condition" and that then current repair efforts could not solve the problem. The consultant's recommendation to reroof also included changes in roof design that will reduce future maintenance effort by improving drainage and reducing roof traffic and will reduce energy consumption through more effective insulating techniques.

IMPACT OF DELAY:

Delaying the repair of the roof will subject the building, its contents and the tank production processes to continued damage from water leakage. Stop-gap repair measures are not sufficient to adequately repair the roof and prevent potential damage to the building and its contents.

PROJECT DESCRIPTION:

This project will provide for completing the second phase (900,000 square feet) (83,610 square meters) of a two-phase roof replacement begun with FY 1980 resources (Figure 2). This project includes the removal of existing roofing and the installation of an aggregate-surfaced, asphalt built-up, 5-ply roof with insulation over the existing concrete deck. Additional flashing, expansion joint covers and pitch pockets, etc. will be repaired/replaced as needed. Also included will be the rehabilitation or replacement of roof hatches, joints, and wood purlins as required. The roof drainage system (vertical and horizontal pipes that carry the water from the roof down through the plant to an underground storm drainage system) will be rehabilitated to prevent water ponding on the roof.

PROJECT COST ESTIMATE:

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	3,800,000
Architectural/structural	SF	900,000	3.90	(3,500,000)
Drainage system	LS	---	---	(300,000)
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total				3,800,000

LIST OF RELATED GRAPHICS:

Figure 1 - MAF Location Plan
Figure 2 - Site Plan

OTHER EQUIPMENT SUMMARY:

No other equipment is required.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

Building 103 roof rehabilitation will be completed with this project.

MICHOUD ASSEMBLY FACILITY
FISCAL YEAR 1981 ESTIMATES
REHABILITATION OF THE ROOF, PHASE II, BUILDING 103
SITE PLAN

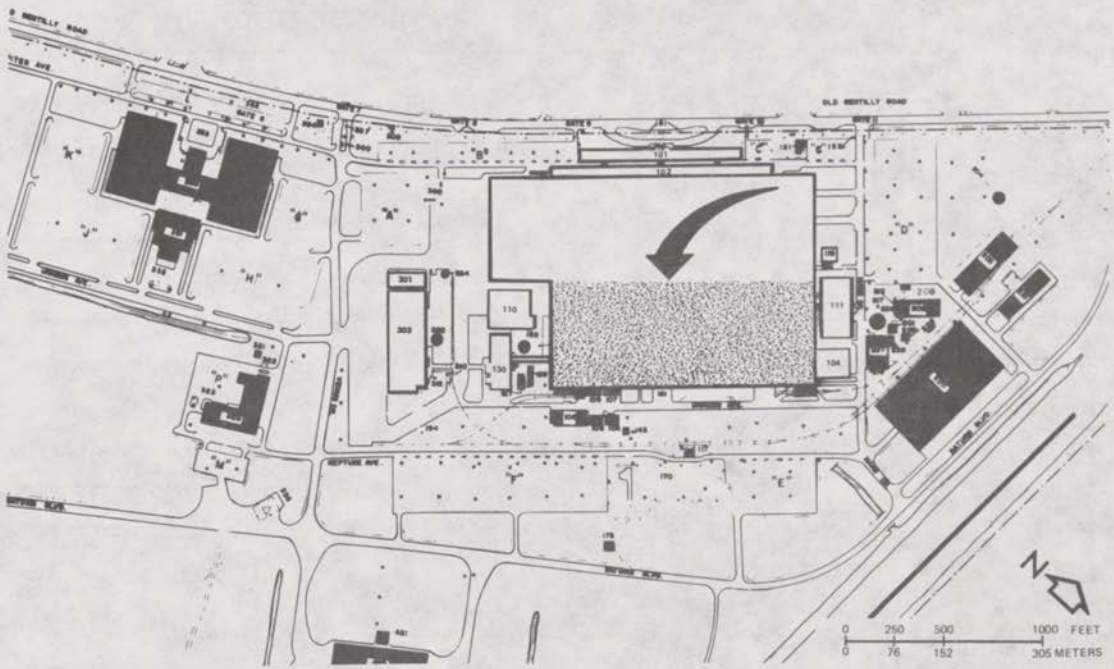


FIGURE 2

CF 6-5

MICHOUD ASSEMBLY FACILITY
FISCAL YEAR 1981 ESTIMATES
REHABILITATION OF CHILLED WATER SYSTEM
LOCATION PLAN

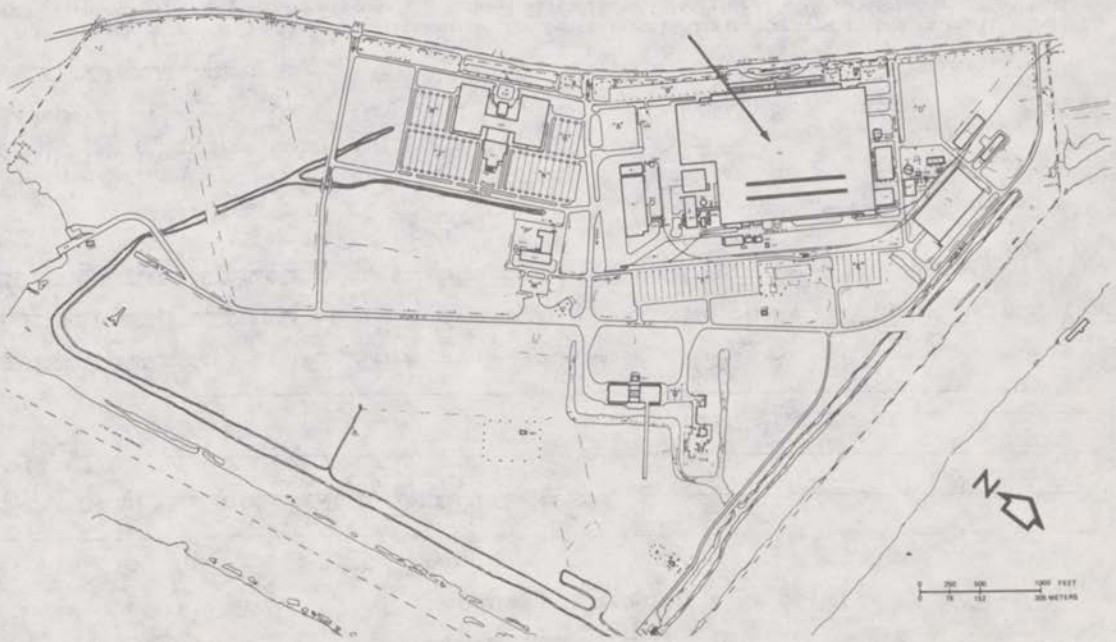


FIGURE 1

CF 6-6

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Rehabilitation of Chilled Water System

INSTALLATION: Michoud Assembly Facility

FY 1981 CoF ESTIMATE: $782,000

LOCATION OF PROJECT: New Orleans, Orleans Parish, Louisiana

COGNIZANT HEADQUARTERS OFFICE: Office of the Comptroller, Facilities Division

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	75,000	---	75,000
Capitalized investment	N/A	---	---
Total	75,000	---	75,000

SUMMARY PURPOSE AND SCOPE:

This project provides for the rehabilitation of the central chilled water system in the External Tank (ET) production area of Building 103 (Figure 1), Michoud Assembly Facility (MAF), with connections to the systems supporting the thermal protection system (TPS) area, Buildings 110 and 130. Approximately 4,300 linear feet (1,300 meters) of the existing chilled water distribution system steel piping will be replaced and reinsulated along with numerous joints, elbows and other fittings. The central chilled water system provides environmental control of the main manufacturing area through 42 fan houses as well as environmental control through various heat exchangers in several special areas. Additions to the chilled water system for the Saturn program and

now for ET production, have caused an imbalance in the system flow. This project will provide for changes in the system to correct the imbalance and will include connections to the systems that support the TPS area thereby providing backup capability.

PROJECT JUSTIFICATION:

The chilled water distribution system was installed in 1943 with light gauge spiral welded steel used for the large size pipe. The need for numerous spot repairs since 1962 have indicated an increasing tendency for this pipe to deteriorate at the seams and to leak. The ET production operations require closely controlled environmental conditions. With the increasing need for repairs, frequent interruptions in the chilled water system could cause serious production delays or shutdown. Part of TPS area is served by the central system. Loss of chilled water and the needed environmental conditions during TPS application could necessitate removing TPS material already applied and recleaning of the tank. Leaking overhead lines also cause damage to tooling and production items. The critical nature of the TPS operations also requires a backup chilled water system. This project will provide that backup capability as well as correct flow problems in existing distribution lines in the west end of Building 103 where the demand has greatly increased.

IMPACT OF DELAY:

As ET production increases to support the projected Space Shuttle launch schedule, there will be less opportunity to close down the chilled water system for planned repairs and rehabilitation. Emergency repairs will adversely impact the ET production and could result in serious cost and schedule impacts.

PROJECT DESCRIPTION:

This project provides for the replacement and reinsulation of approximately 4,300 linear feet (1,300 meters) of the chilled water distribution system steel piping in Building 103. The work will involve the use of man-lifts and/or scaffolding to perform repairs, as most of the pipe, 2 to 20 inches in diameter, is located in the forty-foot high roof trusses of the manufacturing plant. Scheduling of work must be coordinated with on-going ET manufacturing processes and must be performed in close proximity to jigs, fixtures, equipment and machine tools. Additionally, the project will balance the flow of the system and provide a chilled water backup system for Building 110 and Building 130. This backup capability will be provided by connecting the systems in Buildings 130 and 110 with the central chiller system (Figure 2).

PROJECT COST ESTIMATE:

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	782,000
Rehabilitation of chilled water lines	LS	---	---	441,000
Interconnection & modification of chilled water system.	LS	---	---	341,000
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total				782,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Piping Diagram

OTHER EQUIPMENT SUMMARY:

No other equipment is required.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

This project and other necessary work addressed in the repair, and rehabilitation and modification programs in this year's budget estimates is part of a comprehensive rehabilitation program for MAF utilities systems. These initiatives are based on requirements identified in engineering studies of utilities capacities, efficiencies, energy conservation and repair status. Is is planned to continue with similar maintenance efforts in future years that respond to priority requirements in reasonable increments of work. Such planning will focus on non-interference with ET manufacturing while keeping this unique national asset at an adequate level of repair.

MICHOUD ASSEMBLY FACILITY
FISCAL YEAR 1981 ESTIMATES

REHABILITATION OF CHILLED WATER SYSTEM

PIPING DIAGRAM

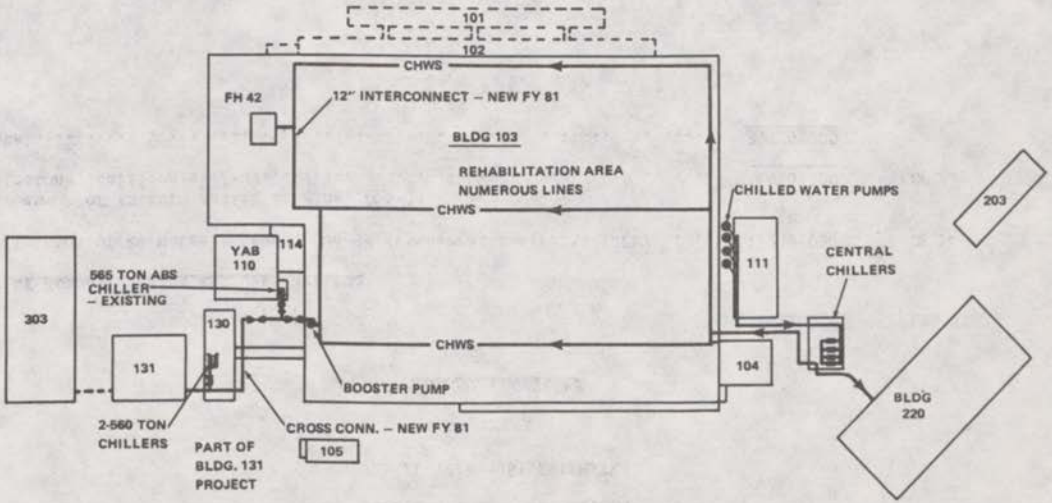


FIGURE 2

CF 6-10

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

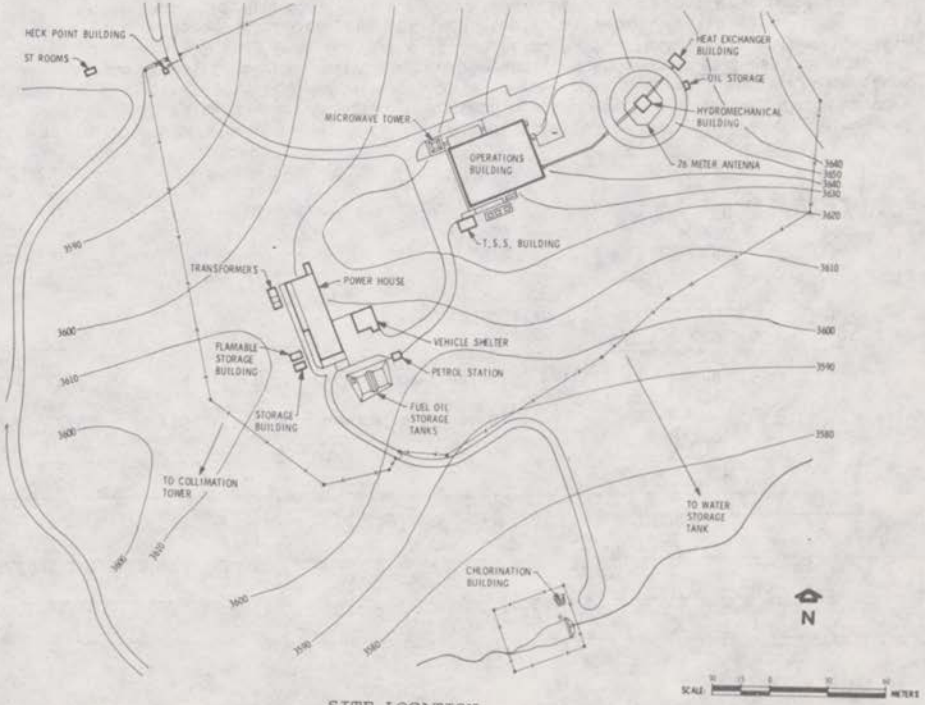
FISCAL YEAR 1981 ESTIMATES

SUMMARY

VARIOUS LOCATIONS

	Amount	Page No.
Office of Space Tracking and Data Systems:		
Modification of 26-Meter Antenna, DSS-44, Canberra, Australia (JPL).....	1,200,000	CF 7-1
Replacement of Azimuth Radial Bearing, DSS-14, Goldstone, California (JPL).....	950,000	CF 7-5
Total.....	2,150,000	

VARIOUS LOCATIONS
FISCAL YEAR 1981 ESTIMATES
MODIFICATION OF 26-METER ANTENNA
DSS-44, CANBERRA, AUSTRALIA



SITE LOCATION
FIGURE 1

CF 7-1

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE:	Modification of 26-Meter Antenna, DSS-44 Canberra, Australia
INSTALLATION:	Jet Propulsion Laboratory
FY 1981 CoF ESTIMATE:	$1,200,000

LOCATION OF PROJECT: Canberra, Australia

COGNIZANT HEADQUARTERS OFFICE: Office of Space Tracking and Data Systems

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	72,000	---	72,000
Capitalized investment	N/A	11,083,000	11,083,000
Total	72,000	11,083,000	11,155,000

SUMMARY PURPOSE AND SCOPE:

Since a significant portion of the NASA deep space missions are characterized by vastly increasing distances from earth, higher frequencies (e.g., X-band) must be employed by both the Spacecraft and the Deep Space Network (DSN), to determine position in space and to achieve an acceptable science data return. The NASA/Australian Deep Space antenna at Honeysuckle Creek, Canberra, Australia, will be modified to operate at X-band frequencies as part of an overall plan to update all such Deep Space Facilities (Figure 1). This will also provide NASA with the capability to array all antennas in the current DSN in Australia at X-band to achieve a substantial increase in data rate return over that which has been possible up to now. The existing antenna will be converted

from 26 to 34 meters to provide this necessary support. The other Deep Space Facility in Australia has already been modified.

PROJECT JUSTIFICATION:

The basic justification for the addition of an X-band capability to existing DSN 26-meter stations is to support presently approved and near term NASA flight missions, which have the following characteristics:

Data Return from Greater Distances

The primary data mode for many on-going and future planetary and interplanetary spacecraft is X-band for achieving higher data rates and precision navigation at greater distances.

Viewing of In-Flight Spacecraft

The very long flight time (years) to the outer planets and the relative positions of the planets produce a "bunching effect" of enroute spacecraft as seen from earth. Thus, more antenna capability is required at each complex to support space missions, since more spacecraft are in view simultaneously. As an example, the close Mars flyby southern trajectory condition will prevail for the Galileo mission, which will require heavy support from the southern hemisphere stations. Other approved missions in flight in the mid 1980's will be in view at the same times from the Australian location, and will require concurrent support.

IMPACT OF DELAY:

FY 1981 funds will assure an operational capability by the mid-1980's to adequately support the in-flight planetary missions.

PROJECT DESCRIPTION:

This project provides for the modification of the existing 26-meter antenna at Canberra, Australia, to operate at both S and X-band frequencies with an aperture of 34 meters to assure adequate performance retention of S-band frequencies. It will include primarily the structural modifications necessary to support a new S and X-band microwave subsystem. This work consists of backup structure modifications, strengthening bolted joints by welding, extending foundations, replacement of air-conditioning and servo lines, and safety modifications to ladders and platforms.

PROJECT COST ESTIMATE:

The basis for this cost estimate is an in-house preliminary engineering analysis based on the three previous conversions.

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	1,200,000
Antenna foundation	LS	---	---	265,000
Counterweights, ladder, installation	LS	---	---	250,000
Weld joints	LS	---	---	275,000
Strip antenna, site preparation, etc	LS	---	---	410,000
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total				1,200,000

LIST OF RELATED GRAPHICS:

Figure 1 - Site Location

OTHER EQUIPMENT SUMMARY:

Electronics data handling equipment, and radio frequency and microwave equipment associated with the S-X conversion is estimated to cost $5,510,000, and will be provided with R&D funding in FY 1981 - 1983.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

No future funding is required for this facility project.

VARIOUS LOCATIONS
FISCAL YEAR 1981 ESTIMATES
REPLACEMENT OF AZIMUTH RADIAL BEARING
DSS-14, GOLDSTONE, CALIFORNIA

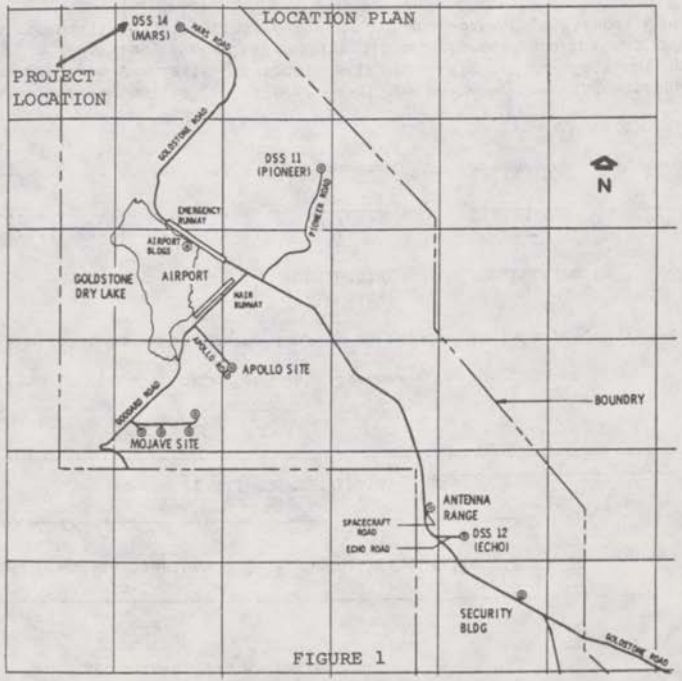


FIGURE 1

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE:	Replacement of Azimuth Radial Bearing, DSS-14, Goldstone, California
INSTALLATION:	Jet Propulsion Laboratory
	FY 1981 CoF ESTIMATE: $950,000

LOCATION OF PROJECT: Goldstone, California

COGNIZANT HEADQUARTERS OFFICE: Office of Space Tracking and Data Systems

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	57,000	---	57,000
Capitalized investment	N/A	27,143,000	27,143,000
Total	57,000	27,143,000	27,200,000

SUMMARY PURPOSE AND SCOPE:

This project provides for the rehabilitation of the radial bearing of the 64-Meter Tracking Antenna (DSS-14) at the Goldstone Deep Space Communication Complex, Goldstone, California (Figure 1). This antenna has been in service for nearly 15 years. In that time, the radial bearing has deteriorated and the risk of failure has increased. The bearing will be rehabilitated by replacing the runner and wearstrip (Figures 2 and 3).

PROJECT JUSTIFICATION:

The replacement of the radial bearing and wearstrip assembly is required in order to preclude an unscheduled shutdown of DSS-14 due to radial bearing failure. A failure of this type could cause a loss of spacecraft data for several months. In addition to the increased risk of failure, the present deteriorated condition of the radial bearing runner results in a loss of antenna performance in high winds. In order to compensate for the present runner condition, the preload has been reduced from 330,000 pounds (150,000 kilograms) to a value under 200,000 pounds (91,000 kilograms). This has caused the antenna to be less stiff in response to both steady and gusty winds. This reduction in stiffness also causes a small increase in tracking error under normal conditions.

The DSS-14 radial bearing has, in the past, shown evidence of a very high deterioration rate. The deterioration was such that it was visible as gaps between the runner and the grout which increased from 0.020-inch to 0.045-inch (.051 centimeter to .11 centimeter). In two areas concrete spalled directly below the runner joint. Since that time, the preload in the wheel assemblies has been reduced and the sheared wearstrip bolts have been replaced. Corings in the grout were made and severe rusting on the grout side of the runner was discovered. Also, there was evidence of shear failure of the dowel pins in the runner. The mechanical joints in the runner were reinforced by welding a portion of the joint, and a polyester material was used to seal the runner-grout gap to exclude moisture and stabilize the oxidation process in the grout.

IMPACT OF DELAY:

The 64-meter antenna subnet is the "backbone and workhorse" of the Deep Space Network. Downtime for the installation portion of this project is four months. The first interval between major mission support periods is May through August 1982. If this project is delayed, then installation cannot be accomplished during a quiet time for the antenna. Work would then have to be scheduled during important mission support periods.

PROJECT DESCRIPTION:

This project will replace the existing radial bearing wearstrip and runner assembly. This will consist of removing the existing radial bearing wearstrip and runner assembly, fasteners, and grout; preparing the concrete collar surface, replacing the fasteners, installing the runner assembly and wearstrip and re-grouting between the runner and concrete collar. The alignment of the runner which is 5-inch (12.7 centimeter) thick steel, 30 feet (9.1 meters) in diameter, is a major and very critical task.

PROJECT COST ESTIMATE:

The basis for this cost estimate is an in-house Preliminary Engineering Report.

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	950,000
Fabrication of wearstrip	LS	---	---	85,000
Fabrication of runner	LS	---	---	700,000
Removal of wearstrip and runner	LS	---	---	80,000
Installation and alignment	LS	---	---	85,000
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total				950,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Azimuth Radial Bearing Design
Figure 3 - Present Condition of Bearing

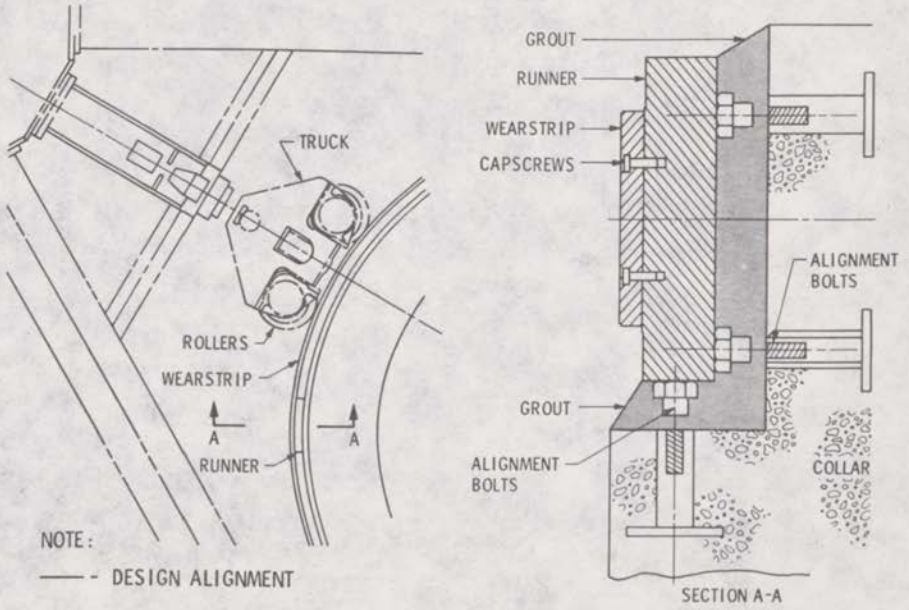
OTHER EQUIPMENT SUMMARY:

No other equipment is required.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

No future funding is required to complete this project.

VARIOUS LOCATIONS
FISCAL YEAR 1981 ESTIMATES
REPLACEMENT OF AZIMUTH RADIAL BEARING
DSS-14, GOLDSTONE, CALIFORNIA

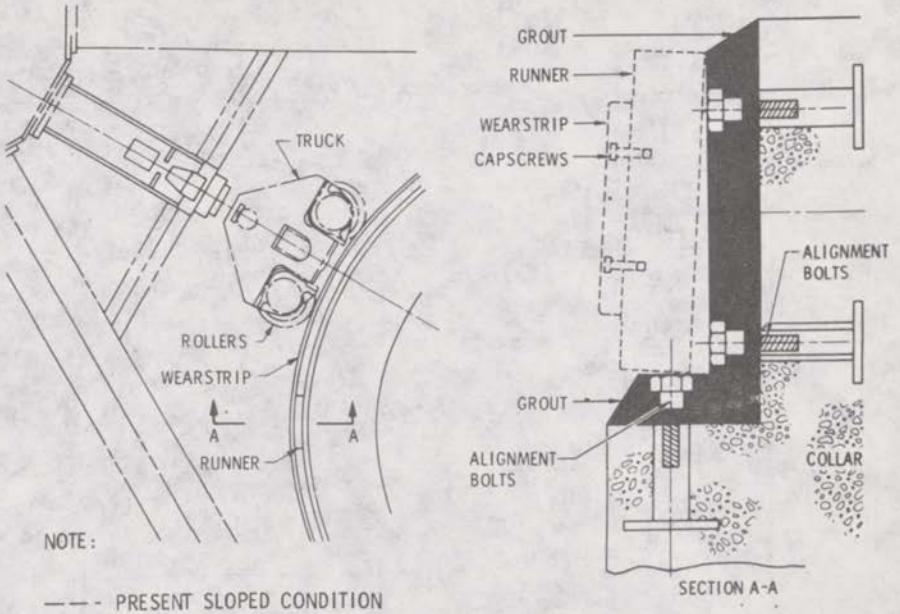


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AZIMUTH RADIAL BEARING DESIGN
FIGURE 2

CF 7-9

VARIOUS LOCATIONS
FISCAL YEAR 1981 ESTIMATES
REPLACEMENT OF AZIMUTH RADIAL BEARING
DSS-14, GOLDSTONE, CALIFORNIA



PRESENT CONDITION OF BEARING
FIGURE 3

CF 7-10

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

SUMMARY

SPACE SHUTTLE FACILITIES

	Amount	Page No.
Office of Space Transportation Systems:		
Summary		CF 8-1
Manufacturing and Final Assembly Facilities:	8,100,000	
Modification of Manufacturing and Final Assembly Facilities for External Tanks (MAF)	5,400,000	CF 8-4
Modifications to SRM Manufacturing and Assembly Facilities, Thiokol Plant, Wasatch, Utah (MSFC)	2,700,000	CF 8-14
Minor Facilities:	2,000,000	
Minor Shuttle-Unique Projects, at Various Locations	2,000,000	CF 8-28
Total	10,100,000	

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Space Shuttle Facilities

INSTALLATION: Various Locations

FY 1981 CoF ESTIMATE: $10,100,000

LOCATION OF PROJECT: Locations are identified in the following documentation.

COGNIZANT HEADQUARTERS OFFICE: Office of Space Transportation Systems

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	6,817,000	69,671,000	76,488,000
Capitalized investment	N/A	137,175,000	137,175,000
Total	6,817,000	206,846,000	213,663,000

SUMMARY PURPOSE AND SCOPE:

The purpose of this project is to rehabilitate, modify, and add to existing Government-owned facilities, and to construct new facilities to meet unique requirements of the Space Shuttle Program. As in prior years, this Shuttle facilities package includes all major facility requirements unique to the Space Shuttle Program. In FY 1981, the proposed Shuttle facilities are primarily related to the external tank (ET) manufacturing and final assembly at Michoud Assembly Facility (MAF) and the solid rocket motor (SRM) manufacturing and final assembly at Thiokol. The majority of requirements addressed in this request were envisioned in previous planning. Certain other requirements have just now become known as manufacturing experience has begun to

mature and the program has developed. Also included are minor rehabilitation and modification projects which are required to support the Space Shuttle and are therefore considered Space Shuttle unique projects.

PROJECT JUSTIFICATION:

Prior year CoF budgets for the Space Shuttle Program authorized modification and construction of facilities for technical development, Space Shuttle main engine tests, ground tests, manufacturing, and launch and landing. All of the facilities to support the first Manned Orbital Flight and the Design, Development, Test and Evaluation portion of the program are essentially completed and have been put into operation or are being activated. The major projects in this funding request are for continuation of modifications to manufacturing facilities for the ET's and SRM's. These projects are required at this time to add to manufacturing capabilities at MAF and Thiokol to meet production needs which, in turn, support planned operational Space Shuttle mission capability.

As in previous requests, the projects included have been carefully reviewed against operational projections and mission capabilities to insure they are not prematurely requested.

PROJECT COST ESTIMATE:

Manufacturing and Final Assembly Facilities	8,100,000
Modification of Manufacturing and Final Assembly Facilities for External Tanks, Michoud Assembly Facility	5,400,000
Modifications to Solid Rocket Motor Manufacturing and Assembly Facilities, Thiokol Plant, Wasatch, Utah	2,700,000
Minor Shuttle Unique Projects	2,000,000
TOTAL	10,100,000

MICHOUD ASSEMBLY FACILITY
FISCAL YEAR 1981 ESTIMATES
MODIFICATION OF MANUFACTURING AND FINAL ASSEMBLY FACILITIES
FOR EXTERNAL TANKS

LOCATION PLAN

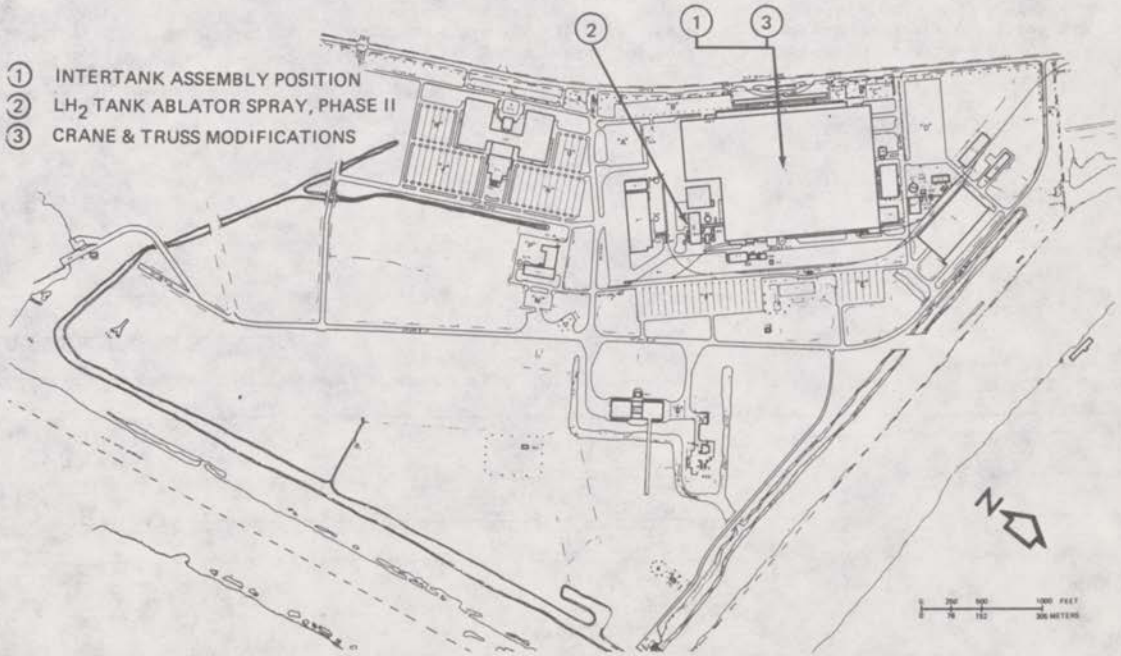


FIGURE 1

CF 8-4

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Modification of Manufacturing and Final Assembly Facilities for External Tanks

INSTALLATION: Michoud Assembly Facility

FY 1981 CoF ESTIMATE: $5,400,000

LOCATION OF PROJECT: New Orleans, Orleans Parish, Louisiana

COGNIZANT HEADQUARTERS OFFICE: Office of Space Transportation Systems

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	5,618,000	59,041,000	64,659,000
Capitalized investment	N/A	132,927,000	132,927,000
Total	5,618,000	191,968,000	197,586,000

SUMMARY PURPOSE AND SCOPE:

This project continues work begun with prior years resources, including FY 1980. It provides for the modification of manufacturing and final assembly facilities at the Michoud Assembly Facility (MAF) for the Space Shuttle External Tank (ET) production. It is required to provide the facilities necessary to fabricate and assemble the three major components of the ET, to test and clean them, to apply the Thermal Protection System (TPS), and to assemble the major components into a complete ET. The assembled ET is then equipped with plumbing and electrical systems and checked for acceptance to be shipped to the launch site.

Prior years resources provided modifications to the Main Manufacturing Building, Building 103; the Vertical Assembly Building (VAB), Building 110; the Final Acceptance and Checkout Building, Building 420; the construction of Phase I, High Bay Addition, Building 114; a facility to apply ablator to the LH_2 tank, Building 131; a proof test facility for the LH_2 tank, Building 451; a Thermal Protection System waste disposal facility; and major rehabilitation of various facilities to support the production of the Shuttle External Tank.

The FY 1980 project provided additional production facilities needed to support ET manufacturing and final assembly. Work also included a facility to dispose of TPS wastes; and two projects to assure the integrity, reliability, and energy efficiency of the total ET manufacturing plant and its basic support systems.

This FY 1981 project (Figure 1) provides for additional facilities for increasing production rate capabilities required to support scheduled Shuttle launches. These facilities are the the third and last phase of the Horizontal LH_2 Tank Spray Ablator Facility, begun with FY 1979 funding and continued with FY 1980 resources, and additional/modified crane coverage and associated truss modifications in the Main Manufacturing Building 103. These projects have been implemented in phases to meet the requirements for production as they increase, but limited so as to avoid unnecessary overbuilding in the early years. Work has been scheduled so that construction will be completed in the central production areas before the ET production rates become critical to the overall program. The current schedule is devised to minimize interference between construction work and ET production.

In addition to the continuation of modifications listed above, one new modification is included in this FY 1981 request. The assembly of the intertank is now being accomplished on a modified tool and foundation from the Saturn program. This tooling configuration has proven inefficient and cannot meet planned production rates. Foundations for two new intertank assembly positions, included in this estimate, will accommodate new, more efficient tooling. This will result in improved production operations and significant cost savings in intertank assembly.

PROJECT JUSTIFICATION:

LH_2 Tank Ablator Spray Facility, Cell "M", Building 131

This phase of facilities modifications for ET manufacturing completes the construction of the third and last cell of the Horizontal LH_2 Spray Ablator Facility. FY 1979 and FY 1980 projects provided a cleaning and priming cell and one ablator spray cell, along with the foundation for this third cell. Because the first ablator spray cell can support a rate of only 16 tanks per year during the early production, a second Cell M, is needed to achieve the rate required to meet the program demands when it is scheduled to come on line in early 1982. The ultimate capability for the ablator application in these two identical cells will be 60 LH_2 tanks per year.

Crane and Truss Modifications, Building 103

Modifications to the existing crane systems in the Main Manufacturing Building 103 are required to help smooth production flow and provide adequate crane coverage in vital areas. The work flow experience of the first few tanks has validated the requirement for additional crane coverage to improve the efficiency of moving material in the production area. Also, existing cranes which range in age from seventeen to thirty-six years have deteriorated. These units must be overhauled to assure their reliability and to meet current OSHA safety standards. Increasing material handling requirements necessitate accomplishing this work at this time to minimize production interruptions when higher production rates are required. Some modifications to the truss system are required to support the crane work.

Intertank Assembly Facilities:

The intertank is presently assembled using modified Saturn tooling. As each intertank is completed, the tooling must be disassembled to permit removal of the completed intertank. This time-consuming disassembly and assembly will prevent meeting future planned production rates. Therefore, to meet the production requirement, a new tool must be installed to allow for crane removal of the intertank without tool disassembly. This project provides the foundation for two intertank assembly positions required to satisfy the ultimate production rate. The intertank assembly positions will also be relocated to provide an improved layout for more efficient operations and to allow collocation of the other associated intertank assembly tasks. The resulting anticipated increased efficiency will lower unit production costs of the intertank.

IMPACT OF DELAY:

The Horizontal LH_2 Spray Ablator, Cell M and the Intertank Assembly Facility are required to support production rates that are projected to be needed at the time these facilities are scheduled to be completed. Failure to provide them at this time would prevent attainment of needed capability to manufacture ET's to support flight rates in 1983. Delay of the crane and truss modifications would necessitate modifications at a time when the production schedule has increased and construction interruptions of manufacturing would be critical.

PROJECT DESCRIPTION:

This project continues work authorized in prior years. It includes construction and modifications in Buildings 103 and 131; adding a spray ablator cell to Building 131, modification of the cranes in Building 103, construction of the foundation for new intertank assembly positions and associated utilities support.

Horizontal LH_2 Tank Spray Ablator Facility, Cell M, Building 131

This is the third cell of a three-cell building (Figure 2). This phase of work will provide the second spray ablator cell. Included in this estimate is the building shell, approximately 50 feet wide (15.2 meters), 60 feet high (18.2 meters), and 150 feet long (45.6 meters); access platforms, stairways, doors, and interior structures. This cell will be connected to the mechanical and utility systems of the existing structure, requiring an increase in capacity to support this new cell. Cranes, fire suppression and other utility service for this cell will also be provided.

Crane and Truss Modification:

Modificatons to existing cranes in the manufacturing facility, Building 103, include new crossovers, relocating existing crossovers, cleaning shoes and rails, replacing or reworking control systems, installing pendants, shortening rails, removing bridges and rails, and in some cases increasing capacities (Figure 3). Areas serviced by this expanded coverage include the Liquid Oxygen Tank offload and storage area, the new offload positions for the Liquid Hydrogen Tank, portions of the operations on the east side of the building and the Chemical Clean and Finish Area.

Intertank Assembly Facility:

This FY 1981 project also provides for construction of a foundation to accommodate two intertank assembly tools, lighting, HVAC service and other supporting utilities. Also included is the installation of four cranes and necessary utility service to the intertank positions (Figure 4).

PROJECT COST ESTIMATE:

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	5,400,000
Intertank assembly position	---	---	---	1,400,000
Architectural/structural	LS	---	---	(1,135,000)
Mechanical systems	LS	---	---	(80,000)
Electrical systems	LS	---	---	(185,000)
LH_2 ablator spray facility	---	---	---	3,000,000
Architectural/structural	LS	---	---	(1,440,000)
Mechanical system	LS	---	---	(1,440,000)
Electrical systems	LF	---	---	(120,000)
Crane and truss modifications	---	---	---	1,000,000
Architectural/structural	Cranes	---	---	(900,000)
Electrical systems	Cranes	---	---	(100,000)
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total				5,400,000

LIST OF RELATED GRAPHICS:

Figure 1 - MAF Location Plan with general location of projects
Figure 2 - Horizontal LH_2 Ablator Spray Facility, Building 131 - Cell M
Figure 3 - Crane and Truss Modification Location Plan
Figure 4 - Intertank Assembly Position general layout

OTHER EQUIPMENT SUMMARY:

Special tooling (spray tooling, assembly tooling, unique work platforms, and special dollies) will be needed for ET production operations. They will be funded from R&D sources. Existing surplus Apollo tooling, with modifications as required, will be used to the maximum extent possible to meet this need.

FUTURE CoF FUNDING REQUIRED TO COMPLETE THIS PROJECT:

Additional CoF resources may be required in the future to provide for completion of production facilities to support the maximum ET production rate. This includes, additional chemical tank farm capacity, an ET storage facility, the remaining two TPS cells in the High Bay Addition (Building 114), and the second final acceptance and checkout station. Additional modification work, not now identified, may also be necessary to satisfy future programmatic requirements as they evolve.

MICHOUD ASSEMBLY FACILITY
FISCAL YEAR 1981 ESTIMATE
MODIFICATION OF MANUFACTURING AND FINAL ASSEMBLY FACILITIES
FOR EXTERNAL TANKS
LH_2 TANK ABLATOR SPRAY FACILITY

CELL M

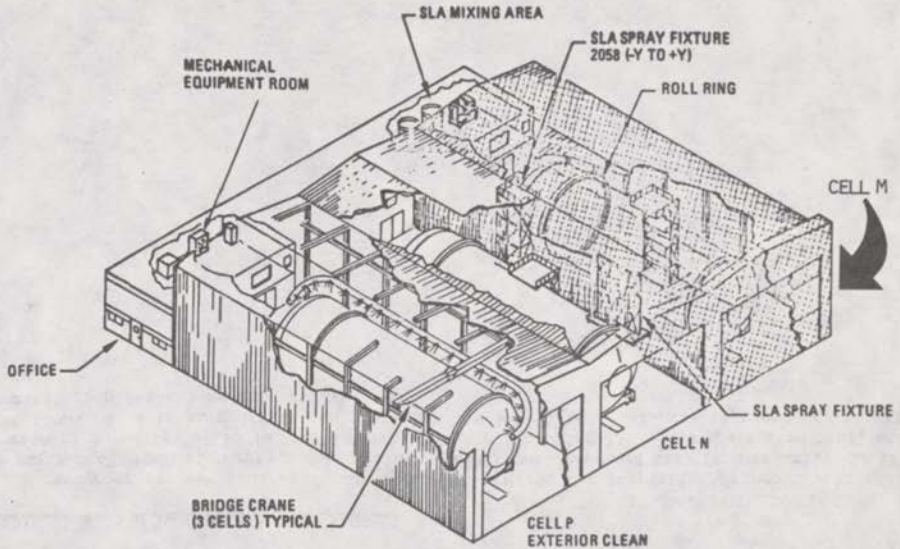


FIGURE 2

CF 8-11

MICHOUD ASSEMBLY FACILITY
FISCAL YEAR 1981 ESTIMATE
MODIFICATION OF MANUFACTURING AND FINAL ASSEMBLY FACILITIES FOR EXTERNAL TANKS
CRANE & TRUSS MODIFICATIONS

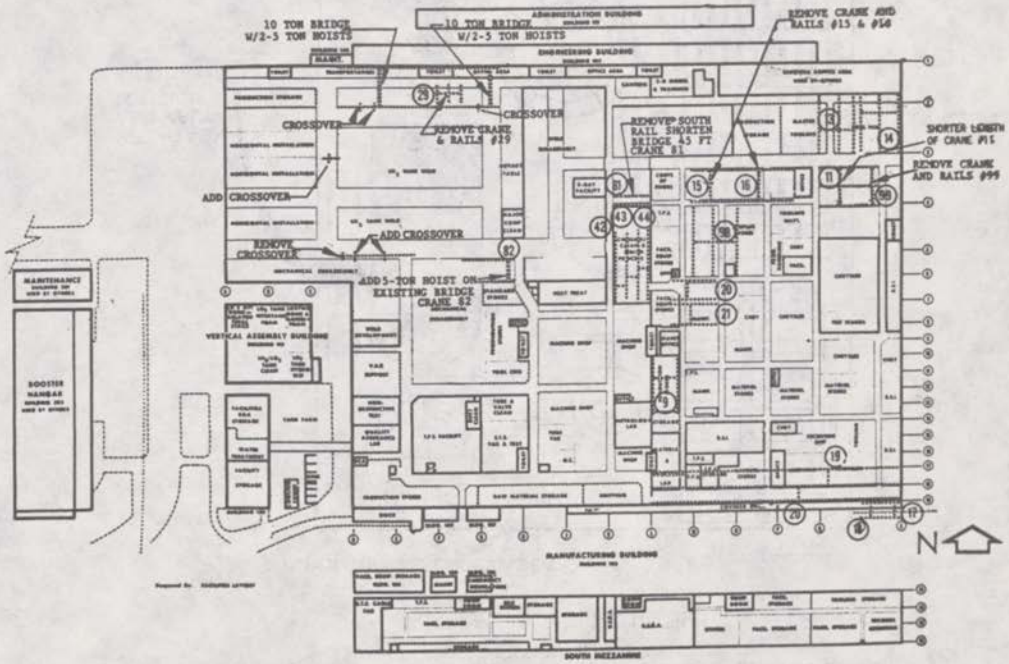


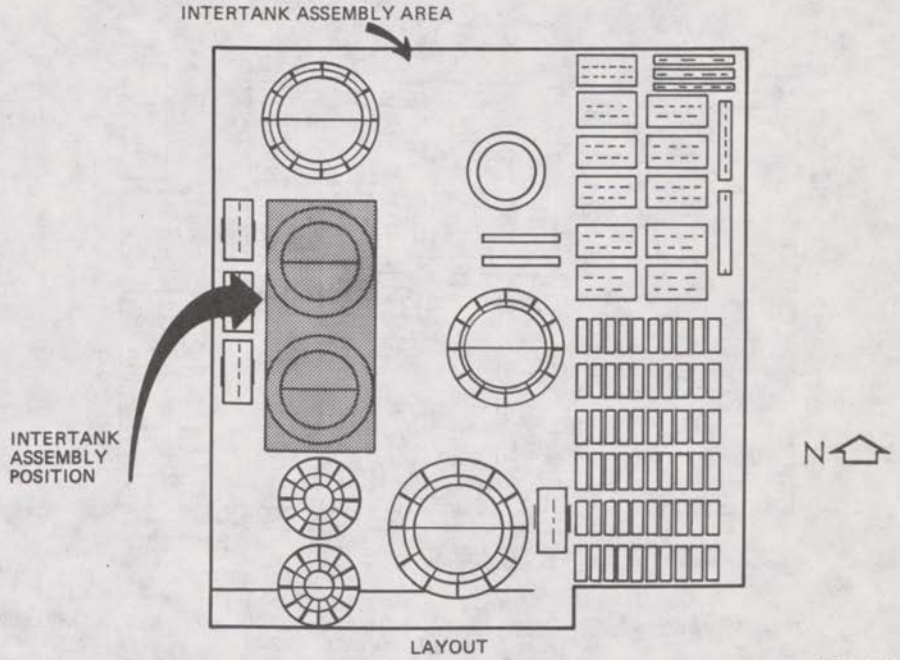
FIGURE 3

CF 8-12

57-166 0 - 80 - 40

MICHOUD ASSEMBLY FACILITY
FISCAL YEAR 1981 ESTIMATES
MODIFICATION OF MANUFACTURING AND FINAL ASSEMBLY FACILITIES
FOR EXTERNAL TANKS

INTERTANK ASSEMBLY POSITION



LAYOUT

FIGURE 4

CF 8-13

THIOKOL/MARSHALL SPACE FLIGHT CENTER
FISCAL YEAR 1981 ESTIMATES
MODIFICATIONS TO SOLID ROCKET MOTOR MANUFACTURING AND ASSEMBLY FACILITIES
THIOKOL, WASATCH, UTAH

LOCATION PLAN

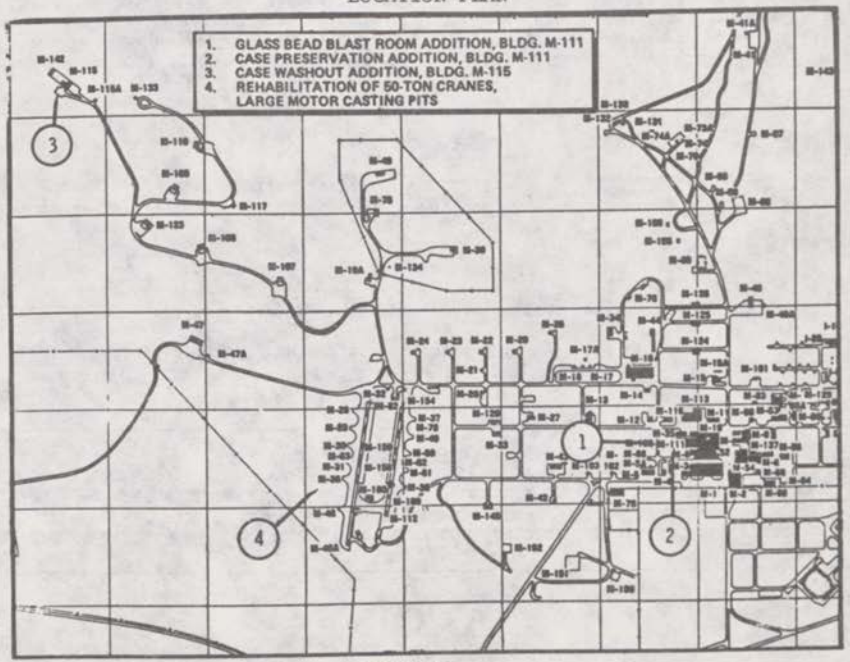


FIGURE 1

CF 8-14

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Modifications to Solid Rocket Motor Manufacturing and Assembly Facilities

INSTALLATION: Thiokol Plant, Wasatch Division, Utah

FY 1981 CoF ESTIMATE: $2,700,000

LOCATION OF PROJECT: Wasatch, Utah

COGNIZANT HEADQUARTERS OFFICE: Office of Space Transportation Systems

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	447,000	1,920,000	2,367,000
Capitalized investment	N/A	2,683,000	2,683,000
Total	447,000	4,603,000	5,050,000

SUMMARY PURPOSE AND SCOPE:

This project continues work begun with prior year resources, and further supplemented by FY 1978 and FY 1979 resources to provide Space Shuttle Solid Rocket Motor (SRM) production capability in Government-owned facilities at the Thiokol Plant, Wasatch Division, Wasatch, Utah (Figure 1). The government facilities involved are portions of Air Force Plant No. 78 located on the adjacent Thiokol facility. The cost of the basic "pre-shuttle" government plant facilities is not included in the prior years funding data above.

Prior year resources were used to modify existing Government-owned buildings to develop, manufacture, assemble, store, and test Space Shuttle Solid Rocket Motors (SRM's). These modifications were geared to provide SRM production and related facility capability for the test phase, early operational phase and to support the Shuttle launch rates in the range of 18 to 24 flights per year.

The FY 1975 funding provided modifications to the oxidizer grinding, case preparation and reclamation, radiographic inspection, nozzle joint test, and casting facilities to support up to 10 Shuttle flights per year. FY 1978 resources provided for an eight-segment process storage facility at Thiokol. The FY 1979 project was planned to increase the manufacturing capability to 24 flight sets per year. However, due to the increased time required to remove case insulation in the washout facility, this FY 1981 project is required to attain a refurbishment capability of 24 flight sets per year. This FY 1981 request will provide resources to further modify Government-owned facilities at the Thiokol/Wasatch plant to provide a production capability in support of a maximum rate of 24 flights per year, and at the same time, minimize production costs.

The proposed work includes an increase in the size of Building M-115 to permit washout and removal of insulation from fired case segments and to accommodate the longer stay times in the facility due to increased insulation complexity and thickness, and the modification of Building M-111 to add a glass bead blast capability to clean the mating joints. It also includes an addition to Building M-111 to provide the capability for inert case preservation, and rehabilitation of two 50-ton cranes at the Large Motor Casting Pits (LMCP) to achieve greater reliability and to meet current OSHA safety standards.

PROJECT JUSTIFICATION:

The Space Shuttle vehicle consists of the Orbiter, a large External Tank, and two Solid Rocket Boosters (SRB's). This project supports the manufacturing of the SRB's. Each SRB consists of four 146-inch (370.8-centimeter) diameter SRM's, and a 152-inch long by 148-inch in diameter (386.1-centimeter by 375.9-centimeter) nozzel and various structural components. SRM case segments are assembled, lined, and insulated in the inert operations complex. Assembled segments, (which are made up of 3 to 4 case segments) called casting segments, are then moved to the casting pits, where they are loaded with solid propellant. After the propellant is loaded, the segments are moved to the final SRM assembly area. There they are weighed, and the center of gravity is determined. The nozzel which consists of three major components (flexible bearing, throat assembly and exit cone) is lined, insulated and assembled. The systems tunnel, nozzle and igniter, instrumentation and handling harness rings are installed and inspected, and prepared for shipment to the launch site. After each flight, the Solid Rocket Motors are returned to Thiokol/Wasatch for case washout and reprocessing.

Case Segment Washout Facility, Building M-115

This facility addition will provide added required case washout capability. The increased complexity and amount of SRM lining/insulation has markedly lengthened the time required in the washout facility to remove the insulation. Rapid turnaround of case hardware is required to minimize procurement of new flight hardware. The new, second washout bay and work stations are required to meet the case segment refurbishment rate required to support a launch rate of 24 Shuttle flights per year.

Glass Bead Blast Room, Building M-111

During the preparation of the SRM case segment, considerable time is required to clean the case surfaces, particularly the clevis and tang areas. This operation presently must be done by hand because grit blasting has proven too abrasive. Process experiments have demonstrated that blasting these areas with glass bead grit reduces the hand cleaning to a minimum. This modification will provide a glass bead blast capability that will support a production rate of 24 Shuttle flight sets per year.

Case Segment Preservation Application Facility, Building M-111

Proper preservation of the SRM Case Segments is required to prevent corrosion. The process that was proposed for refurbished case segments has not proven effective. The refurbished case will, as a result of this project, receive the same treatment applied by the manufacturer to new cases when they are shipped to the Thiokol plant. This operation must be located with other related operations in Building M-111, but because of contamination possibilities, the preservation application functions must be isolated. This project provides the space and facilities, including utility service, for the electrostatic application of the case preservative.

Rehabilitation of 50-Ton Gantry Cranes

The two Government-owned 50-ton cranes at the Large Motor Casting Pits (LMCP) are 20 years old and must be rehabilitated. Time-consuming breakdowns cannot be tolerated when production rates reach a level to support 24 launches per year. Considerable maintenance and breakdown problems related to LMCP cranes have been experienced recently. The reliability of these cranes must be improved to insure continous smooth operation at the LMCP's to meet increasing production rates. The current OSHA safety requirements for this type of crane are currently not being met.

IMPACT OF DELAY:

Delay in providing these critical SRM manufacturing facilities will prevent attainment of the 24 Shuttle

flight sets per year required by the program. Furthermore, production shortfalls could be further aggrevated by the questionable safety and reliability of cranes. And finally, production cost savings that can be achieved by more efficient cleaning processes and proper case preservation will be denied.

PROJECT DESCRIPTION:

The proposed work includes additions and/or modifications to Buildings M-111 and M-115 and the rehabilitation of two 50-ton gantry cranes at the Large Motor Casting Pits (LMCP).

Case Segment Washout Facility, Building M-115

This 7,840 square feet by 30 feet high (728 square meters by 9.14 square meters) addition to Building M-115 (Figure 2) will be constructed on the south side of the nozzle washout addition (provided as part of the FY 1979 CoF Project). This new washout addition will have three work positions in addition to an actual 1,000 square feet (92.9 square meters) washout bay. These positions are: 1) Receiving and preparation bay - 800 square feet (74.2 square meters); 2) Manual washout bay for removal of the systems tunnel, external joint and and internal joint seal - 1,000 square feet (92.9 square meters); and 3) preservation and shipping bay - 800 square feet (74.2 square meters). In addition to the operational positions, there will be an 1,800-square foot (167.2-square meter) equipment storage and control room area. Also included are a pump room, work platforms, utility services, bridge cranes, track and conveyor system; and a new settlement pond. Provisions for a future additional washout bay will be incorporated into the structure.

629

Glass Bead Blast Room, Building M-111

Building M-111 will be modified to add a glass bead blastroom located in the south end of the West Bay of the building. The blastroom will be 400 square feet by 15 feet high (37.16 square meters by 4.57 square meters high) to allow the installation of a pre-engineered structure. Included will be a pit which provides access to the area of the case (the clevis joint) to be blasted. A recycling system will be installed for collecting spent beads and removing fines. A negative pressure will be maintained in the blastroom to prevent glass particles and dust from migrating to other operations in the building. All necessary utility services will also be provided (Figure 3 and 4).

Case Segment Preservation Application Room, Building M-111

A 400-square foot (37.16 square meter) preservation station will be added at the north end of the building. This station will have a covered access area with a monorail crane for lifting case segments, and a pit in the floor for access to the outside surface and the inside surfaces of the case segments. A personnel hydraulic

lift will be installed in the access pit. This lift will be capable of moving back and forth under the case so that both the outside and inside surfaces can be reached with preservative. The case will be positioned on powered rollers which will rotate the case during application of preservatives (Figures 3 and 5).

Rehabilitation of 50-ton Gantry Cranes:

The two Government-owned 50-ton cranes at the Large Motor Casting Pits (LMCP) will be completely rehabilitated. This will include diesel engine overhaul, electrical generator overhaul, overhaul of the brake system and addition of a secondary braking system, replacement of controls and electrical cabling, installation of new lifting cables, replacement of all wearing points such as wheel bearings, replacement of clutches and replacement of gearing (Figure 6).

PROJECT COST ESTIMATE:

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	2,700,000
Case segment washout facility, building M-115	---	---	---	1,800,000
Site work	LS	---	---	(56,000)
Paving	SY	2,000	8.00	(16,000)
Foundations and slab	CY	1,000	453	(453,000)
Building structure	SF	7,840	70.16	(550,000)
Mechanical systems and equipment	LS	---	---	(625,000)
Electrical (interior and exterior)	LS	---	---	(100,000)
Glass bead blast room, building M-111	---	---	---	200,000
Demolition	LS	---	---	(15,000)
Foundation and pit	LS	---	---	(22,000)
Building structure	LS	---	---	(82,000)
Mechnical and equipment	LS	---	---	(60,000)
Electrical	LS	---	---	(21,000)

	Unit of Measure	Quantity	Unit Cost	Cost
Case segment preservation application facility building M-111	---	---	---	300,000
Site preparation	LS	---	---	(10,000)
Foundation and storage pad	LS	---	---	(30,000)
Building structure and canopy	LS	---	---	(120,000)
Mechanical/equipment	LS	---	---	(125,000)
Electrical	LS	---	---	(15,000)
Rehabilitation of 50-ton gantry cranes	LS	---	---	400,000
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total				2,700,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location Plan
Figure 2 - Case Segment Washout Facility
Figure 3 - Site Location Projects Building M-111
Figure 4 - Glass Bead Blast Room, Building M-111
Figure 5 - Case Segment Preservation Application Facility, Building M-111
Figure 6 - Rehabilitation of 50-ton Gantry Cranes

OTHER EQUIPMENT SUMMARY:

Special tooling and equipment will be needed to support production. This Government-furnished tooling and equipment will be funded from R&D resources and is estimated to cost $645,000.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

Additional resources may be required for SRM facilities to support flight rates that exceed 24 per year. Details of the potential requirements cannot be validated at this time.

THIOKOL/MARSHALL SPACE FLIGHT CENTER
FISCAL YEAR 1981 ESTIMATES
MODIFICATION FOR SOLID ROCKET MOTOR MANUFACTURING AND ASSEMBLY FACILITIES
THIOKOL, WASATCH, UTAH

SRM CASE WASHOUT FACILITY ADDITION BLDG M-115

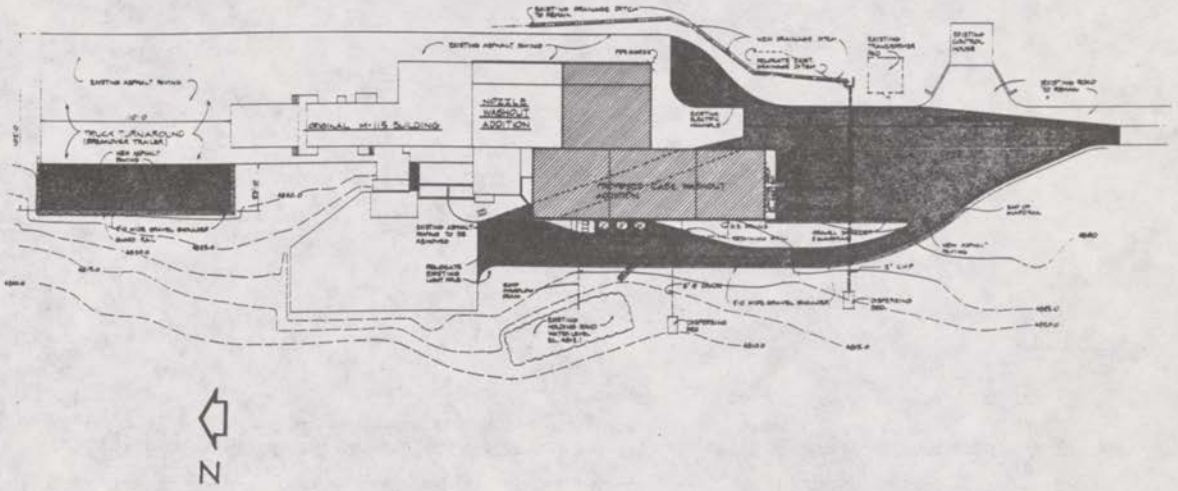


FIGURE 2

CF 8-23

THIOKOL/MARSHALL SPACE FLIGHT CENTER
FISCAL YEAR 1981 ESTIMATE
MODIFICATION FOR SOLID ROCKET MOTOR MANUFACTURING AND ASSEMBLY FACILITIES
THIOKOL, WASATCH, UTAH
SITE LOCATION PROJECTS – BUILDING M–111

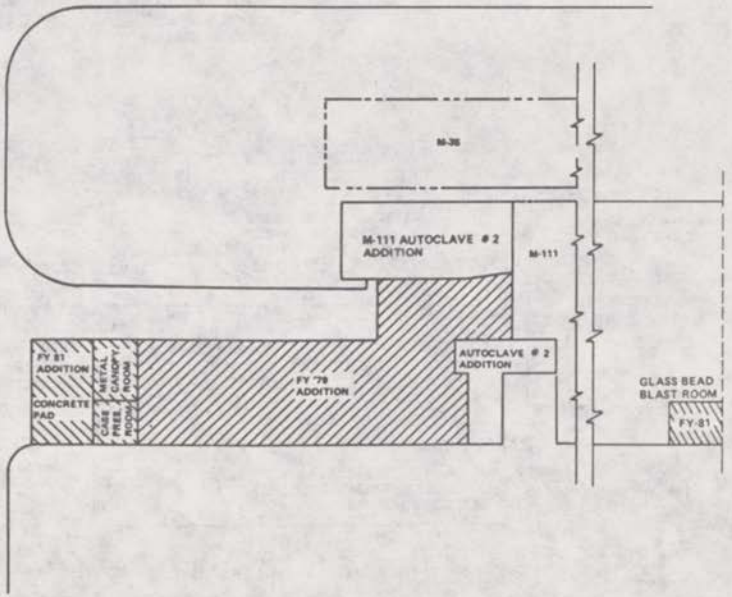


FIGURE 3

CF 8-24

THIOKOL/MARSHALL SPACE FLIGHT CENTER
FISCAL YEAR 1981 ESTIMATES
MODIFICATION FOR SOLID ROCKET MOTOR MANUFACTURING AND ASSEMBLY FACILITIES
THIOKOL, WASATCH, UTAH

GLASS BEAD BLAST ROOM–BUILDING M–111

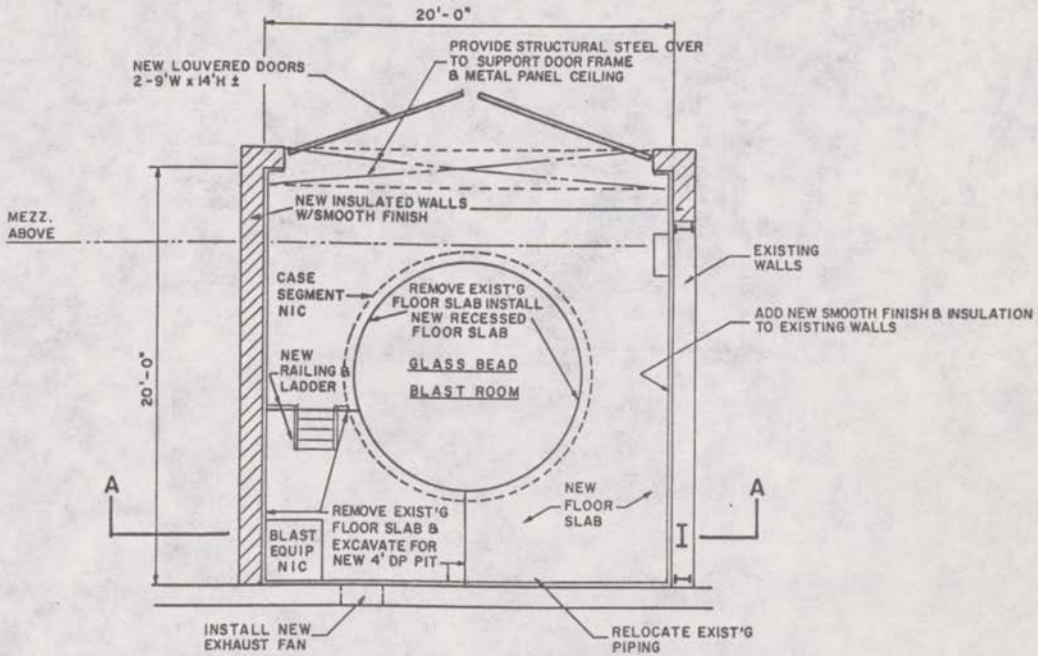
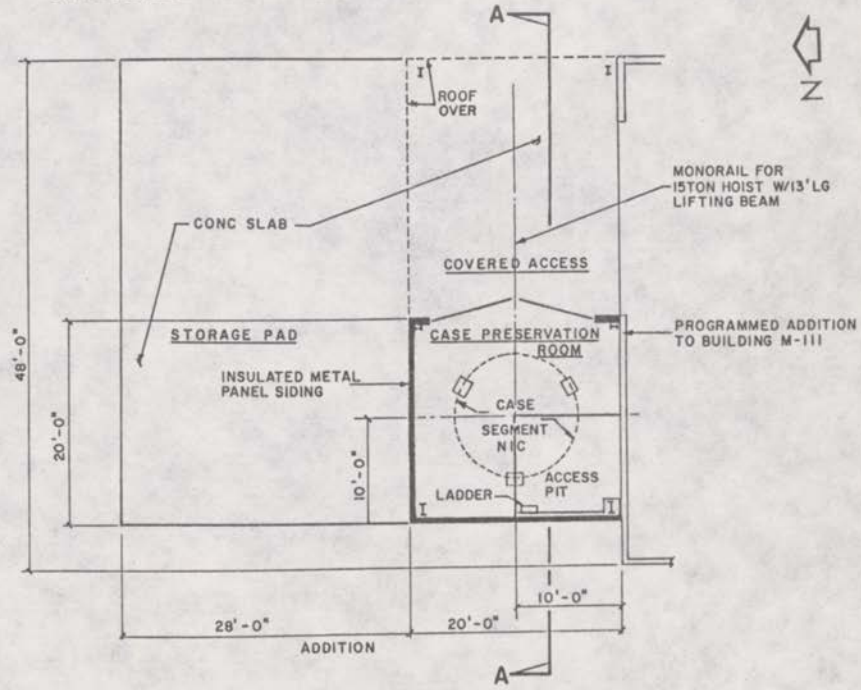


FIGURE 4

CF 8-25

THIOKOL/MARSHALL SPACE FLIGHT CENTER
FISCAL YEAR 1981 ESTIMATES
MODIFICATION FOR SOLID ROCKET MOTOR MANUFACTURING AND ASSEMBLY FACILITIES
THIOKOL, WASATCH, UTAH
CASE SEGMENT PRESERVATION APPLICATION FACILITY – BUILDING M–111



CF 8-26

FIGURE 5

THIOKOL/MARSHALL SPACE FLIGHT CENTER
FISCAL YEAR 1981 ESTIMATE
MODIFICATION FOR SOLID ROCKET MOTOR MANUFACTURING AND ASSEMBLY FACILITIES
THIOKOL, WASATCH, UTAH
REHABILITATION OF 50- TON GANTRY CRANES

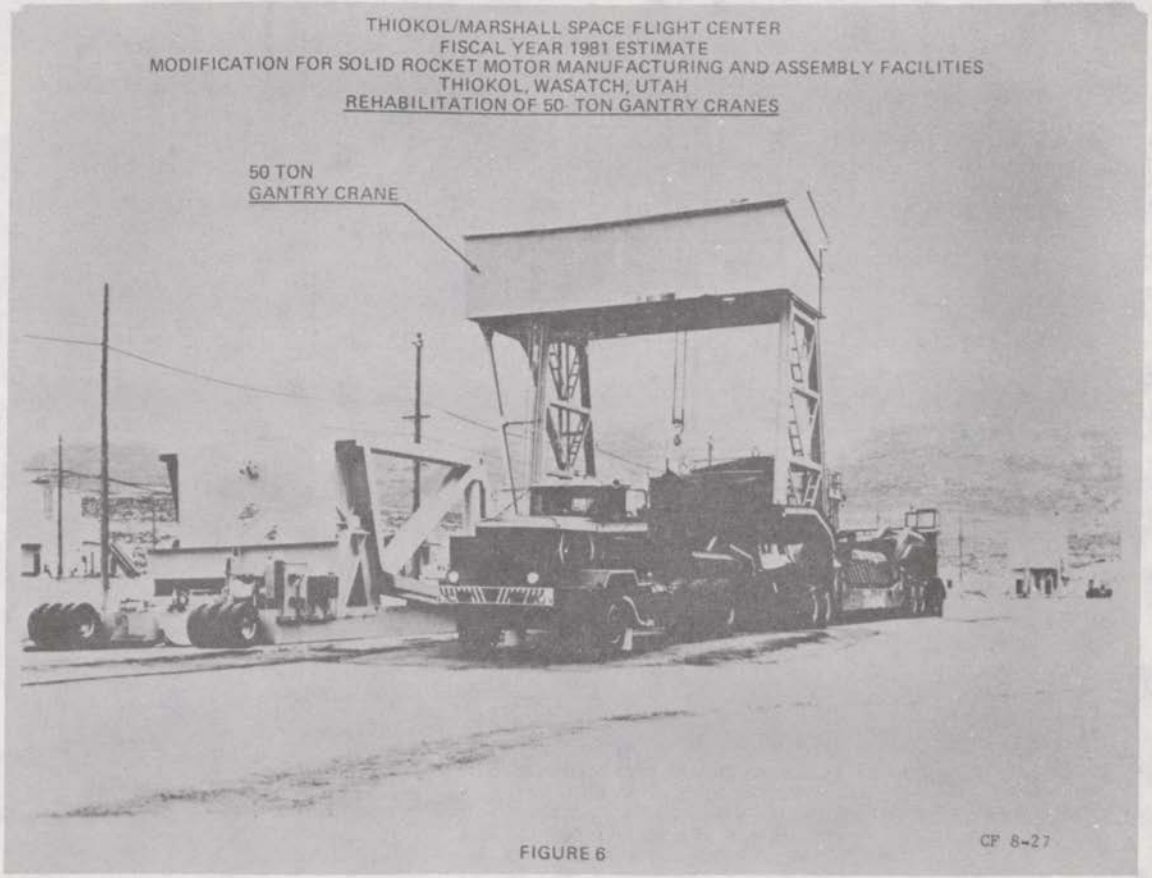


FIGURE 6

CF 8-27

57-166 O - 80 - 41

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Minor Shuttle-Unique Projects

INSTALLATION: Various Locations

FY 1981 CoF ESTIMATE: $2,000,000

LOCATION OF PROJECT: Various Locations

COGNIZANT HEADQUARTERS OFFICE: Office of Space Transportation Systems

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	752,000	*8,710,000	9,462,000
Capitalized investment	N/A	**1,565,000	1,565,000
Total	752,000	10,275,000	11,027,000

*CoF Minor Shuttle-Unique Projects
**R&D/R&PM Minor Shuttle-Unique Projects

SUMMARY PURPOSE AND SCOPE:

The purpose of this project is to provide minor rehabilitation and modifications and construction of facilities necessary for support of the Space Shuttle Program at various NASA field installations. Included in this funding request are facility projects estimated to cost not in excess of $500,000 each. These projects respond to unique requirements of the Space Shuttle Program and are needed to achieve initial operational capability or to meet the program milestones.

PROJECT JUSTIFICATION:

Space Shuttle development, assembly, and test requirements are being accomplished to a large extent in Government facilities at various NASA installations and industrial plants. Any major modifications or new construction required at these locations is described as a major project elsewhere in this budget request. This project includes only those Shuttle-unique facility rehabilitation and modification and construction projects estimated to cost not in excess of $500,000. Each item of work listed under "PROJECT DESCRIPTION" is necessary to support a specific Shuttle requirement, insure continued reliability, provide a safer environment, and/or improve the efficiency and economy of individual facilities supporting the Space Shuttle Program. It is recognized, however, that during project planning and implementation some rearrangement of priorities may be necessary. These changes will be accomplished within the available resources.

For clarity, full disclosure purposes, and better fiscal and technical control, all Space Shuttle facility costs for both major and these minor facility projects, are summarized under "Space Shuttle Facilities - Various Locations". The cost of these minor projects are thus charged against the total Space Shuttle facilities commitment.

PROJECT DESCRIPTION:

The justifications, descriptions, and cost estimates for all elements of the Shuttle-unique minor projects are listed below:

640

A. Dryden Flight Research Center (DFRC).....	490,000
1. Rehabilitation of Microwave Scanning Beam Landing System Cabling.....	490,000

Permanent installation of the Microwave Scanning Beam Landing System (MSBLS) at Edwards Air Force Base is required in mid-1981 to support the Secondary Landing Site concept for contingency Space Shuttle landings. After the early Space Shuttle developmental test flights are completed, the MSBLS equipment will be relocated from runway 17/35 at the dry lakebed to runway 04/22 for permanent installation. The present control and monitoring cabling has been subjected to vehicular traffic and the debilitating effects of a desert-like environment. This cabling was not planned as a permanent installation, and is not direct burial cable. Project resources will be used to procure and install approximately 30,000 linear feet (9,144 meters) of audio wide-band cabling for control and monitoring of the MSBLS. This project was deferred from FY 1980 in order to accomplish work of higher priority.

B. Johnson Space Center (JSC)..... 580,000

1. Modications for Relocating Software Development Laboratory, Mission Control Center Building 30..... 490,000

The Software Development Laboratory (SDL), presently located in the Mission Operations Wing, is to be relocated to the Administration Wing of the Mission Control Center (MCC) at Johnson Space Center (JSC). It must be reconfigured from its existing capability which supports singular software system development, integration, and verification to a facility capable of mass production of software systems to support Shuttle operations. Increasing flight rates during Shuttle operations will require the SDL to simultaneously manage up to 30 software systems in various stages of development. This expanded requirement necessitates an increase in the SDL's capability, thus, requiring more floor space than presently allocated. The work includes various interior modifications within an area of approximately 6,800 square feet (632 square meters) which will reconfigure the core area on the first floor of the MCC. Relocation of interior partitions and doors, installation of raised flooring, and minor changes to the lighting will be accomplished to suit program needs. Also included are modifications to the electric power distribution, modification and rebalancing of the air-conditioning, installation of additional electric power and air-conditioning, and installation of a chilled water cooling system required for computer equipment. This project will also provide changes to the fire detection system and for the extension of the fire suppression system into the new computer complex.

2. Modifications for STS Operations, Mission Operations Wing, Building 30..... 90,000

This project is phase III of a multiyear program to reconfigure the Mission Operations Wing (MOW) of Building 30 at the Johnson Space Center (JSC) for the Shuttle era. The MOW is presently configured for single mission capability. To support Shuttle operations, the third floor of the MOW must be reconfigured to simultaneously support multiple Shuttle flights. If this project is not accomplished, the existing facility configuration could not support the Shuttle flight schedule, once the space transportation system becomes fully operational.

This phase provides for various modifications on the third floor of the MOW to reconfigure seven rooms. In general, work includes removal of partitions and doors, installation of new partitions and doors, and replacemnt of damaged suspended ceiling and raised flooring. Also included are modifications to the lighting, electric power distribution, air-conditioning, and fire detection/suppression systems.

C. Marshall Space Flight Center/Michoud Assembly Facility (MSFC/MAF)..... 930,000

1. Modification of Building, 103, Production Support and Maintenance Area..... 490,000

This modification is required to provide logistics support for the thermal protection system (TPS) activities performed in the Vertical Assembly Building (110) and the High Bay Addition (114). The current use of trailers, and remote offices and cleaning facilities is costly, time consuming, and will create management difficulties as production rates increase. This project provides for modification of an area 50 feet (15.2 meters) by 90 feet (27.4 meters) in Building 103 to provide a maintenance area and to accommodate forty-two people for production support. As part of this modification, two rooms for cleaning TPS application guns will be provided. Related fencing and security devices are also included.

2. Modification to Thermal Protection System (TPS) Cells B&C, Building 110,..... 440,000

The continuing development of the TPS spray process has highlighted a need to prevent contamination of external tank components prior to spraying. Experience has shown that spray activities cause deposits to collect on cell walls. These deposits often contaminate the surface of the next article to be sprayed. Such contamination prevents a satisfactory spray application bond, thus, making the TPS coating unacceptable. The current rough, uncoated concrete surfaces of the cells are highly susceptible to contamination and must be cleaned after each spraying process. This cleaning costs approximately $15,000 for each tank and requires about seven days to accomplish, during which time other work cannot be performed in the cells. A high-gloss ceramic-like coating will be applied to the cells which will be less susceptible to contamination and will reduce the time and cost for cleaning by about one-half. The coating will cover approximately 31,000 square feet (2,800 square meters) of the interior walls of Cells "B" and "C". Doors and support structures will also be coated. All holes and pores will be grouted prior to coating in order to provide a smooth surface and to eliminate areas and pockets where overspray could build up and induce contamination. This work is required to support planned ET production rates.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

SUMMARY

SPACE SHUTTLE PAYLOAD FACILITIES

	Amount	Page No.
Office of Space Science:		
Rehabilitation and Modification for Payload Ground Support Operations (KSC)	1,617,000	CF 9-1

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JOHN F. KENNEDY SPACE CENTER
FISCAL YEAR 1981 ESTIMATES
REHABILITATION AND MODIFICATION
FOR PAYLOAD GROUND SUPPORT OPERATIONS
LOCATION PLAN

CP 9-1

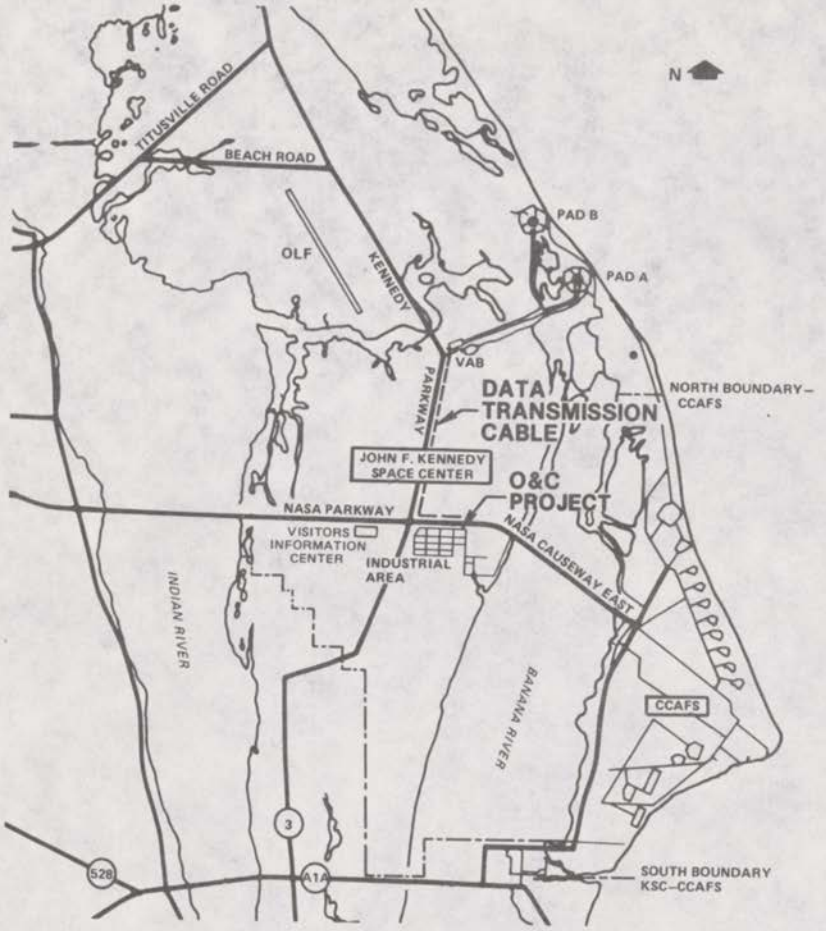


FIGURE 1

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Rehabilitation and Modification for Payload Ground Support Operations

INSTALLATION: John F. Kennedy Space Center

FY 1981 CoF ESTIMATE: $1,617,000

LOCATION OF PROJECT: Merritt Island, Brevard County, Florida

COGNIZANT HEADQUARTERS OFFICE: Office of Space Science

FY 1980 AND PRIOR YEARS FUNDING: The following prior years funding is related to this project:

	Planning and Design	Construction	Total
Specific CoF funding	1,351,000	12,590,000	13,941,000
Capitalized investment	N/A	48,363,000	48,363,000
Total	1,351,000	60,953,000	62,304,000

SUMMARY PURPOSE AND SCOPE:

This project continues construction, and rehabilitation and modification of facilities necessary to support Space Shuttle payload ground operations at the NASA launch site, Kennedy Space Center (KSC), begun with prior year resources. This year's request provides for modifying an area in the Operations and Checkout (O&C) Building to house instrumentation, control equipment, and data distribution hardware to enable payload users to monitor and control their payloads as they progress through the O&C Building to the Orbiter Processing Facility (OPF). The work includes modifying approximately 7,500 square feet (697 square meters) of existing

control room space and installing data transmission cables in the O&C Building, and installing approximately six miles (9.66 kilometers) of data transmission cable between the O&C Building and the OPF (See Figure 1).

PROJECT JUSTIFICATION:

Space Shuttle payload ground support operations will be conducted at NASA's launch site, KSC. Many different facilities, requiring both major and minor construction, and rehabilitation and modification, will be involved in payload support operations. For the purposes of clarity, full disclosure, and better technical and fiscal control, all payload ground support projects at KSC are included in one budget estimate category.

The Space Transportation System (STS) operational phase of the Space Shuttle program will commence after the first four development flights beginning in CY 1980. After those initial development flights, the primary purpose of the STS will be in the support of payload operations. In prior years, resources were provided for payload activities which established the O&C Building as the location for horizontal processing and buildup of Spacelab payloads and other classes of horizontal payloads. In addition, the Vertical Processing Facility (VPF) was modified to provide facilities for the vertical processing and buildup of payloads to be handled in this configuration. In FY 1980, the first increment of resources was provided for payload ground support operations. Included in the FY 1980 project were modifications for Spacelab Level IV integration in the O&C Building, upgrading payload handling capability in the VPF, and modifications for a life science support facility. As a result, many of the planned activities in the O&C Building, the supporting assembly and checkout stands and subsidiary stands for pallets and racks currently occupy all the available floor space in the assembly and checkout area which leaves minimal maneuvering space for flight hardware.

This project will alleviate congestion in the assembly and checkout area and allow payload users to monitor their payloads as they flow through the O&C Building to the OPF. The project includes modifications to an area adjacent to the assembly and checkout area to house payload users' instrumentation and control equipment, and the installation of data transmission cabling through the O&C Building to the OPF. The O&C to OPF data transmission cable, approximately six miles (9.66 kilometers) long, is necessary to accommodate the high-rate data (50 megabits per second) required by Spacelab subsystems. The existing cable transmission system has a limitation of 4.5 megabits per second and has a reliable life expectancy only until 1982.

IMPACT OF DELAY:

As the Shuttle moves into its operational phase in CY 1981, increasing numbers of payloads will be processed through the O&C Building and the OPF. The first Spacelab mission is scheduled for launch in the second quarter of CY 1982. Payloads flying on this mission will begin processing and integration in the O&C Building approximately twelve months prior to this launch date. To monitor payload functioning, the payload users'

rooms, with associated data transmission systems, are required to be operational at that time. It is only through such a complete payload monitoring system that malfunctions can be identified and timely corrective measures taken to repair or replace defective payloads. In order to satisfy this vital requirement when it is needed, FY 1981 funding is essential. Without the capability to monitor individual payloads, the possibility exists that certain individual payloads within a Spacelab or other cargo could be functioning improperly and, if not corrected, would result in lost mission capability.

PROJECT DESCRIPTION:

This project modifies approximately 7,500 square feet (697 square meters) in the O&C Building to provide two payload user rooms and an area to house data processing and distribution equipment (Figure 3). The work will include: modification of the raised tile flooring, electrical lines, and air-conditioning ducts in rooms 4239, 4245, 4249, 4255, and 1263; and installation of fire protection systems. Also included is a data transmission cable system in the O&C Building consisting of cabling and associated hardware connecting the test stands in the High Bay area, room 1263, and the payload user rooms. To transmit data from the OPF to the O&C Building, approximately six miles (9.66 kilometers) of data transmission cable will be installed (Figure 2).

PROJECT COST ESTIMATE:

The basis of this cost estimate is a Preliminary Engineering Report and related studies.

	Unit of Measure	Quantity	Unit Cost	Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	1,617,000
Modify O&C building	---	---	---	645,375
Demolition	SF	7,500	4.30	(32,250)
Architectural/structural	SF	7,500	29.00	(217,500)
Mechanical systems	SF	7,500	31.00	(232,500)
Fire protection	SF	7,500	10.75	(80,625)
Electrical systems	SF	7,500	11.00	(82,500)
O&C cabling system	LS	---	---	524,625
Cables	LS	---	---	(102,120)
Associated hardware	LS	---	---	(422,505)
O&C to OPF cabling system	LS	---	---	447,000
Equipment	---	---	---	---
Fallout Shelter (not feasible)	---	---	---	---
Total				1,617,000

LIST OF RELATED GRAPHICS:

Figure 1 - Location plan
Figure 2 - Site plan
Figure 3 - Pictorial of O&C

OTHER EQUIPMENT SUMMARY:

Certain noncollateral equipment, such as payload data transmitters, receivers and processing systems to be funded from R&D resources (estimated to cost approximately $1 million), will be required to support initial operations.

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

It is anticipated that future modification work will be necessary to support additional processing tasks at KSC. The requirement for such work and its scope cannot be validated at this time.

JOHN F. KENNEDY SPACE CENTER
FISCAL YEAR 1981 ESTIMATES
REHABILITATION AND MODIFICATION FOR PAYLOAD GROUND SUPPORT OPERATIONS
SITE PLAN

CF 9-7

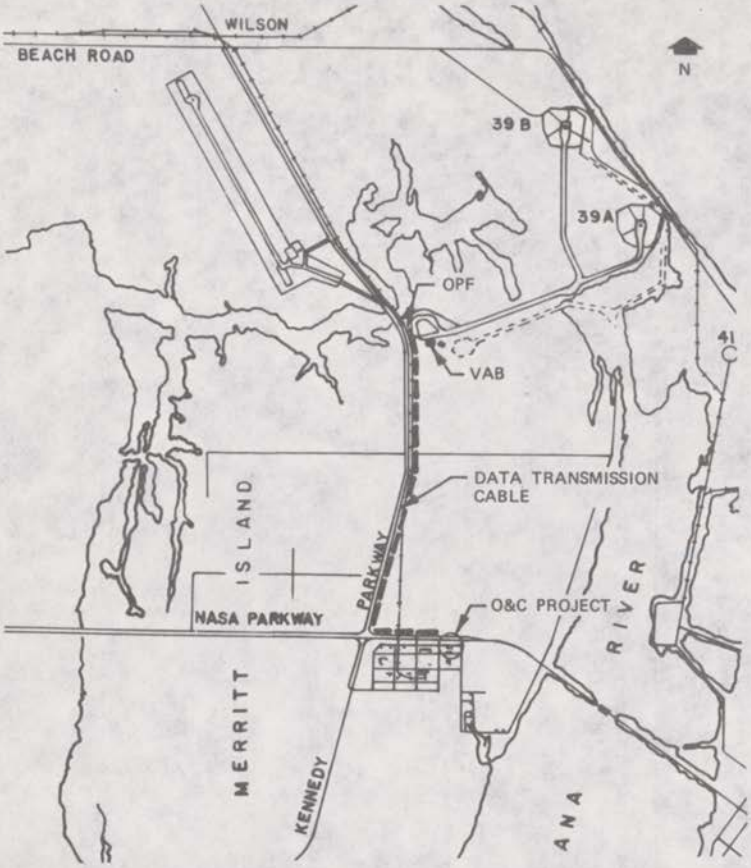


FIGURE 2

JOHN F. KENNEDY SPACE CENTER
FISCAL YEAR 1981 ESTIMATES
REHABILITATION AND MODIFICATION FOR PAYLOAD GROUND SUPPORT OPERATIONS
PICTORIAL VIEW – O&C BUILDING

CF 9-8

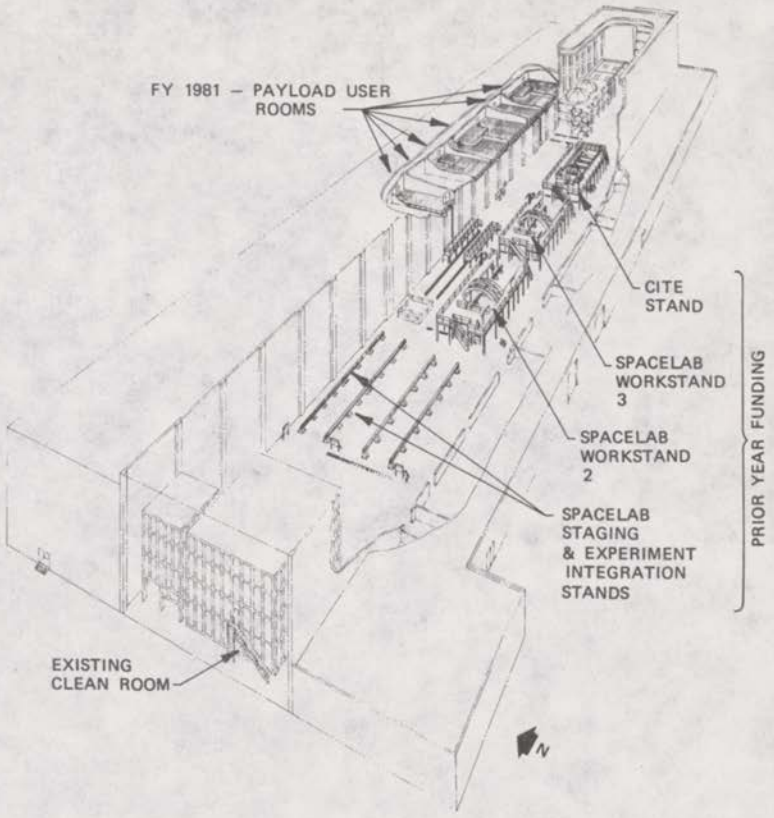


FIGURE 3

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

SUMMARY

REPAIR

Summary of Project Amounts by Location:	Amount	Page No.
Ames Research Center	310,000	CF 10-3
Goddard Space Flight Center	985,000	CF 10-3
Jet Propulsion Laboratory	1,120,000	CF 10-5
Johnson Space Center	1,730,000	CF 10-6
Kennedy Space Center	1,640,000	CF 10-8
Langley Research Center	1,190,000	CF 10-10
Lewis Research Center	1,645,000	CF 10-11
Marshall Space Flight Center	2,310,000	CF 10-13
Michoud Assembly Facility	1,470,000	CF 10-15
National Space Technology Laboratories	870,000	CF 10-17
Wallops Flight Center	965,000	CF 10-19
Miscellaneous Projects less than $150,000 each	765,000	CF 10-20
Total	15,000,000	

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CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE:	Repair of Facilities, Not in Excess of $500,000 Per Project
INSTALLATION:	Various Locations
	FY 1981 CoF ESTIMATE: $15,000,000
FY 1979: None	FY 1980: $12,000,000

COGNIZANT INSTALLATIONS/LOCATION OF PROJECT: Various Locations

COGNIZANT HEADQUARTERS OFFICE: Office of the Comptroller

SUMMARY PURPOSE AND SCOPE:

These resources will provide for large repairs to facilities at NASA field installations and Government-owned industrial plants supporting NASA activities. Included in the request are those facility repair needs for FY 1981 that can be foreseen at the time of the submission of these estimates, and that are estimated not to exceed $500,000 per project. The thrust of this program is to provide a means to restore facilities or components thereof, including collateral equipment, to a condition substantially equivalent to their originally intended and designed capability. It includes the substantially equivalent replacement of utility systems and collateral equipment necessitated by incipient or actual breakdown. This work also includes major preventive measures which are normally accomplished on a cyclic schedule of greater than one year.

PROJECT JUSTIFICATION:

A major portion of the Agency's facilities inventory is in the 15 + year-old bracket and increases in repair requirements are to be expected. Maintenance and repair costs for mechanical and electrical systems in a typical building are almost three times higher during the 16- to 30-year period of a building's life than they

are during the initial 15 years of beneficial occupancy. At about the 15-year point many electrical and mechanical components reach the end of their serviceable or economic life and should be replaced in the interest of long-term economy. Continued piecemeal repair of these components usually requires more resources in the long run than replacement after the end of the economic life of the original components. This condition is now being encountered at locations such as Goddard Space Flight Center (GSFC) and Johnson Space Center (JSC). The sheer age of other portions of the plant, such as at Langley Research Center (LaRC) and Lewis Research Center (LeRC), highlight the need for an aggressive repair program. Some 75 percent of the physical plant is in the 16 to 30-year old bracket.

The major thrust of this repair program as well as the rehabilitation and modification program is to preserve the Agency's $6.4 billion (September 31, 1979) physical plant. However, the major distinction between these classes of work is whether or not the intended work is to bring the "facility and its components to a condition substantially equivalent to its designed capacity, efficiency and capabilities." If such is the case, the work is properly classed as "repair." An analysis of each of the projects which follows indicates that this is the type of work which must be addressed and progressively accomplished. Unless this is done, resultant risks are increased, and future costs of the specific work will be greater. More importantly, there will be increased breakdown and costly emergency repair required.

This project includes only facility repair work having an estimated cost not in excess of $500,000. The work is of such a nature and magnitude that it cannot be accomplished by routine day-to-day facility maintenance and repair activities, or by related routine facility work efforts that are provided for in other than CoF estimates. Each repair project estimated to cost more than $500,000 is reflected elsewhere as a separate major CoF line item project.

PROJECT DESCRIPTION:

Proposed repair projects for FY 1981 totaling $15,000,000 are described under "PROJECT COST ESTIMATE". Only those projects estimated to cost less than $150,000 have not been individually described or identified by center. The total cost for these miscellaneous projects is $745,000. This program has been distilled from requests totaling $27,364,000 and thus represents a modest request in relation to the backlog of this type of work. Based on relative urgency and expected return on investment, the projects which comprise this request are considered to be of the highest priority. Deferral of this mission essential work would adversely impact the availability of critical facilities and program schedules.

57-166 O - 80 - 42

During the course of the year, some rearrangement of priorities may be necessary. This may force a change in some of the items to be accomplished. Any such change, however, will be accomplished within available resources. The following broad categories of work are described further in the "PROJECT COST ESTIMATE".

a. Utility Systems	5,600,000
b. General Purpose Buildings	475,000
c. Technical Buildings/Structures	1,530,000
d. Pavements and Drainage	2,910,000
e. Building Exteriors and Roofs	4,075,000
f. Fire Protection	410,000

PROJECT COST ESTIMATE:

A. Ames Research Center (ARC)	310,000
1. Repair of Roofs, Buildings N-204, N-210, N-223 and N-235	310,000

This project replaces mineral surfaced roofs on Buildings N-204, N-210, N-223, and N-235. Approximately 60,000 square feet (5600 square meters) of new roofing will be applied to these buildings. As part of this repair, two inches of rigid foam thermal insulation will be installed. The roof on Building 204 is 24 years old; Building N-210's is 39 years old; Building N-223's is 24 years old; and Building N-235's, although only 15 years old, continues to leak. This work is necessary to prevent water damage to the interior of these buildings.

B. Goddard Space Flight Center (GSFC)	985,000
1. Repair Roofs of Payload Testing Facility, Building 7, and Environmental Test Laboratory, Building 10	280,000

These resources provide for repair of approximately 90,000 square feet (8,400 square meters) of roof surfaces on Buildings 7 and 10. This work includes the removal of the deteriorated roofing material and insulation, and the installation of a 5-ply system with new insulation. Flashing will be installed as necessary.

This project results from a survey of the roof conditions at the Center and is a portion of a planned program for corrective action. An inspection of the roofs of Buildings 7 and 10 indicated blistering of the roofing felts due to moisture penetration, cracks, alligatoring, and a loss of gravel. Extensive deterioration of the roofing of these buildings dictates the need for total replacement. Also, the underlying insulation requires replacement as it has become moisture saturated and has lost its insulating effectiveness. These conditions have resulted in extensive leaks and maintenance, and threaten building research equipment. For these reasons, Buildings 7 and 10 were selected for repair at this time. The remaining buildings surveyed were in better condition and repairs can be deferred to future years.

2. Repair Paved Surfaces..... 380,000

These resources provide for the initial portion of work in a planned repair program to improve the paved surface areas of the Center. This work will include resurfacing with 2.5 inches (6.4 centimeters) of asphalt paving, approximately 26,000 square yards (21,700 square meters) of parking lots serving Buildings 2, 12, and 21. Drainage, curbing, patching and related repair work will also be included. These parking lots, selected from a study of the conditions of the paved surfaces, are in the most urgent need of repair. In future years, the remaining paved surfaces will be considered for repair. Originally constructed in the early 1960's, they have deteriorated due to heavy usage. The severity of the past two winters, has caused numerous potholes and depressions to develop resulting in accelerated deterioration and poor surface conditions. Further roadway deterioration, with attendant rise in costs will occur if this work is delayed.

3. Repair Building Exterior Surfaces..... 165,000

These resources will provide for repair to the window caulking of some 5,000 windows in 18 major buildings of the Center. Buildings included in this project are 1, 2, 4, 5, 6, 7, 8, 9, 11, 12, 16, 17, 18, 19, 20, 21, 25, and 26. This work will include the removal of the deteriorated material around the window frames, replacement with commercial-grade sulfide caulking and painting. A survey of the window conditions of the Center surfaced the need for this work. These buildings are 15 years old and the deterioration is the result of the aging and weathering process. Window drafts contribute to energy loss in the buildings.

4. Repair Parkway Bridge..... 160,000

These resources provide for necessary repairs to the two-lane, 380-foot (116 meter), highway bridge over the Baltimore-Washington Parkway. Work includes replacement of concrete drainage gutter sections, removal and replacement of portions of concrete toe walls, and the sand blasting and repainting of steel surfaces. Also included is the resealing of the cracks in the wearing course of the bridge and approach roadway and other related work. This bridge was built in 1966 to provide the primary employee access to the Center from the

Baltimore-Washington Parkway. An inspection of the bridge reveals that poor joint design and lack of maintenance has allowed leakage of water and salt brine on the outside lanes of the bridge. This has resulted in corrosion of the steel. Also, the concrete surfaces are cracking and spalling. Further costly deterioration of the bridge structure will result if the work is delayed.

C. Jet Propulsion Laboratory (JPL)..... 1,120,000

1. Repair UPS Battery Station in Space Flight Operations Facility 230..... 215,000

These resources provide for the replacement of the 15-year old battery bank of the uninterruptible power supply (UPS) with a system consisting of 184 cells with an 8-hour rating of 1950 ampere hours, and an associated main fused disconnect switch rated at 2,000 amperes, 600 volts. This will result in a system of two complete battery banks, normally operating in parallel, but separable for necessary maintenance or other downtime. The UPS supplies the computer equipment for the Space Flight Operations Facility, Building 230, and accommodates transfer of load between normal and emergency supply without the loss of computer service. The present UPS system is of redundant design which allows for the failure of any single component without loss of the system. The backup battery bank, however, is 15 years old and the batteries are approaching the end of their useful life. Deterioration is occuring and batteries are beginning to fail. The bank is no longer fully rated and can now supply only a portion of the total UPS requirement. Therefore, it cannot adequately backup the system when the main battery bank is being serviced. The proposed replacement will result in two battery banks of equal capacity, each with its own disconnect, to allow for servicing and emergency back-up of one bank with the system fully operational.

2. Repair Below Grade Waterproofing at Physical Science Lab 183..... 420,000

These resources provide for the repair of below grade waterproofing along the entire north side and parts of the east and west sides of Building 183. This project includes the removal and replacement of 3,570 square feet (330 square meters) of ground cover, shrubs, specimen trees, and irrigation lines. Concrete walks, stairs, stair foundations, and paving will also be removed and replaced. Earthfill will be removed from around the building, exposing all surfaces of below grade concrete walls and footings, including concrete roof beams of the basement level particle accelerator room. A 5-ply built-up waterproofing system will be installed along with a foundation level perimeter perforated drainage system. The excavated earth, stockpiled on the site, will be backfilled and compacted. All walks, stairs and plant material will be reinstalled. Water leaks and damage to interior surfaces of the north side of Building 183 have been a problem for over 10 years. Attempts have been made to seal joints with epoxy pressure grout but without success. Water penetrates the interior stairways, offices and laboratories which are two floors below grade. Of particular concern is water penetration and damage to the concrete radiation shields of the particle accelerator.

3. Repair Roofs of Various Buildings (156, 161, 186, and 248)..... 485,000

These resources provide for the replacement of all the 4-ply built-up roofing and rigid board insulation on Computer Program Office Building 156, Telecommunications Laboratory Building 161, and the 10-Foot Space Simulator, Building 248. All deteriorated gravel guards, coping, and built-up parapet wall flashing will be replaced. A total of 34,700 square feet (3,200 square meters) of roof will be replaced. The Space Sciences Division Building 186 will have 20,200 square feet (1,900 square meters) of blistered urethane foam, built-up roofing and rigid insulation replaced with a new 5-ply composition and gravel roof. Ten new roof drains will be added to Building 186 to improve the drainage system. The roofs on Buildings 156 and 161 are 25 years old; they have exceeded their useful life, are badly deteriorated and should be replaced now. The roof on Building 186 was covered with urethane foam in 1973 to provide protection for the deteriorated built-up roof and to eliminate excessive ponding of water. The urethane foam system has failed. Building 248 sustained severe damage from oil spilled during a solar energy experiment.

D. Johnson Space Center (JSC)..... 1,730,000

1. Repair of Roofs, Various Building..... 315,000

This project is Phase III of a multiyear program to repair the roofs of various buildings at JSC. This phase provides for work on Buildings 16, 24, and 32. In general, the work will consist of removing and replacing roofing material at blisters, roofing insulation board and flashing, and resealing and caulking perimeter flashing. Moisture relief vents will be provided where inspections have revealed that excessive moisture collects. Approximately 40,000 square feet (3,700 square meters) of roofing, 3,500 square feet (325 square meters) of insulating board, and 1,100 linear feet (335 meters) of perimeter flashing will be replaced on Building 16. On Building 32, approximately 20,000 square feet (1,900 square meters) of roofing, 1,500 square feet (140 square meters) of insulating board, and 900 linear feet (275 meters) of perimeter flashing will be replaced. On Building 24, approximately 25,600 square feet (2,400 square meters) of roofing, 10,200 square feet (950 square meters) of insulation board, and 750 linear feet (230 meters) of perimeter flashing will be replaced. This project is essential to the continued operation of these JSC facilities. A recent roof survey indicated that the roofs of these buildings now require extensive repair. Over the past 15 years, the normal aging process, together with various building modifications affecting the roofs and the presence of many roof penetrations, have resulted in numerous leaks and moisture accumulations in roofing materials. This project is needed to preclude damage to the building structures, as well as damage to interior ceiling panels and equipment. Normal routine maintenance no longer can keep up with increasing rates of roof deterioration; therefore, this project is now necessary.

2. Repair of Heating, Ventilating, and Air-Conditioning Systems, Various Buildings..... 475,000

This project is part of a multiyear program to repair heating and cooling equipment in various buildings at JSC. The work in this phase includes the repair or replacement of air handler casings and structures, compressors, condensors, controls, valves, pumps, condensate units, and fan/scroll assemblies. In addition, tasks of coil cleaning, damper and duct repair, suspension replacement, piping replacement or repair, instrumentation calibration, insulating, and painting of all components and ancillary equipment will be performed. This work will be accomplished in Buildings 11, 14, 17, 25, 32, 36, 37, and in the 200 Area. It includes the repair and/or replacement of 96 chilled water air handlers and ancillary equipment, the replacement of 10 direct expansion air handlers totalling approximately 80 tons, and the replacement of three water heaters. Age, high humidity, and salt/chemical content of the air in the JSC region has caused serious deterioration of the coils, fans, and casings of air handling units. Also, the various heating and cooling system components are approaching the end of their useful life.

3. Repair Steam and Chilled Water Systems, Building 24 Complex..... 180,000

This project is part of a multiyear program to repair various components of the Center's primary utilities generation and distribution systems which are located in the Central Heating and Cooling Plant (Building 24) and its associated facilities (cooling tower 24a and the utility tunnel system). The work in this phase includes the repair of two heat exchangers and controls. It also includes replacement of approximately 10 expansion joints, repair of six valves, and the repair of pipe insulation in the utility tunnel steam and condensate lines. Work on the chilled water system includes repair of 30 chilled water and condenser water valves in the utilty tunnel system, replacement of insulation and repair of one refrigerant condenser. The project also includes repair of three 200-hp condenser water pumps located at cooling tower 24. This project is essential to the continued use and reliable operation of these facilities at JSC.

4. Repair of Various Facilities, White Sands Test Facility..... 315,000

Repairs will be made to the heating, ventilating, and air-conditioning equipment by replacing deteriorated cooling towers at Buildings 201 and 203 and replacing deteriorated components in the hot and chilled water systems in the 200 Area. The water distribution system will be refurbished by replacing deteriorated water lines and repairing the exterior of the water storage tank. Also included is the replacement of the gates in the 9-foot (2.74 meter) diameter isolation valves at Test Stands 401 and 403 and the installation of a modified seal system. Additionally, 89,300 square yards (74,700 square meters) of 1-inch (2.54 centimeter) thick asphaltic overlay will be applied to the access roadway that extends from U.S. Highway 70 to the WSTF entrance gate. The road will also be restriped. This project is part of a continuing program to repair facilities and systems at WSTF. The cooling towers have been in constant service since 1970 and are badly

deteriorated. The hot and chilled water systems have been in service since 1965 and many of the carbon steel water lines require replacement. The water tank has been in service since 1964 and requires exterior repair. Vacuum chamber isolation valve gates at Test Stands 401 and 403 have warped. This condition reduces the effectiveness of the seal system and makes it difficult to achieve the vacuum required to support test programs. The access road was constructed during 1964 and 1965 and was last sealed in 1971. These proposed road repairs are now required to prevent further deterioration.

5. Repair of Various Facilities, NASA Industrial Plant, Downey, CA..... 445,000

These resources provide for the repair of various buildings and systems at the NASA Industrial Plant, Downey, California. The work includes repair and/or replacement of coils, condensate drain pans, motors, blowers, and controls of 17 of the 29 air handling units located on the roof of Building 006; and the replacement of 165,000 square feet (15,300 square meters) of the saw-toothed portion of the Building 001 roof. The buildings included in this project house Shuttle Orbiter manufacturing functions. The air handlers were installed in 1956 and have been in almost continuous operation for 24 years. The chilled water coils, the control valves and operators, and the blower shafts are now badly deteriorated. Because of the condition of the existing equipment, the efficiency of each system is greatly reduced, and routine maintenance cannot achieve satisfactory results. Building 001 was constructed in increments between 1928 and 1940 and has a roof system which is a combination of wood, steel, and transite decking. This roof has had a history of numerous leaks and now requires continuous repairs and patching. The condition of the roof has now reached a state where, if this repair work is not performed, water from the leaks will cause considerable damage to ceilings, floors and building contents.

E. Kennedy Space Center (KSC)..... 1,640,000

1. Repair Roofs, Various Buildings 475,000

These resources provide for the repair/replacement of approximately 26,600 square feet (2,500 square meters) of the high bay and fifth floor roof of the Operations and Checkout Building, M7-355; 54,000 square feet (5,000 square meters) of the roof on the Supply, Shipping and Receiving Building #1, M7-505; and approximately 25,000 square feet (2,300 square meters) of the roof on the Utility Annex, K6-947. The work includes repairs to blisters, cracks, and splits; flashing repairs; pitch pocket repairs; and removal and replacement of aggregate and resaturation with asphalt. Repair is required due to accumulated deterioration of the built-up roof systems since they were built in the mid-1960's. Failure to perform this repair will result in damage to ceilings, walls, and equipment in these buildings.

2. Repair of Hot Water Heating Systems, Various Building..... 445,000

These resources provide for the repair of hot water heating systems in four buildings: Automotive Maintenance and Service Building M6-688; Supply Warehouse #1, Building M6-794; Central Supply Building M6-744; and Supply Warehouse #2, Building M6-698. The work to be performed in these facilities includes the replacment of piping, insulation, and miscellaneous plumbing components serving each individual heater; descaling of each heater core; and the painting of all heater housings. In addition, fan motors will be replaced in Buildings M6-744 and M6-698. This work is necessary to remedy accrued deterioration which is causing increasingly higher maintenance and utility costs. The hot water heating systems are closed-loops. For long periods of time the water lays dormant in the pipes. This causes the pipes to rust internally and also causes scale to build up in the heating units. These systems have been in operation for nine to twelve years without refurbishment. Unless the corroded and deteriorated components are replaced and the heaters descaled, unscheduled breakdowns are inevitable.

3. Repair of Banana River Bridge..... 240,000

These resources provide for sandblasting and painting the bascule bridge over the Banana River. This bridge provides access for motor vehicles between Merritt Island and Cape Kennedy. It passes over a channel for barge traffic between the Atlantic Ocean and Launch Complex 39 via Port Canaveral. The bridge is a two-lane structure, 31 feet (9.4 meters) wide and 660 feet (201 meters) long. It has spans consisting of a double leaf trunnion bascule main span of structural steel 138 feet (42.1 meters) long between two supporting bascule piers. The other 12 sections are of prestressed concrete supported by concrete piles. Approximately 25,000 square feet (2,300 square meters) of steel will be sandblasted and coated with zinc rich primer. All open joints and skip welds will be caulked prior to priming. Although this bridge was coated with a zinc rich primer in 1966, corrosion can now be seen on the steel surfaces. This corrosion, accelerated by the salt atmosphere, will eventually cause structural damage to the bridge. Failure of this bridge would not only affect access to the space center and the air force station but would affect barge delivery of space hardware to Launch Complex 39.

4. Repair of the Indian River Bridge..... 480,000

These resources provide for sandblasting and painting of the Indian River Bridge which links the Merritt Island Industrial Area with the Florida mainland. Spanning the Intracoastal Waterway, the bridge is a four lane structure consisting of two separate bridges each of which is 2,933 feet (894 meters) long. It is comprised of 55 prestressed concrete spans, and one double leaf trunnion bascule main span of structural steel, 143 feet (43.6 meters) long, between two supporting bascule piers. Approximately 50,000 square feet (4,650 square meters) of steel is to be sandblasted and coated with zinc rich primer. All open joints and skip welds will be caulked prior to priming. This bridge was constructed in 1964 and, at that time, a zinc rich primer was applied for protection of the steel surfaces. The salt atmosphere has deteriorated this coating during this 15-year period and exposed the steel surfaces. Unless a new coating is properly applied, deterioration will eventually cause structural damage. Failure of this bridge would not only affect access to the space center but would also interrupt Intracoastal Waterway traffic.

F. Langley Research Center (LaRC)..... 1,190,000

1. Repair of Electrical Power Distribution System, Building 642..... 465,000

This project replaces the outdoor exposed 2,300 volt "G" bus in Building 642. Also included is the replacement of the exposed disconnect switches, obsolete 2,300 volt switchgear and auxiliary items in the substation. The new switchgear will be located on elevated foundations above the storm flood zone. The existing substation, which was installed in 1941, is subject to flooding and does not comply with current safety standards.

2. Repair of Roof, Building 643..... 360,000

These resources provide for replacement of the 45,000 square foot (4,200 square meter) roof on the Full Scale Wind Tunnel, Building 643. The corrugated asbestos roof will be replaced with a metal roof. Downspout and drains located in the roof valleys will be enlarged, and other necessary repairs will be made. Most of the roof on this building is the original roof put on in 1931. The roof panels have become so brittle with age that many panels and water seals have broken. A heavy sheet of roofing has already broken off in high winds. In addition, the roof drain capacity is inadequate, resulting in water backup and heavy roof loads during storms.

3. Repair of Potable Water Lines, West Area..... 365,000

These resources provide for replacement of approximately 4,000 linear feet (1,220 meters) of the 6-inch (15 centimeter) and 8-inch (20 centimeter) cast iron water main along Gregg Road to Building 1221, and along Stratton Road to Durand Road and Building 1232A. In addition, the water main from Building 1232A to Building 1231 will be replaced. This cast iron pipe is unlined and has been in the ground in excess of 30 years. Corrosion nodules have formed within the pipe. Drinking water analysis indicates that maximum permissible levels of physical and chemical contaminants have been exceeded. Repair of these lines is necessary to insure that the quality of the drinking water is brought up to required standards.

G. Lewis Research Center (LeRC)..... 1,645,000

1. Repair of Flight Research Building Apron, Building 4..... 470,000

This project will repair a major portion of an active paved aircraft apron on the south side of the Flight Research Building. The work includes replacement of approximately 6,000 square yards (5,000 square meters) of deteriorated pavement with 12-inch (31 centimeter) thick concrete. Also included is the installation of new drainage and subdrainage systems which discharge into the Lewis Research Center's industrial waste system. The existing pavement is composed of the original concrete pavement installed in 1942 and a 3-inch (7.6 centimeter) thick asphaltic overlay installed in 1960. Weather and heavy usage over the years have caused this pavement to fail. Inadequate for today's heavy aircraft, the pavement has cracked in many places and water seeps through to saturate the subgrade. Aircraft movement on the apron causes a pumping action which forces this water saturated subgrade material to the pavement surface. This material and spalled pavement is a safety hazard. It can be ingested by aircraft engines and cause serious damage.

In addition, debris blown about by operating aircraft is hazardous to personnel in the immediate vicinity. This project will minimize the debris hazard and provide an apron capable of accommodating today's heavy aircraft.

2. Repair of Steam Condensate System, Various Buildings..... 160,000

This project replaces steam condensate piping in three buildings. The work includes replacement of various sizes of pipe, valves, strainers, traps and condensate pumps ranging from three-quarter inch (1.9 centimeter) through three and one-half inch (8.9 centimeter) pipe size. Insulation of all exposed pipe is included to protect personnel from the hot piping. Approximately 1,300 feet (400 meters) of piping in Building 4, 1,600 feet (490 meters) of piping in Building 14, and 900 feet (275 meters) of piping in Building 50 are to be replaced. Also, all heating equipment no longer in service will be removed. This system is part of the

steam system for space heating of these and other buildings at the Lewis Research Center. The piping in these three buildings has been in service for over 29 years. Corrosion and plugging have reduced the integrity of this piping and have seriously hampered its ability to provide adequate building heating. This work will reduce maintenance of this piping and restore required operational capability.

3. Repair of Domestic Water Systems, Buildings 5 and 6..... 270,000

This project replaces the 35-year old domestic water piping in Buildings 5 and 6. The work includes replacement of main building header piping, building branch piping, and individual room supply piping. Piping in Building 5 will be replaced with 5,200 feet (1,585 meters) of pipe ranging in diameter from 1-inch (2.5 centimeter) to 8 inches (20 centimeters). Piping in Building 6 will be replaced with 1,300 feet (395 meters) of pipe ranging in diameter from three-quarters of an inch (1.9 centimeters) to 4 inches (10 centimeters). The existing piping is severely rusted. This is particularly true where deteriorated insulation has permitted condensation to form on the piping. Leaks continually develop and in many cases are difficult to repair due to the condition of the piping. The new piping will be insulated to minimize this condensation problem. Also, scale build-up has substantially reduced the flow capacities of the piping to be replaced. This project will eliminate the present heavy maintenance requirement and restore the needed flow capacity to these domestic water systems.

4. Repair of Service Air System..... 175,000

This project replaces approximately 2,200 feet (671 meters) of 8-inch (20-centimeter) diameter underground service air distribution piping. This piping supplies clean, dry, compressed air at 125 pounds per square inch (86.2 Newtons per square centimeter) to more than 20 buildings at the Lewis Research Center. The service air system operates continuously to provide air for instruments, safety devices, controls, and small endurance testing research equipment. Installed approximately 30 years ago, this piping is located approximately four feet (1.2 meters) below grade and is routed beneath roads, driveways, lawns and plants. Corrosion of this piping has greatly reduced its integrity and leaks are common. The weld areas, in particular, are deteriorating rapidly. Since this system is always pressurized, loss of air through leaks significantly increases compressor operation and energy consumption. This project will restore the integrity of this service air system piping and eliminate the increasing maintenance disruptions to this essential service.

5. Repair of Roofs, Various Buildings..... 265,000

This project repairs approximately 73,500 square feet (6,800 square meters) of roof on eight buildings at the Lewis Research Center. The work includes major repairs to the roofs of buildings 4, 6, 15, 49, 51, 55, 100, and 203. Equipment that is no longer in service will be removed from these roofs and necessary roof

penetrations will be brought up to current standards. Unnecessary penetrations will be removed wherever possible. Roof surfaces exposed to pedestrian traffic will be protected with roof walkways. The roofs on these buildings are over 20 years old and require extensive maintenance to prevent water from damaging the building structure and equipment. Normal weathering, deterioration, and pedestrian traffic have reduced the integrity of these roofs to the point that major repairs are now necessary.

6. Repair of Roads..... 305,000

This project provides for the repair of deteriorated road surfaces at the Lewis Research Center (LeRC). The West Area Road will be repaired between Walcott Road and Guerin Road. The existing paved surface of this two-lane road will be leveled, a 4-inch (10 centimeter) lift of asphaltic concrete will be placed, and 880 feet (270 meters) of new subsurface drainage will be installed. A 2-inch (5-centimeter) thick layer of asphaltic concrete will be placed on the berms. Walcott Road will be repaired between Building 135 and Building 20. The work includes the replacement of approximately 1,230 linear feet (375 meters) of deteriorated concrete curbs and sidewalks and also preparation and resurfacing of 13,000 square yards (10,900 square meters) of asphaltic concrete pavement. In addition, pavement in the Rocket Laboratory Complex (35) will be repaired to include replacement of 1,000 square yards (840 square meters) of road base and resurfacing of 4,200 square yards (3,500 square meters) of pavement. Normal weather conditions, including winter freezing and thawing in the Cleveland, Ohio area, are extremely damaging to roads. This, along with subbase deterioration, inadequate subsurface drainge, and normal wear have severely damaged these 15 to 20 year old roads. In addition, steep grades have caused creep type slippage of the West Area's pavement. Major repair of these roads is necessary at this time to prevent extensive pavement failure and to arrest progressive deterioration of the subbase. This work will also improve the condition of sidewalks for safe pedestrian traffic.

H. Marshall Space Flight Center (MSFC)..... 2,310,000

1. Repair Overhead Piping, Various Buildings..... 200,000

These resources provide for the repair of plumbing in equipment rooms and attic areas of 14 MSFC buildings to correct deteriorating conditions. The work consists of replacement and/or insulation of overhead water lines, steam lines, condensate and sump pump lines. Buildings included in this project are 4353, 4471, 4481, 4485, 4487, 4491, 4493, 4494, 4498, 4499, 4612, 4663, 4707, and 4708. These buildings have been in continuous operation for the past 20 to 35 years and it is planned to continue using these buildings in the future. Normal, routine maintenance can no longer keep pace with necessary repairs; thus, this project is required.

2. Repair Heating, Ventilating and Air-Conditioning Components..... 300,000

These resources provide for the repair or replacement of heating, ventilating and air-conditioning (HVAC) equipment in various MSFC buildings to correct severe deteriorating conditions now developing. Deficient equipment includes cooling towers, coils, chillers, pumps, fans, converters and a boiler in Buildings 4200, 4202, 4491, 4663, and 4567. This equipment ranges in age from 15 to 30 years, but had an original design life of only 15 years. This effort is being undertaken in order to provide more reliable support of program requirements, to minimize non-routine maintenance effort, and to conserve energy. All of the affected facilities directly support the Space Shuttle and Spacelab programs and other significant research and development programs.

3. Repairs to Roofs, Various Buildings..... 460,000

This project provides for the repairs of roofs on five buildings at MSFC. Repairs are required to rectify blisters, soft spots, and general deterioration. Repairs include 143,100 square feet (13,300 square meters) of roofing, 150,000 square feet (13,900 square meters) of insulation and 4,470 linear feet (1,360 meters) of damaged flashing; and resaturating 75,500 square feet (7,000 square meters) of roof to provide a firm, smooth finish. Also included is the replacement of 2,350 linear feet (715 meters) of gutters and downspouts and the replacement of roof drains. The buildings to be repaired are 4471, 4643, 4650, 4707, and 4674. These roof repairs are essential to prevent leaking and damage to building systems and equipment. The expected roof life at MSFC is 15 years. In recent years, normal maintenance has not been able to keep pace with rapidly deteriorating conditions. Thus, this project is urgently needed.

4. Repair of High Pressure Gas Distribution System..... 450,000

These resources provide for the repair/replacement and certification of the 5,000 pounds per square inch (34,500,000 Newtons per square meter) gaseous nitrogen and 3,500 pounds per square inch (24,100,000 Newtons per square meter) air systems servicing the test and industrial areas at MSFC. The work will include the repair or replacement of some 50,000 linear feet (15,200 meters) of 1-1/2 to 3 inch (3.8 to 7.6 centimeter) high pressure piping and abandonment of 10,000 linear feet (3,050 meters) of unneeded piping in 14 buildings. Also included will be the overhaul of a pressure reducing station, replacement of a manifold and repair of 10 storage batteries. The systems have deteriorated through age and heavy cyclic use and are near the end of their design life of twenty years. Radiographic inspection of the system has revealed serious deterioration of the welds.

5. Repairs to Exteriors of Various Buildings..... 450,000

These resources provide for the maintenance, painting, and preservation of exterior walls and other surfaces of selected MSFC buildings and structures. Work includes surface preparation and application of a protective coating of high-quality paint to 403,000 square feet (37,400 square meters) of exterior surfaces. Priority for this repair work has been given to those facilities determined to be in greatest need, as identified by a detailed field investigation. Buildings included in this project are 4481, 4483, 4487, 4704, 4705, 4471, and 4712. This project is required to protect MSFC facilities against the cumulative damaging effects of wear, deterioration and weather, and to preserve the facility capabilities for continued operation.

6. Repairs to Test Facilities 450,000

This project provides for the repair, preservation and downmoding of thirteen (13) test facilities in the East and West Test Areas of MSFC. Upon completion of the Shuttle structural testing, these test facilities will not have an immediate follow on mission. However, the facilities must be preserved for future potential uses. The facilities to be downmoded will range from large (360 feet high (110 meters) test stands to small isolated hazardous test cells. The systems included in the preservation effort are high pressure gas systems, pumping stations, cryogenic systems, electrical and electronic equipment, heating, air-conditioning and plumbing systems, special test equipment, and control and instrumentation systems. The facilities to be preserved are: 4572, 4573, 4574, 4630, 4667, 4668, 4669, 4670, 4671, 4672, 4673, 4674, and 4699. These facilities have a potential use in support of future programs. It will be necessary to prepare them for long duration storage of at least 5 years to insure that it will be economically feasible to reactivate them at some future time. This work will provide for a mixture of preserving in place; disconnecting and abandoning in place; and removal and storage, depending on an economic analysis of the life cycle preservation cost over this five year period for each system and item of equipment. Some test facilities, however, must be down-moded in such a manner as to minimize reactivation time in the event that Shuttle inflight anomalies necessitate their use for problem solving.

I. Michoud Assembly Facility (MAF)..... 1,470,000

1. Repair Roads and Parking Lots..... 240,000

These resources provide for repair of various roadways and parking areas at MAF. Work consists of preparing, patching and leveling, and overlaying approximately 58,000 square yards (48,500 square meters) of roadways and parking areas with a 1 1/2 inch (3.8 centimeter) layer of bituminous asphaltic concrete. Prime coats are to be applied to all existing surfaces to be overlaid. Overlaid surfaces will receive a slurry seal coat of sand and asphalt. Roads and parking lots included in this project are roadways south of Building 103

from Mars Drive west to the taxi-strip; the roadway east of Building 420 from Saturn Boulevard to Building 404; and parking lots "B", "H", and "N". Repair of these areas is required to correct the deteriorated condition of the bituminous surfaces. The unstable soil conditions in the New Orleans area have resulted in settlement, ponding of water, pitting, and rolls in the roadway. Resurfacing and repair are necessary to prevent further deterioration and more expensive rehabilitation resulting from base failure.

2. Repairs to Electrical Feeders #14 and 15..... 200,000

These resources provide for the removal and replacement of electric feeders #14 and #15. The existing feeders are each composed of three paper insulated lead covered cables. They extend 800 feet (244 meters) from the East Master Substation to Substation #12 at Building 103, and 700 feet (213 meters) from Substation #12 to Substations #13 and #16 at the Boiler Plant, Building 207. The new feeders will each be three ethylene propylene polymer insulated cables, shielded with a polyvinyl chloride jacket. The work includes high voltage testing of the completed installation, cleaning of the underground ducts and reconditioning of eight oil switches. Feeders #14 and #15 are now 36 years old and have reached the end of their expected useful life. They are critical to external tank (ET) production since they service Substation #12 (chilled water pumps) and Substations #13 and #16 (condenser water pumps, cooling tower fans, refrigeration equipment). Each of these substations aids in providing the essential environmental conditions inside Building 103. Failure of these feeders represents an unacceptable risk to the ET manufacturing program.

3. Repair Sewer Line in Roof Truss, Manufacturing Building 103..... 440,000

These resources provide for replacement of approximately 2,000 linear feet (610 meters) of 8- and 10-inch (20 and 25 centimeter) diameter steel pressure sanitary sewer pipe located at the 40-foot (12 meter) level in the roof truss of Building 103. This overhead line runs between sewer lift stations No. 4 and 8 in a North-South direction in the building, and between sewer lift station #6 and the East wall of the building, in an East-West direction. Fittings, hangers, valves, and valve boxes will be replaced. Also, this project includes pressure and leakage testing. The overhead location of this work and the easily damaged equipment and space hardware below makes this repair work particularly difficult. Five leaks have been repaired in this line in the past year. During recent repair efforts the severely deteriorated condition of the piping was highlighted. This piping is located above critical External Tank production activities. Future failures will disrupt work activities, and could result in interruption of production schedules and contamination of the manufacturing parts.

4. Repairs to Fire Water Piping..... 410,000

This project is the initial phase of repair for the underground fire water piping network at MAF. Phase I provides for the repair of 12,700 linear feet (3,870 meters) of pipe. Installed in 1943, the fire protection system consists of 8, 10, 12, and 16 inch (20, 25, 30, and 41 centimeter) diameter pipe. All underground pipe outside building walls is steel pipe with flexible couplings. Pipe laid under railroad tracks is encased in a 12-inch (30-centimeter) inside diameter wood stave pipe. Minimum cover over the underground piping is 2.5 feet (0.76 meters). The project includes renewing and rebolting pipe and rehabilitation of concrete thrust blocks at the intersections and corners of the underground loop main. Numerous leaks have been repaired in the underground piping network over the past several years. All buildings at MAF are protected by this system, with the exception of Buildings 320, 350, and 404. The buildings serve NASA's External Tank contractor personnel, equipment, hardware, materials, and tenant government agencies. System failure during a fire could result in loss of lives and extensive damage to buildings, equipment and hardware.

5. Repairs to Michoud Slip Channel..... 180,000

This project provides for dredging the Michoud Slip Channel to a uniform depth of 22 feet (6.7 meters) below mean sea level. Work includes a sounding study to determine the volume of spoil to be removed, removal of subsurface material/debris, and disposal of excavated material to spoil areas on the MAF site. Also included is the removal from MAF of all debris resulting from the dredging operations. The Michoud Slip Channel was last dredged in 1966. Since that time, silt and debris from the adjacent Intracoastal Waterway has gradually been deposited in the slip, thereby reducing water depths. MAF barge movement will be restricted in the near future if this deposited material is permitted to continue to accummulate. The design slip depth is required to accommodate sea going vessels transporting the External Tank, materials, and hardware.

J. National Space Technology Laboratories (NSTL)..... 870,000

1. Repair of High Pressure Gas System Components..... 470,000

This project provides for the removal, replacement and/or repair of selected critical components of the NSTL high pressure gas systems. These systems serve the Space Shuttle Main Engine (SSME) test complex as well as base facilities which are required to support the Shuttle program. To be replaced or repaired during the accomplishment of this project are pressure regulators; bleed/drain, manual and hand valves; and vacuum pumps. The activity is necessary due to the obsolescence and extreme deterioration being experienced in large numbers of high pressure gas systems components. The components are 12-13 years old and have been subjected to severe use during this period from pressure cycling, submersion, electrolytic corrosion, and periodic removal for chemical cleaning during system maintenance. These components are subjected, in their operating environment,

to extremely high pressure service (up to 6,000 pounds per square inch (41,400,000 Newtons per square meter), and have suffered continued deterioration through normal wear and tear. This condition constitutes a hazard to personnel and equipment safety. A potential for compromise of the mission assurance for support of the SSME Program exists with continued use of components in their current condition.

2. Repair of High Temperature Hot Water Circulating Pumps..... 160,000

This project will provide for the replacement or overhaul of 13 high temperature hot water (HTHW) circulating pumps. These pumps are located within the Central Heating Plant, Building 3204, and the High Pressure Industrial Water Plant, Building 4400. HTHW is circulated by these pumps to the various buildings for use in the heating and hot water absorption cooling systems. The pumps will receive a major overhaul at which time internal rotating parts will be replaced. The electric motor will be overhauled or replaced and the bearings, sleeves, stuffing box, coupling alignment, and motor amperage draw will be checked for compliance with manufacturers' specifications. These pumps have been in operation for approximately 14 years with minor overhaul on an as required basis. These pumps supply hot water for environmental control within critical areas in both the Test Area and the Base Area. Failure of the pumps within the Test Area would severely affect the Space Shuttle Main Engine (SSME) program goals. Failure of the pumps within the Base Area would severely affect the overall goals of those operations requiring continuous environmental control. Returning these pumps to peak operating condition will improve the efficiency and reliability of the systems, resulting in an energy savings and preventing continuous costly repair to keep the pumps operational.

3. Repair of Absorption Water Chillers..... 240,000

This repair provides for the replacement or overhaul of nine absorption water chilling systems serving the engineering, industrial and shuttle test complexes. These systems maintain the environmental control within offices and electronic equipment areas on a continuous basis. The absorption systems require rehabilitation on a periodic basis. Overhaul shall consist of removal of the heads, replacement of damaged tubes, replacement of the lithium bromide solution where analysis indicates its deterioration, and pump overhaul. Those units found to be uneconomical to overhaul will be replaced with energy efficient equipment. These absorption systems were procured and installed in 1963 through 1965. During the past three years requirements for corrective maintenance and incidents necessitating system downtime have increased due to equipment age.

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These systems support the Space Shuttle Main Engine (SSME) and other NSTL operations. Therefore, any downtime severely affects major NSTL programs. Rehabilitation and/or replacement with new equipment will restore the operating efficiency and reliability, thereby resulting in energy and maintenance savings. Potential adverse impact on program activity at NSTL will be prevented.

K. Wallops Flight Center (WFC)..... 965,000

1. Repair of Airfield Pavement..... 425,000

These resources provide for urgently needed repair of the aircraft parking and taxi ramp from the A-1 Tower to the B-129 area. The work will include removing and replacing approximately 2,200 square yards (1,840 square meters) of failed concrete pavement and the placement of approximately 30,000 square yards (25,100 square meters) of two-inch (5-centimeter) bituminous concrete overlay on the ramp areas. Also included are related repairs, patching, curbing, shoulder grading, and seeding. Repair of this aircraft parking and taxi ramp is necessary to maintain an acceptable surface quality for aircraft operations. The existing surface has failed in areas and spalling is occurring throughout. There is a serious potential for damage to conventional and research aircraft. If this work is delayed, further pavement deterioration will result in more extensive and costly future repairs and will have an unacceptable impact on research aircraft operations.

2. Repair Roofs, Various Buildings..... 350,000

These resources provide for the necessary repair of the roofs of Buildings F-1, F-2, F-4, F-5, M-15, M-16, M-20, and other smaller buildings. Repairs include the removal of the deteriorated roofing material and the installation of new roofing, insulation, and related work on approximately 85,000 square feet (7,900 square meters) of roof surface. This repair proposal is the result of a survey of the roof conditions at the Center which revealed leaks and chronic cracking and blistering of roofing felts. These 20-year old roofs now require extensive repair work to restore them to serviceable condition.

3. Repair Paved Surfaces..... 190,000

This project provides for repair of roads, sidewalks, and paved areas at Wallops Flight Center (WFC). Included is the replacement of approximately 600 square yards (500 square meters) of 8-inch (20-centimeter) concrete roads that have failed and the replacement of approximately 500 square yards (420 square meters) of 4-inch (10-centimeter) concrete sidewalks on portions of Anderson, O'Reily, Bliss, Price, Rickett, Anglin, and Fulton Streets; N-161 Road; and the F-10 parking area. In addition, this work includes related repair of the curbs and shoulders of these paved areas and sealing of about 54,000 linear feet (16,500 meters) of pavement joints and cracks. These repair requirements resulted from a study of the primary road conditions at the

Center . Since 1959, maintenance of the primary heavy traffic roads at WFC has been accomplished by sealing and other short-term measures. Major repairs are needed at this time to correct pavement failures and settlement, protect the subgrade, and provide adequate drainage. Accomplishment of this work now will prevent further pavement deterioration which would result in more extensive and costly repairs in the future.

MISCELLANEOUS PROJECTS LESS $150,000 EACH	765,000
TOTAL	15,000,000

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

An estimated $12 million to $16 million each year will be required for the continuation of this repair program.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

SUMMARY

REHABILITATION AND MODIFICATION

Summary of Project Amounts by Location:	Amount	Page No.
Ames Research Center	950,000	CF 11-3
Dryden Flight Research Center	750,000	CF 11-4
Goddard Space Flight Center	2,230,000	CF 11-5
Jet Propulsion Laboratory	1,310,000	CF 11-7
Johnson Space Center	2,645,000	CF 11-9
Kennedy Space Center	820,000	CF 11-12
Langley Research Center	2,115,000	CF 11-13
Lewis Research Center	1,740,000	CF 11-15
Marshall Space Flight Center	1,575,000	CF 11-17
Michoud Assembly Facility	540,000	CF 11-19
National Space Technology Laboratories	1,395,000	CF 11-20
Wallops Flight Center	2,065,000	CF 11-22
Various Locations	725,000	CF 11-24
Miscellaneous Projects Less than $150,000 each	1,140,000	CF 11-25
Total	20,000,000	

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE:	Rehabilitation and Modification of Facilities, Not in Excess of $500,000 per Project
INSTALLATION:	Various Locations
	FY 1981 CoF ESTIMATE: $20,000,000
FY 1979: *$15,300,000	FY 1980: $19,790,000

COGNIZANT INSTALLATIONS/LOCATION OF PROJECT: Various Locations

COGNIZANT HEADQUARTERS OFFICE: Office of the Comptroller

SUMMARY PURPOSE AND SCOPE:

These resources will provide for the rehabilitation and modification of facilities at NASA field installations and Government-owned industrial plants supporting NASA activities. Included in this request are those facility rehabilitation and modification needs for FY 1981 that can be foreseen at the time of the submission of these estimates, and that are estimated not to exceed $500,000 per project. The purpose of this program is to restore or enhance the condition of a facility so that it will accomplish its designated purpose more effectively or increase its functional capability.

As part of the rehabilitation and modification work, the Agency continues to emphasize those projects that relate directly to the conservation of energy at the various field installations. The energy related projects constitute $2,385,000 of the total $20,000,000 requested for FY 1981 and include both institutional and programmatic energy reduction initiatives. Each initiative has a simple payback period of five years or less.

*Authorized, P.L. 95-401

PROJECT JUSTIFICATION:

At its initial cost, the existing NASA physical plant totals approximately $6.4 billion (September 30, 1979). A continuing program of rehabilitation and modification of these facilities is required to:

a. Protect the capital investment in these facilities by minimizing the cumulative effects of wear and deterioration.

b. Ensure that these facilities are continuously available and that they operate at peak efficiency.

c. Improve the capabilities and usefulness of these facilities and thereby mitigate the effects of obsolescence.

d. Provide a better and safer environment for all personnel.

e. Provide for significant reductions in energy consumption through the initiation of energy conservation projects including improved utility control systems.

This program includes only facility rehabilitation and modification work having an estimated cost not in excess of $500,000. The work is of such a nature and magnitude that it cannot be accomplished by routine day-to-day facility maintenance or by related routine facility work efforts that are provided for in other than CoF estimates. Rehabilitation and modification work estimated to cost more than $500,000 is reflected as a separate major project.

PROJECT DESCRIPTION:

Proposed rehabilitation and modification projects for FY 1981 totaling $20,000,000 are described under "PROJECT COST ESTIMATE." Only those projects estimated to cost less than $150,000 have not been individually described or identified by center. The total cost for these miscellaneous projects is $1,140,000. The $20,000,000 of requirements has been distilled from requests of over $43 million and represents a modest request in relation to the current backlog of this type of work. Based on relative urgency and expected return on investment, the projects which comprise this request are considered to be of the highest priority. Deferral of this mission essential work would adversely impact the availability of critical facilities, program schedules, and energy conservation goals.

During the course of the year, some rearrangement of priorities may be necessary. This may force a change in some of the items to be accomplished. Any such change, however, will be accomplished within available resources. The following broad categories of work are described further in the "PROJECT COST ESTIMATE."

a. Utility Systems	4,360,000
b. Fire Detection/Protection Systems	2,985,000
c. General Purpose Buildings	3,590,000
d. Technical Buildings/Structures	8,580,000
e. Pavements and Drainage	485,000

PROJECT COST ESTIMATE:

A. Ames Research Center (ARC)	950,000
1. Modification of the Central Computer Facility, N-233	465,000

This project modifies approximately 4,000 square feet (370 square meters) of space in rooms 165 and 170 of the Central Computer Facility, Building N-233, to accommodate the installation of a new computer system. It includes modifications to the heating, ventilating and air-conditioning (HVAC) system, the electrical and power conditioning system, and the fire protection systems. Building N-233 houses ARC's main large scale computer, computer support equipment and data communications center. Approved FY 1981 automatic data processing (ADP) plans include the acquisition of a new computer. The new system will provide high speed interactive computing and data base management services associated with wind tunnel and computational fluid dynamics investigatons.

2. Modification of Computer Communication System	485,000

This project modifies the ARC underground cable complex used for computer data communications. It includes the installation of additional cables in existing ducts and the installation of additional underground communication ducts. Approximately 4,500 linear feet (1,400 meters) of new duct banks will be installed. The main underground duct lines will consist of polyvinyl chloride (PVC) ducts encased in a reinforced concrete envelope. The main underground duct lines shall be routed along McCord Avenue, Durand Road and Arnold Avenue. Buildings N-207, N-213, N-215, N-221, N-227,N-233, N-239, N-240, and N-242 will be connected to the system by

this work. The exisiting communications distribution system is not adequate to link all the major users into the current large scale computer system. In addition, center ADP plans have been approved for a major new large scale computer system for FY 1981. Thus, an expanded communications system is necessary. The existing underground cable system is overcrowded and inadequate to meet current and future needs.

B. Dryden Flight Research Center (DFRC)..... 750,000

1. Rehabilitation of Laboratory Building 4800..... 260,000

These resources provide for architectural, structural, mechanical, and electrical rehabilitation and modification work to approximately 50,000 square feet (4,600 square meters) of space on the first floor in Building 4800. The interior work will consist of rehabilitation of floors, walls, ceilings, lighting fixtures and miscellaneous hardware. Air-conditioning and ventilation duct work will be modified where required, and door hardware will be replaced, mainly on heavy traffic doors. Weatherstripping of exterior doors will be provided. A general rehabilitation of the utilities in the building will be accomplished. Exterior work will consist of minor rehabilitation of building concrete damage such as sealing cracks, chipped surfaces, etc. and rehabilitation and painting of metal sunshades, metal seismic joints, and exterior doors and windbreaks. Also, rehabilitation of exterior door concrete entrance walks which have cracked and spalled will be accomplished. This building has been in constant use over the past 25 years and with the exception of air-conditioning modifications in 1972 has received no major upgrading. The building appearance reveals years of aging and requires a considerable amount of interior rehabilitation. Additionally, a survey of the attic spaces indicates a clear need to upgrade the electrical wiring, ductwork, and piping.

2. Modification of Fire Protection System..... 180,000

These resources provide for modifications to existing facilities for fire protection and safety. They include the installation of wet-pipe sprinklers in the Integrated Support Facility, Building 4825. In addition, eight fire hydrants with associated piping will be installed, and a two-hour fire rated separation wall will be built between the mezzanine mechanical room and the computer area in the Aircraft Construction and Modification Hangar, Building 4801. These facility modifications will improve fire protection systems at DFRC and thereby enhance the safety of personnel and the protection of mission essential and high value equipment. A fire protection survey of DFRC validated the need for this work.

3. Modifications to Various Buildings for Energy Conservation..... 310,000

These resources provide for modifications to the heating, ventilating and air-conditioning systems in fourteen buildings to improve their energy efficiency. The buildings to be modified include 4800, 4801, 4803,

4806, 4807, 4808, 4809, 4810, 4820, 4823, 4826, 4832, 4833, and 4834. Modifications will include the installation of evaporative coolers, night setback controls, automatic temperature controls and building modifications to reduce outside air infiltration. This work will result in more efficient use of energy and produce an annual savings of 1,900,000 BTU resulting in a simple payback period of approximately 5 years.

C. Goddard Space Flight Center (GSFC)..... 2,230,000

1. Modification of Meterological Systems Development Laboratory, Building 21..... 480,000

These resources provide for modifications to approximately 10,500 square feet (975 square meters) of space on the ground floor of the Meterological Systems Development Laboratory (21) for the Space Telescope Science Operations Center (STSOC). Work will include installation of approximately 6,200 square feet (580 square meters) of raised flooring for computers. In addition, partitions will be modified and new ceilings will be installed. Related modifications to the electrical power, lighting, HVAC, and fire protection systems will also be included. These modifications are necessary at this time to support the Space Telescope Program, and to provide space for the Spacecraft Operations Control Center, and the Scientific Control Center.

2. Modification of Central Flight Control and Range Operations Laboratory, Building 3..... 320,000

These resources provide for modification of approximately 10,000 square feet (930 square meters) of space in the Central Flight Control and Range Operations Laboratory (3). This work will include modifications to the electrical power and HVAC systems for the installation of a replacement computer system. Also included is the installation of an on-hand Uninterruptible Power Supply and related equipment to permit the computers to operate from commercial or emergency power systems. Modification of this facility will permit the installation of a new, more energy efficient, computer system for flight dynamics control, orbit determination, and spacecraft command management. Because the present computer system must continue to support spacecraft missions during the activation of the new computer system, duplicate support systems will be required for a six-month period. The new computer system requires a continuous electrical power source for reliability essential to the support of spacecraft programs. This project is required at this time to support the installation of this vital mission related computer system.

3. Modification of Data Interpretation Laboratory, Building 23 for IPF..... 335,000

This project modifies the Data Interpretation Laboratory (23) of the Image Processing Facility (IPF). Work includes the removal and replacement of approximately 12,700 square feet (1,180 square meters) of deteriorated computer flooring on the third floor with vinyl covered panels. The cast iron drainage system in the photographic laboratory will be replaced with a polypropylene pipe system. Also, some 6,000 square

feet (560 square meters) of damaged flooring in the photographic laboratory will be replaced along with damaged ceilings and lighting fixtures on the second floor. The IPF provides support for numerous spacecraft programs that have image sensor experiments. Some of these programs are Landsat, Nimbus G, Heat Capacity Mapping Mission, Multilinear Array, and Cosmic Background Explorer. The computer area flooring and the flooring system in the photographic laboratory have deteriorated through the years such that they have become a maintenance problem. Similar flooring on the first and second floor was replaced six years ago and this work is now required. The drain system in the photographic laboratory has deteriorated, is leaking, and must be replaced.

4. Modifications to HVAC Systems Three Buildings..... 265,000

These resources provide for modifying the heating, ventilation and air-conditioning (HVAC) systems in the Research Projects Laboratory (2), the Meterological Systems Development Laboratory (21), and the Attitude Control Laboratory (305). These modifications are for energy conservation and provide for converting constant-air-flow, double duct systems to variable-air-flow, single duct systems controled by demand thermostats. Included in the work are: fan air volume control systems, and related equipment and control to vary the air volume to the conditioned space based on the cooling or heating demand. These modifications are estimated to result in annual savings of 385,000 kWh and 33,000 gallons (125,000 liters) of oil with a payback of five years.

5. Modification of Spacecraft Operations Facility for MSOCC, Building 14..... 220,000

This project modifies approximately 6,000 square feet (560 square meters) of space in the Spacecraft Operations Facility for a Multi-Satellite Operations Control Center (MSOCC). Modification work will include the installation of ten mission operations rooms of about 300 square feet (28 square meters) each along the west corridor of the second floor. The remaining 3,000 square feet (280 square meters) will be modified for the associated data processing equipment. This work will include some modifications to the partitions, ceilings, raised flooring, electrical power, lighting, HVAC, and fire protection systems. All spacecraft whose support does not demand a Payload Operations Control Center devoted exclusively to the full-time monitoring and servicing of their flight will be served by the MSOCC. This concept of shared resources and reuse of equipment has proven to be cost effective, and this project will allow more efficient operations and the capacity to handle additional spacecraft. The MSOCC is currently assigned support responsibilities for 12 operational spacecraft, together with launch vehicle support for all Delta operations.

6. Modifications of Various Buildings..... 450,000

These resources provide for the interior modification of approximately 31,000 square feet (2,900 square meters) of space at the Goddard Space Flight Center. Modification work includes some new partitions, ceilings,

and flooring. The electrical power, lighting, fire protection and HVAC systems will also be modified as necessary. This modification work will provide space for data processing and analysis equipment, necessary support activities, and personnel to meet applications support requirements in the 1982 time period. The modification work is needed at this time to relieve crowded conditions and to effectively utilize available facilities to support expanding applications programs.

7. Rehabilitation of Elevator, Central Flight Control and Range Operations Laboratory, Building 3..... 160,000

These resources provide for the rehabilitation by replacement of the elevator in the Central Flight Control and Range Operations Building (3). Work will include the replacement of the 4,000 pound (1,800 kilogram) passenger elevator with a heavy duty elevator. This rehabilitiation includes the cab, related equipment, and all worn parts. The elevator in Building 3 was installed when the building was constructed in 1961 and has been in constant use for transporting both personnel and equipment in support of mission and data operations in this facility. Due to the unusual wear in transporting heavy equipment, the elevator is frequently out of service and downtime is excessive due to the difficulty in obtaining parts. Replacement of the elevator is necessary at this time to restore proper service and eliminate the impact to the operations of the various mission control centers and computing facilities in the building, currently resulting from the condition of the existing elevator.

D. Jet Propulsion Laboratory (JPL)..... 1,310,000

1. Modifications in 25-Foot Space Simulator Building 150..... 310,000

These resources provide for relocation of the 500-horsepower (373 KW) axial compressor from wind tunnel service in Compressor Building 58 to the 25-Foot Space Simulator, Building 150, to provide pumpdown of a 25-foot (7.6 meter) vacuum sphere from atmospheric pressure to 5 millimeters of mercury (670 Newtons per square meter). The new pumpdown period will be two hours or less. The project will also include: relocation of auxiliary equipment such as switchgear and controls; connection to the main vacuum piping header; replacement of an existing worn out muffler; installation of new moisture traps, valves, drains and piping; and, modifications to the operational console. A complete factory service maintenance check of the dismantled axial compressor is also to be performed. Included in this vacuum pumping system modification is the purchase of two new mechanical vacuum pumps, cryogenic baffles and all necessary piping, valves, electrical power and controls.

At present, the rough pumping portion of air evacuation process for the 25-Foot Space Simulator uses the 11,000 horsepower (8,200 kilowatt) wind tunnel compressor plant in Building 58. The wind tunnel compressor plant is being phased out of service leaving the 25-Foot Space Simulator without adequate rough pumping capacity.

Lacking the pumping capability of the compressor plant, the pumpdown time of the Space Simulator will increase from 70 minutes to 12 hours, which will exceed the test articles' operating time limit. A reduction in horsepower used for pumpdown will significantly reduce the electrical demand charge. These mechanical pumps together with the axial compressor will provide the full evacuation capability.

2. Modification to a 10-Foot Solar Simulator for Cryogenic Pumping, Building 248..... 350,000

These resources provide for replacement of three diffusion pumps, presently used to evacuate the 10-foot (3.1 meter) diameter space simulator, with three 36-inch (0.91 meter) diameter cryogenic pumps and will eliminate the need for the high vacuum valve and cryogenic baffle assembly. The vacuum valve body will be converted into a plenum and the 35-inch (0.88 meter) bottom flange will be increased to 36 inches. A new vacuum cryogenic slide gate will be attached to the wider flange. The cryogenic pump will then be attached below the new valve. The cryogenic pump will be of a two-stage closed loop gaseous helium type with a liquid nitrogen shroud and remote compressor. The helium compressor will be an air cooled unit. Electrical power, controls, and cryogenic piping for installation of the cryogenic pumps is also included. In the 10-foot simulator, the final stage of evacuation is done with three standard oil diffusion pumps which have the inherent problem of oil vapor back streaming. The back streaming of oil vapors causes contamination and disruption of tests which is costly in time and manpower. To provide increased utilization at greater cleanliness levels, the existing facility must be updated with equipment for clean, high vacuum. This requires changing from diffusion pumps to cryogenic pumps.

3. Modifications to Fire Protection System (E-22 and E-32), ETS..... 165,000

This project continues implementation of the fire safety plan that was initiated at JPL in 1972/1973. The project provides new fire protection systems for Administration and Shop Building E-32, and Control and Recording Center, Building E-22, at the Edwards Test Station (JPL-ETS). In Building E-22, a wet sprinkler system will be added and the detection system modified. The complete system will include valves, piping, alarms, fire department connections, and a fire service main. The computer underfloor area is to be further protected by a modular, Halon 1301 System, which is to be actuated by cross zoned ionization detection. In Building E-32, a new wet sprinkler system will be installed. The extreme fire hazard created by the handling, storage and testing of various types of propellants makes fire protection a particualrly important issue at JPL-ETS. The fire-fighting capability at JPL ETS is provided by fire fighting teams at Edwards AFB which is approximately 10 minutes away. Building E-22 houses expensive electronic computing and recording equipment and is located very close to test stands. Building E-32 houses the entire administrative staff and files of the JPL-ETS activity. The proposed fire sprinkler systems will provide protection to both buildings.

4. Rehabilitation of Central Section Utility Tunnel, ETS..... 485,000

This project provides for the rehabilitation of the central section of the utility tunnel at the Edwards Test Station which is badly deteriorated and too small to accommodate future requirements. This work will include the removal of the corrugated metal pipe (CMP) utility tunnel and the installation of approximately 150 feet (46 meters) of 8 x 10 feet (2.4 x 3.1 meters) waterproof concrete utility tunnel from the Control and Recorder Building E-22 to the north-south main utility tunnel. The rehabilitated tunnel will carry all present and projected utility services required in this area. Cable trays will be installed on one side of the tunnel and utilities will be accommodated on the other side. A new "T" at the east end of the new tunnel will be designed to facilitate the crossover of the cables and utilities as they enter the main north-south tunnel and continue in both directions.

E. Johnson Space Center (JSC)..... 2,645,000

1. Modifications for Air-Conditioning System, Photographic Technology Laboratory, Building 8..... 475,000

These resources provide for modifications to the mechanical equipment room in Building 8 for replacement of equipment and to eliminate overcrowding of this equipment. This project includes construction of a 2,350-square foot (220 square meter) penthouse mechanical room to be located above the existing mechanical room. Also included is the replacement of six air handlers with two new air handlers which will be located in the new mechanical room. All controls, ductwork, insulation and drain lines will be modified or rehabilitated as required. Also included is the replacement of two small air handlers located above rooms 274 and 275. The primary activity in this building is photographic processing which requires continuous air-conditioning. The photo processing operations create a corrosive and high humidity condition that causes rapid deterioration of the air-conditioning system. As a result, the existing air handlers, which are generally inaccessable for repair in their present location, are in need of replacement. Additional space provided by the new mechanical room will permit easy access to the air handlers so that all of the air-conditioning equipment can be easily maintained in the future. If this project is not approved, there will be a continued increase in maintenance costs and more frequent and lengthy building outages.

2. Modification of Air-Conditioning System, Electronic Systems Compatibility Facility, Building 44..... 165,000

These resources provide for modifications to the air-conditioning system in the Checkout Systems Laboratory (CSL) located in the high bay wing of the Electronic Systems Compatability Facility, Building 44. The work consists of isolating the CSL from the high bay area to allow controlling of conditions in this area with an

independent cooling system. The CSL control room is not presently air-conditioned and this will be included. Three existing 10-ton (35 KW) direct expansion air-conditioning units and a cooling tower will be removed and replaced by one 10-ton (35 KW) chilled water unit. In addition, two air handling units totalling 63 tons (220 KW) will be replaced. The existing air-conditioning system serving the CSL was originally designed to provide underfloor conditioned air for a large computer load that has since been removed. In the present configuration the small area cooled by this large capacity system results in short intermittent cooldown periods and unacceptably high humidity conditions in the laboratory. Implementation of these modifications will achieve proper control of temperature and humidity in the CSL and reduce energy consumption.

3. Rehabilitation of Utility Control System..... 490,000

This project is Phase II of a multiyear program to replace obsolete equipment in the data acquisition portion of the JSC Utility Control System (UCS) with state-of-the-art remote terminal units. The work in this phase includes the replacement of the data acquisition terminals in 9 buildings with new terminal units that have improved data acquisition and control capability. Also included is the connection of terminal units to the existing UCS computer and to the existing sensors in each building. The existing UCS data acquisition units provide marginal performance, with frequent failures resulting in considerable downtime. This low reliability results in a considerable amount of lost data which impedes energy conservation efforts. The existing models are no longer being manufactured, and replacement electronic printed circuit cards must be manufactured in-house at high costs. The proposed new units will be of state-of-the-art design but functionally similar to the existing units.

4. Modifications to Central Cafeteria, Building 3..... 485,000

These resources provide for modifications to the Central Cafeteria. The work includes reconfiguration of the serving area to incorporate a "scramble" system and will involve removing old equipment; installing new serving equipment; modifying the walls; reworking utility connections; modifying stainless steel counters and cabinets; and altering lighting, air-conditioning, and exhaust systems. In addition, the existing dish conveyor system will be replaced by portable carts to return soiled dishes to the dishwashing area. The existing equipment is old and obsolete, and must be replaced in the near future. Also, the current serving area configuration is extremely wasteful in terms of manpower utilitization. The proposed new configuration will allow an estimated 36-percent reduction in personnel from 14 to 9 in the serving area with a 10-percent reduction in costs to be passed along to the customer. Further the "scramble" system will increase capacity (20-25 percent) and will reduce employee serving time during the congested lunch period. The cafeteria equipment has been in use for 13 or more years at JSC, and is essentially of 1950 vintage. Replacement parts are costly and extremely difficult to obtain. The proposed modifications will result in a much needed reorganization in the cafeteria's operation, greatly improving the quality of service. In recent years, the inefficient operation

has resulted in declining use of the facility. The cafeterias at JSC provide the primary source for feeding both employees and visitors and therefore should be modified to provide suitable service.

5. Modifications to Various Buildings..... 485,000

This project provides for modifications to several heating, ventilating and air-conditioning (HVAC) systems at the Johnson Space Center (JSC) to reduce energy consumption. The existing systems were installed during 1964-1967 when energy was plentiful and inexpensive. With energy supplies now very critical and costly, the efficiency of such systems must be improved. The work required consists of: (1) the modification of existing HVAC systems to variable air volume (VAV) operations in Buildings 37 (Life Sciences Laboratory) and 45 (Project Engineering Facility); (2) modifications of air-conditioning systems in Buildings 9 (Technical Services Facility) and 32 (Space Environmental Simulation Laboratory) to provide economizer cycle operations; and (3) modification of computer environmental support systems in Buildings 17 (Engineering Building) and 29 (Water Immersion Facility) to reduce energy consumption. Modification to provide VAV systems reduce the amount of energy consumed by automatically adjusting the air handler horsepower to match the actual air volume required. These VAV modifications have a project payback period of 2.6 years. Economizer cycle (enthalpy control) operation of HVAC systems uses outside air when the enthalpy (temperature and humidity) of the outside air makes it suitable for direct cooling. Modifications to provide economizer cycles are especially attractive energy savings initiative because 24-hour operation permits frequent opportunities to draw in outside air when its temperature and humidity are sensed to be acceptable for the conditioned space. This modification has a payback period of 4.4 years. Modification of the environmental support systems in computer areas will eliminate infiltration of heat and humidity into conditioned areas, resulting in energy savings. Computer facilities in these buildings are environmentally controlled by separate systems that provide conditioned air underfloor directly to the computers and overhead distributed air for personnel comfort. Additional savings can be achieved by separating the control of the two types of air. By operating the personnel air only when needed, and still supplying continuous cooling to the computers, a reduction in total energy is achieved. The systems will also be modified to limit reheat for the control of humidity from a separate energy source, instead the heat from the computers will be used for humidity control. These modifications to the computer facilities will result in a payback of less than 1/2 year.

6. Modifications for Utilities Metering, Various Buildings..... 165,000

This project is Phase II of a two year program to provide the individual building utilities metering necessary to obtain needed energy management information. This project provides for the replacement of the primary chilled water flow devices at 33 buildings which are linked to the Utility Control System (UCS). The work includes replacement of flow devices and piping modifications to increase the accuracy of metering from the present 66 percent of the total flow range to approximately 90 percent of the total flow range. Flow

devices and piping in the present configuration do not provide the capability to fully meter flows. Accurate, dependable, energy consumption data monitoring requires upgrading of the existing equipment. This project is necessary for analysis of energy consumption to improve energy usage at JSC.

7. Rehabilitation of Air Compressors, Central Heating and Cooling Plant, Building 24..... 380,000

This project is Phase I of a two-year program to rehabilitate the air compressors in Building 24. This phase provides for the rehabilitation of the utility air supply system by replacing two reciprocating compressors with one centrifugal compressor. The project includes removal of the two 1,024 cfm (483 liters/second) reciprocating compressors and installing one new 2,600 cfm (1,300 liters/second) centrifugal compressor, and its associated piping, air intake filters, electrical modifications, and required controls. The existing compressors are reciprocating type with teflon piston rings. These units require excessive maintenance resulting in large manhour expenditures and high replacement parts costs. By comparison, the proposed centrifugal air compressors require little maintenance. Additionally, the centrifugal compressors will produce a lower noise level, partially alleviating the existing noise problem in the plant.

F. Kennedy Space Center (KSC)..... 820,000

1. Rehabilitation of the Fender System, Haulover Canal Bridge..... 405,000

This project is to replace the Haulover Canal Bridge timber pile fender systems including the wooden wales, walkways and handrails. The bridge, which provides access to KSC from the north, is a two-lane structure approximately 30 feet (9.1 meters) wide and 225 feet (69 meters) long. It has three spans consisting of a double leaf trunnion bascule main span with two steel girder flanking spans. The clear channel distance between the fender systems is 90 feet (27 meters). The two fender systems along the channel consist of 132 treated timber piles, (66 piles each system) 40 feet (12 meters) long, rough cut treated timber wales, walkways and handrails. Each fender system is approximately 160 feet (49 meters) long. The fender systems are to be completely replaced using concrete prestressed piling and roughcut treated timber wales, walkways and handrails. A recent underwater inspection of the Haulover Canal Bridge fender systems revealed that the timber piles have been severely damaged by shipworms. Piling had an average section loss of 30 to 60 percent with approximately 20 percent of the piling having a section loss of between 60 and 90 percent. The fender system protects the bridge piers from boat and barge traffic. Damage to this bridge would not only affect access to KSC but would also interrupt Intracoastal Waterway traffic.

2. Modify Fire Suppression System, Goddard Unified S-Band Operations Building 415,000

This project modifies the fire suppression system in the electronics areas in the Goddard Unified S-Band Operations Building, M5-1494. Presently this area has Halon 1301 fire protection. Halon 1301 systems were installed at the Unified "S" Band Facility in the early part of 1973. Due to the consolidation of the worldwide tracking capabilities to this facility, and preparations for the Shuttle program requirements, the interior configuration and space utilitization has changed considerably. Additionally, NASA safety standards have been recently revised to establish automatic sprinkler systems as the accepted fire suppression system for electronic equipment operations. These standards also prohibit the use of Halon 1301 in facilities which are substantially renovated, remodeled, or expanded. All areas, other than the Halon 1301 areas, of the Operations Building have automatic wet pipe sprinklers installed. These resources will provide a wet pipe sprinkler system in the electronics operations areas. Also, new ionization detectors will be installed so all electronic operations areas will have an early warning system. The existing Halon control panel, which contains control/monitor capabilities for seven out-of-building Halon zones, will be relocated to the new control station in the Operations Building.

G. Langley Research Center (LaRC)..... 2,115,000

1. Modification to .3 Meter Transonic Cryogenic Tunnel, Building 1242..... 475,000

This project provides an active boundary layer control system for the .3 Meter Transonic Cryogenic Tunnel in Building 1242. Included in this work is installation of a compressor, reinjector piping, and controls necessary for improved test section boundary layer treatment. These new components will augment the vented test section by using flow control valves and other associated controls to reinsert the nitrogen gas back into the tunnel circuit. This boundary layer removal system will support the advanced airfoil research program, which requires the high quality, high Reynolds number aerodynamic performance data to be provided by this modification. Data derived from this test program will support development of the new generation aircraft such as the energy efficient transports and high capacity cargo aircraft.

2. Rehabilitation of Electric Power Distribution..... 475,000

This project increases the capacity of the Taylor Road Substation (Building 1147) from 12,000 kilovolt-amps (KVA) to 19,500 KVA by adding a 7,500 KVA transformer. In addition, a tie cable and switchgear will be installed between the Taylor Road Substation and Drive Control Building 1241 which will interconnect the Taylor Road Substation, Moffett Road Substation and Ames Road Substation. The additional capacity provided for the

Taylor Road Substation is necessary because the present connected load of existing facilities exceeds 33,000 KVA. The tie cable is necessary to insure the reliability of the system in case of an equipment failure at the Taylor Road Substation by providing an emergency backfeed from the other two substations.

3. Rehabilitation of Instrument Research Lab, West Wing, Building 1230..... 465,000

These resources provide for rehabilitation of approximately 43,000 square feet (4,000 square meters) of office, shop and laboratory space in the west wing of Building 1230. The work includes the replacement of dampers, coils and controls in the heating, ventilating and air-conditioning (HVAC) system. Anodized bronze aluminum frame windows, new ceilings, lights, wall and floor finishes are also included in this project. This rehabilitation project is necessary to replace the deteriorated components of this 35-year old facility. The HVAC system, as an example, is outdated and requires new components of current design to reduce maintenance and conserve energy.

4. Modifications to the Transonic Dynamics Tunnel, Building 648..... 400,000

This project modifies the freon handling system in Building 648 of the Transonic Dynamics Tunnel to reduce the loss of freon to the atmosphere. These modifications include disassembling the two compressors and replacing components that are worn out. In addition, the efficiency of the freon recovery system will be improved by installing a heat exchanger and condenser. Mixing of freon and air which now occurs in the test section during removal and replacement of freon will be minimized by reducing structural pockets in this region. These modifications are needed because: (1) the breakdown of one of the freon recovery system compressors could cause a lengthy shutdown of the facility; and (2) the loss of freon to the atmosphere is presently 88 tons (80,000 kilograms) per year. This project will reduce the loss to 38 tons (35,000 kilograms) per year.

5. Modification for Fire Protection, Buildings 1268 and 1268A..... 300,000

This project provides a fire protection sprinkler system for 60,000 square feet (5,600 square meters) of the electronic operations areas in Buildings 1268 and 1268A. These buildings house computational equipment valued at more than 45 million dollars which provides critical and essential support to on-going research at LaRC. The fire protection system provided by the project will protect the Government's investment in this equipment and these buildings.

H. Lewis Research Center (LeRC)..... 1,740,000

1. Modification of Extrusion Press, Materials Processing Laboratory (105)..... 350,000

These resources provide modifications to the 1,000-ton (8,900 Newton) extrusion press in the Materials Processing Laboratory, Building 105, to enable creep forming of high temperature materials. The work includes installation of a new electro-hydraulic control system which slows the low end speed of the hydraulic ram. In addition to this control system work, an electronic data acquisition system will be installed to record various extrusion event characteristics as a function of the press' ram travel and/or time. The press' existing water hydraulic system and pneumatic control system will also be rehabilitated for increased reliability.

This press is basic metal working equipment for most of the alloy research conducted at the Lewis Research Center. It is also used extensively to support other government agencies and contract programs. Since its installation in 1959, this press has been used principally for powder metallurgy research and extrusion of refractory metal shapes such as tungsten tubing. Current programs employing this press include the development of new composite materials, ceramics, and high temperature alloys needed for turbine blades and vanes in gas turbine engines. Production creep forming in industry has resulted in extruded shapes for turbine rotors and blading which require very little machining. Use of this technology has led to production costs which are substantially lower than those for producing parts by more conventional machining methods. The new low speed capability provided by this project will enable the development of creep forming techniques for some of the new high temperature materials being developed.

2. Modification of Drive Speed Control for 8-Foot x 6-Foot Supersonic Wind Tunnel, Building 53..... 460,000

This project provides for modifications to the drive motor system speed controls for the 8-Foot by 6-Foot (2.4 meter by 1.8 meter) Supersonic Wind Tunnel. The obsolete controls on this 87,000 horsepower (65,000 kilowatt) drive motor system were originally designed for adequate control over a speed range of 770 revolutions per minute to 880 revolutions per minute. These controls will be replaced with a new control system that will enable precise control of the drive system over a speed range of 480 revolutions per minute to 880 revolutions per minute. The new controls will include an electronic tachometer for sensing rotational speed, speed set-point controls, power rate-of-change controls, and associated wiring.

Use of this 30-year old wind tunnel has changed over the years. Although originally designed for operation from Mach 1.4 to Mach 2, modifications have expanded the range to include speeds between Mach 0.4 and Mach 2. Current research programs in this tunnel require many operations near Mach 0.4. The existing controls however, are not designed to attain and precisely hold the 480 revolutions per minute drive motor system speed required for Mach 0.4 operation.

Because of the age of the existing control system, its reliability is decreasing and repair parts are not available. Many components are badly worn and the wiring insulation has deteriorated. The modifications provided by this project will greatly improve the operation and reliability of this tunnel. Test conditions will be attained more rapidly, resulting in manpower and energy savings.

3. Modification of Propulsion Systems Laboratory, Building 125..... 260,000

This project modifies both the thrust measurement system in the Propulsion Systems Laboratory Test Chamber 4 for 2-dimensional measurements and the medium voltage switchgear for the spray cooling water supply and return pumps. This work in Building 125 is necessary to accommodate changed research requirements.

The two gas turbine engine test chambers in this facility, Test Chambers 3 and 4, are used for a variety of full scale operating engine tests. Such tests are in support of NASA programs and joint NASA-Department of Defense programs. In addition to testing the performance and efficiency of engines used in conventional take-off and landing (CTOL) type aircraft, these test chambers are used to support work on engines for short take-off and landing (STOL) type aircraft. This STOL work requires the testing of engines with exhaust-deflecting nozzles which have thrust components in two directions. The modifications to the Test Chamber 4 thrust measuring system included in this project will provide the necessary multi-axis thrust measuring capability.

This facility contains an engine exhaust gas spray cooling system. It has two 600 horsepower (450 kilowatt) cooling water supply pumps and two 450 horsepower (340 kilowatt) pumps for returning the heated water to a cooling tower. Normal operation of these pumps requires that they be cycled on and off frequently during test runs to provide the necessary cooling water flow. The existing electrical switchgear being used for this purpose consists of four 2,400 volt feeder circuit breakers. These units are not designed for the heavy cyclic duty they perform and frequent maintenance is required to keep them operational. A failure of any one of these four breakers to interrupt power during a fault situation would cause the facility main breaker to interrupt power to the entire facility. Such a disruption of power is not only undesirable, but is also potentially hazardous. To assure increased reliability, the existing switchgear will be replaced with 2,400 volt, fused, air-break type motor starters with power supplied to them by one of the existing motor circuit breakers.

4. Modification of Lighting Systems, Various Buildings..... 220,000

This project will replace incandescent lighting in selected areas of eleven buildings at the Lewis Research Center. Energy efficient high pressure sodium or flouresecent lighting will be installed in Buildings 5, 16, 49, 85, 86, 88, 90, 92, 114, 500, and 501. Deteriorated rubber insulated wiring will be replaced to eliminate the potential fire hazard it presents. This cost-effective work will assure adequate illumination levels in these areas, and save approximately 625,000 kilowatt hours of energy annually. In addition, the new lamps have a much longer life expectancy than the incandescent lamps which results in reduced maintenance manpower requirements and enhanced safety. The estimated payback period for this work is less than 5 years.

5. Modifications of Electrical Substation B, Building 13..... 450,000

This project provides modifications to medium voltage electrical switchgear known as the Emergency Bus Switchgear and to the B2 2,400 volt electrical distribution system at Lewis Research Center's (LeRC) Electrical Substation B (13). The 35-year old 2,400 volt Emergency Bus Switchgear consists of six sets of three individually operated no-load break type fused disconnect switches. This manually operated switchgear provides a portion of the 2,400 volt power supplied to every facility at LeRC built before 1952. Operation is hazardous because a switchman must open the switchgear cabinet doors and manually open or close the three disconnect switches one at a time. This obsolete switchgear will be replaced with gang operate fused switchgear that can be operated with the cabinet doors closed. The 35-year old B2 2,400 volt electrical distribution system supplies power to approximately 27 buildings throughout the Center and is the original 2,400 volt source of power at the Center. Additional substations have been added and modest capacity tie circuits were installed between the 2,400 volt systems. Increases in loads connected to these systems have made the backup systems provided by these tie circuits inadequate. This project provides an alternate power source for the B2 system by the installation of appropriate switchgear and tie circuitry between the B2 transformer and the nearby lightly loaded B4 transformer. This tie circuit will provide a full capacity backup for the B2 system. In addition, the capacity of the existing tie circuit between Substations B and G will be increased and reconnected to the B4 system. This modification will allow all B2 system loads to be transferred to the B4 system without load shedding. Overall reliability of these electrical power sources will be substantially increased.

I. Marshall Space Flight Center (MSFC)..... 1,575,000

1. Modifications to Provide Automation of Building Systems Management..... 400,000

This project will increase the usefulness and efficiency of the computer-based Utility Control System (UCS) through the addition of energy conservation options. These options, such as outside air temperature cutout and reset, true economizer cycle, supply air reset, high temperature hot water reset, optimized chiller

control, and damper closure, will be implemented through the existing software programs and addition of new hardware to the UCS. The existing computer-based system was designed to accept additional energy-saving options and more buildings. These additions will not only provide a more efficient use of the Utility Control System but also they will generate fossil fuel savings. Total annual savings achieved by this phase of work are estimated to be 1.09×10^6 KWH of electricity and 10.8×10^6 pounds (4.9×10^6 kilograms) of steam. Simple payback period for this project is estimated to be 3.3 years.

2. Rehabilitation of Building 4487, "C" Wing East..... 450,000

These resources provide for the interior and exterior rehabilitation of approximately 68,000 square feet (6,300 square meters) of "C" Wing East, adjacent corridors, and a portion of "B" Wing East, Building 4487. The work involves renovation or replacement of heating, ventilating and air-conditioning (HVAC) systems, lighting and power systems, water and gas distribution systems, and repair of walls, floors, windows, and ceilings. This is the last increment of modification and rehabilitation projects for this building. Building 4487 was originally constructed in the 1950's, and normal deterioration over more than 20 years has increased energy consumption, maintenance costs, and building systems downtime. This building is one of the primary laboratory facilities at MSFC. The area to be upgraded houses elements of the Electronics Development Division of the Electronics and Control Laboratory. These specialized laboratories are used to accomplish R&D technology objectives. Completion of this project will result in a reduction of maintenance costs and energy consumption, and will provide improved laboratory support for NASA programs.

3. Rehabilitation and Modification of Cable Distribution System, Communications Facility, Building 4207..... 475,000

These resources provide for the rehabilitation and modification of the Central Communications Cable System. Specifically, the modification provides for construction of three manholes, a cross connect and distribution equipment building, and installation of approximately 14,000 feet (4,300 meters) of large diameter cable. The manholes will be eight feet (2.4 meters) deep and six feet (1.8 meters) square. The building will be 320 square feet (30 square meters) and be provided with environmental control, 15 KW motor generator set backup power, and racks for mounting electronic equipment. The cable tunnels will extend from beneath room 107 of the present communications building to a point a few feet west of the building and from the cross connect building to an existing manhole. The rehabilitation consists of replacing rusted structural supports in 14 manholes. Technical integrity of the MSFC communication cable plant must be maintained and the system must be modified to meet increasing requirements. The modifications will provide a cross connect capability that will increase the cable service to the 4700 area. Reliability will be increased by the use of new cable between Building 4207 and the manhole near the new cross connect building. The present system has deteriorated and has been extensively repaired twice in the past five years. MSFC is responsible for the NASA Voice

Teleconferencing Network which is operated from this facility. It connects all major NASA installations and contractor locations, and helps NASA effectively manage its widespread programs.

4. Modifications to Various Buildings for Energy Conservation..... 250,000

These resources provide for the installation of storm windows in selected areas of five buildings, and the installation of sodium vapor lamps in the high bay areas of three buildings at MSFC. The work includes the installation of approximately 18,200 square feet (1,690 square meters) of storm windows in building areas which require heating, ventilating and air-conditioning 24 hours per day, 365 days per year. These facilities are Building 4207 (Communications Facility), Building 4487 (Laboratory and Office Building), Buildings 4491 (Office and Laboratory Building), Building 4619 (Structures and Mechanics Laboratory) and Building 4663 (Computer Facility). Also included in this project is the replacement of approximately 400 mercury vapor lamps and ballasts with energy efficient high pressure sodium vapor lamps and ballasts in the high bay areas of Buildings 4619, 4705 (Fabrication and Machine Shop) and 4708 (Engineering and Development Laboratory). The number of lamps will be reduced by approximately 50 percent but will provide the same lighting intensity. This project is necessary to reduce energy consumption at MSFC. Utility rates have increased approximately 200 percent in the last 5 years and trends indicate similar increases in the future. Delay in accomplishing the work included in this project will adversely impact the energy reduction program. The buildings involved will continue to support many NASA programs such as Space Shuttle, Spacelab, Space Telescope, Space Processing, Large Space Structures, Solar Heating and Cooling, and Space Research and Technology. The project payback period is estimated to be 4.1 years.

J. Michoud Assembly Facility (MAF)..... 540,000

1. Rehabilitation of Steam Boiler, Building 207..... 335,000

These resources provide for the replacement of Boiler No. 2, a 60,000-pound per hour (27,200 kilograms per hour) steam boiler in the MAF Boiler House, Building 207. The project includes removing a portion of the Boiler House wall, removal of the boiler, installation of a new 100,000-pound per hour (45,400 kilograms per hour) boiler, and modifications to the steam piping, feedwater piping, blowdown piping, and forced draft ductwork. The boiler house provides steam to the Main Manufacturing Building as well as other supporting buildings for both environmental control and External Tank (ET) production. Increases in ET production rates will cause an increase in steam demand which may exceed the capability of the primary boiler. Thus, Boiler No. 2 will provide backup capability. The present boiler was installed in 1970, has been out of service since 1976, and was recently declared uneconomical to repair. Delay of this project could result in interruption of External Tank production.

2. Modifications for Automation of Building Systems Management..... 205,000

This is Phase III of an incrementally funded project to provide for the installation of a utility control system (UCS). These resources provide for incorporation of additional hardware, such as temperature and pressure sensors, status and alarm points, and start-stop relays into the UCS. This hardware will permit expanded use of the UCS computer software by providing more data-collection and automatic control of pumps, motors, and other equipment. Also included will be the automated control and monitoring of high bay lighting, chillers, parking lot lighting, and security systems. The additions will result in the conservation of energy through expanded use of the UCS computer software capability. It will also enable more effective use of maintenance personnel and increase the efficiency of the plant.

K. National Space Technology Laboratories (NSTL)..... 1,395,000

1. Modification of Fire Alarm System..... 300,000

These resources provide for modification of the Utilities Control System (UCS) to incorporate a fire alarm system for 38 buildings and facilities. The existing fire alarm system annunciator and relay panels will be removed. New relay panels will be installed and tied into the UCS using new field interface devices to interconnect to the UCS Central Processor Unit. Additional memory capability will be provided in the Central Processor Unit to accommodate programming of the fire alarm system. Existing smoke detectors will be replaced by new detectors. The Fire and Security Dispatch Office will be modified to accommodate the new fire alarm system.

The present fire alarm system was installed between 1963 and 1966. During the past year a large number of the relays in this system have failed. As a result of these failures, the spare relays available for this system have been depleted. Some of these relays, critical to system operation, are no longer manufactured and replacements are unobtainable. If the failure rate of these cables and components continues at the current rate, portions of the sitewide service will become inoperative in the next five years. The sitewide Utilities Control System interconnects all buildings and facilities at NSTL. This modification of the UCS system to include fire alarms is economical in that it utilizes existing distribution lines and equipment and eliminates the costly replacement and maintenance of a parallel distribution system.

2. Modification of 13.8 KV Electrical Distribution System..... 210,000

This project provides for modification of the 13.8 KV primary distribution system in the base and Space Shuttle Test Areas. The modifications will include installation of automatic reclosers, additional fused and sectionalizing switches, and fault relays/indicators; provision for automatic load transfer switching equipment

in critical areas; and construction of three new manholes to permit the continued use of the existing canal submarine cables. In the past several years numerous faults have occurred in the electrical distribution system. These faults have been caused by natural phemomenon (winds, lightning, etc.) and equipment failure due to aging and fatigue. Improvements to the distribution system will: (1) improve reliability by decreasing the number of faults and associated electrical disruptions to critical facilities; and (2) decrease the operational impact of interruptions by greatly reducing the number of facilities/areas affected and thereby reducing the time required to restore service to critical facilities. This project will assure the required reliability of the electrical system and prevent costly schedule delays and possible equipment damage.

3. Modifications to Cooling Towers..... 250,000

These resources provide for the installation of fire protection sprinklers on 11 wood cooling towers and automatic chemical feed and monitoring systems for 20 cooling towers. The sprinkler systems will include automatic sprinklers, pressure regulators and manual control valves and will be in conformance with the national fire protection codes. The automatic chemical feed systems will include installation of an electronic dissolved solids meter, chemical injection pump, interconnecting piping, a drain solenoid valve and corrosion coupon within the piping system, and electrical service for each of the cooling towers. A recent safety survey found that the 11 wood cooling towers serving NSTL facilities should be provided with an automatic sprinkler system. The survey conclusions were that, in the event of a fire, the fire service trucks cannot reach the facility location in time to preclude substantial damage to the towers and possibly adjoining facilities. The potential property damage and the resulting work interruptions make completion of this work essential. The present cooling tower chemical feed systems provide chemicals in amounts not balanced to the requirements for water quality control. The excess chemicals cause premature deterioration of cooling towers and an increased cost for unneeded chemicals. The proposed automatic system will continuously monitor the chemicals and inject only the amounts required, resulting in savings, better protection, and full compliance with EPA requirements.

4. Rehabilitation of Warning and Paging Systems..... 160,000

This project will replace the oral warning system cable by installation of new cables suitable for underground installation. Above ground cable termination pedestals will be installed. This is the first year of a multiyear program for oral warning and paging system cable replacement. The first year program will install new cables and pedestals from Building 7001 to Building 1200 including the connection of Building 8100. Cables from Building 4995 to Buildings 4400, 4210, 4220, 4110, 4120, and 4122 will also be included in the first year effort. The oral warning system was installed in 1965 in underground ducts with interconnecting cable splices made in underground manholes. Following heavy rains, the water table is raised and the cables are exposed to water. Over the years such exposure to water has caused deterioration, especially at the junction where the splices were made. The above ground pedestal type terminations will prevent water from

entering at other splice connections. Failure to correct the problem will result in continued interruption to the oral warning and paging systems with eventual failure of the system. The loss of this system would reduce the effectiveness of the communication system which is required for sitewide notification of hazardous test conditions. The paging system also contributes to crowd control during periods of natural disaster when disaster victims are sheltered at NSTL.

5. Modifications of Various Facilities 475,000

This project provides for the modifications of interior and exterior lighting systems in 21 buildings and replacement of inefficent electrical motors in 17 buildings. Interior lighting modifications include reducing the number of light fixtures consistent with lower illumination standards, replacing inefficient lamps with higher efficient lamps that are now available commercially, replacing discolored diffusers, and improving control of lighting. Exterior lighting modifications for associated external work areas, parking lots, and roads will consist of reducing the number of lighting fixtures and installing high efficiency lamps sufficient to maintain the minimum effective area lighting. The project also provides for replacement of low efficiency electrical motors with high efficiency motors in 17 buildings.

These motors are used to drive pump and air-handlings in the 17 buildings and are presently oversized or otherwise inefficient for the required loads. Replacement of these motors with sizes that match the equipment load and are more efficient will reduce energy. The lighting system modifications provide for reducing electrical energy for lighting by 25% - 30%. This reduction will result in a payback of less than 4 years. Replacement of inefficient electrical motors is necessary to reduce not only the kilowatt hours consumed but also the penalties based on power factor disparity and peak electrical demand loading. The energy saved by this element of the project will result in a payback of 2.4 years.

L. Wallops Flight Center (WFC)..... 2,065,000

1. Rehabilitation of Building F-4..... 435,000

These resources provide for the rehabilitation of 10,200 square feet (950 square meters) of space in Building F-4 which is used by visiting launch range users, experimenters and foreign nationals participating in research operations. The exterior work includes replacing the doors and windows. Interior rehabilitation includes insulation of exterior walls, new wall and floor coverings, new bathroom facilities, and some new plumbing, lighting, and wiring. In addition, a new energy efficient central heating, ventilating and air-conditioning system will be installed. Building F-4 was constructed in 1945 and is in substandard condition.

Rehabilitation of this facility is required to correct excessive and widespread deterioration, and reduce the consumption of energy.

2. Modification of HVAC Systems, Various Buildings..... 390,000

This project modifies the heating, ventilating and air-conditioning (HVAC) systems of Buildings E-104 through E-108 and N-159 for more effective utilization of chilled water capacity. This work will include the installation of 2,000 linear feet (600 meters) of insulated chilled water pipe from the existing large capacity oversized chiller in Building N-159 to Buildings E-104 through E-108. The chillers from Buildings E-106 and E-108 will be relocated to Building N-159. The relocation of these chillers to more effectively utilize available chiller equipment and conserve energy was defined by an energy conservation study accomplished at the Center.

3. Rehabilitation of Buildings F-1 and F-2 485,000

This project provides for the exterior and interior rehabilitation of Buildings F-1 and F-2. Exterior work includes replacement of doors and windows; reductions in window areas; cleaning, tuckpointing, and sealing of the brick exteriors; and replacement of roofs. Interior work includes the installation of energy efficient variable volume forced-air central heating and cooling systems having economizer cycles, insulation of exterior walls complete with new interior surfaces, installation of new plumbing systems, upgrading of lavatories, and application of new interior wall and floor finishes. In addition, ventilation will be installed in the reproduction area of Building F-1 to conform with current safety standards. These 34-year old buildings, which house offices and reproduction areas, have deteriorated to substandard condition throughout and now require extensive rehabilitation. The steam heating systems are in poor condition and require frequent repairs to control leaks. Temperature controls are no longer adequate. The present window-type air conditioners waste energy. This project will restore these buildings to standard condition, protect them against the weather and substantially improve their energy efficiently.

4. Modification of Water and Fire Protection Systems, Mainland and Island Areas..... 300,000

This project modifies the Mainland and Island water supplies and fire protection systems to correct serious fire protection deficiencies. Mainland area work includes the provision of a 50,000-gallon storage tank, and installation of a 6-inch (15 centimeter) diameter water main along Radar Road from Building U-75 to Building U-30. This main, complete with the necessary pumping capability, will supply water to three existing hydrants and to one new hydrant also included in this project. In addition, a sprinkler system and a fire detection system will be installed in Building U-70. Radar systems in this building provide essential research support of both Wallops Flight Center and Kennedy Space Center missions. Island work includes restoring

operation of the existing elevated water tank, Facility V-90; installing an 8-inch (20 centimeter) main in the vicinity of Building Z-65 between the Island Road 6-inch (15 centimeter) main and the Launch Area By-Pass Road 10-inch (25 centimeter) main; and installing a sprinkler system in Building W-20, Blockhouse 3, which is the control room for the Scout rocket launch site. The water supply systems in both the Mainland and the Island areas have inadequate water flow and pressure capabilities for meeting fire protection requirements in these areas.

5. Modification of Water and Fire Protection Systems in the M and A-41 Areas 455,000

This project provides modifications to water supply mains and fire protection systems for the M and A-41 areas on the Main Base. Included is the installation of a 10-inch (25 centimeter) diameter water main routed from the vicinity of aircraft hangar Building D-1, under runway 10-28 and the associated taxiway, to the M area. Water will be supplied to the A-41 area by an 8-inch (20 centimeter) diameter branch line extending from the 10-inch (25 centimeter) diameter main at the north end of runway 17-35. This system will furnish water to four existing hydrants as well as to the three new hydrants and the new sprinkler systems in Buildings M-15, M-16, M-20 and A-41 also included in this project. This work is urgently needed to correct serious fire protection deficiencies in these areas. The M-area buildings are used for storage, inspection, and handling of solid rocket motors. Building A-41 houses the air field radar facilities. Because of the high risks associated with a potential fire in the M-area and the serious impact on air field operations of a fire at A-41, this work must be accomplished now.

M. Various Locations..... 725,000

1. Rehabilitation of Gear Box Support on Three 64-Meter Antennas..... 335,000

These resources provide for the rehabilitation of the gear box supports for three 64-Meter Antennas located in Madrid, Spain; Canberra, Australia; and Goldstone, California. The work will include the fabrication at all three 64-Meter sites of an active elevation gear box support assembly to continuously maintain the alignment of the pinion - bullgear mesh. This assembly will enable the continuous readjustment of the gear mesh for even gear wear under changing loads. The existing gear box assembly is a passive system providing rigid support only. Major adjustments to compensate for changing conditions require extensive effort with large expenditures of station time and manpower. The lack of active compensation for changing conditions is causing excessive wear on both the bullgear and back-up roller assembly. Replacement of the assembly is required to insure reliability of the 64-Meter Antennas.

2. Modifications to Deep Space Network Power Plants, Goldstone, California..... 390,000

This project will provide for the remote operation of three manually operated Deep Space Network (DSN) power plants at Goldstone, California, to provide for safety, increased reliability and more effective utilization of electrical power.

The power plants will be modified by adding automatic controls and protective devices required for remote operation of the power generating equipment. The work will include the installation of automatic synchronizers and motor operated controls to adjust generator or bus frequency and voltage for paralleling. Relays, current transformers and potential transformers are required to provide sensing and logic switching for automatic controls. Additional protective devices will be installed to report operating conditions of each engine-generator set, fuel level, fluid leakage, and fault conditions. Signals from each of the new and existing protective devices will be available to monitor evaluate and analyze equipment operations to effectively support critical mission operations. The addition of automatic controls will reduce the risk of human error.

With the present system, the operator must perform several manual operations to switch power from commercial to generators, or to replace one generator with another. These operations must be performed in a specific order and coordinated with data displayed by various instruments. During emergency conditions, when reaction time is important, operator errors may be difficult to avoid. The automated controls will accomplish these functions in the proper sequence without the need for operator assistance.

Safety of the equipment will be enhanced by the additional protective devices. Remote alarms will indicate pending failure conditions and logic will be provided to determine the proper action required based on the current situation and equipment availability. Immediate decisions will be made to replace operating equipment before a major problem develops. The automatic controls will allow fast implementation of the actions required.

This project will significantly reduce the potential for loss of power which could result in lost tracking data and could jeopardize the mission or even cause loss of a spacecraft.

MISCELLANEOUS PROJECTS LESS THAN $150,000 EACH..... 1,140,000

TOTAL..... 20,000,000

FUTURE CoF ESTIMATED FUNDING TO COMPLETE THIS PROJECT:

An estimated $18 to $22 million per year will be required for the continuation of the facility rehabilitation and modification program.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

SUMMARY

MINOR CONSTRUCTION

Summary of Project Amounts by Location:	Amount	Page No.
Ames Research Center	400,000	CF 12-2
Dryden Flight Research Center	245,000	CF 12-3
Goddard Space Flight Center	850,000	CF 12-3
Jet Propulsion Laboratory	950,000	CF 12-4
Johnson Space Center	80,000	CF 12-6
Langley Research Center	640,000	CF 12-7
National Space Technology Laboratories	435,000	CF 12-8
Wallops Flight Center	205,000	CF 12-9
Various Locations	195,000	CF 12-9
Total	4,000,000	

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE:	Minor Construction of New Facilities and Additions to Existing Facilities, Not in Excess of $250,000 Per Project
INSTALLATION:	Various Locations
	FY 1981 CoF ESTIMATE: $4,000,000

FY 1979: $4,200,000 FY 1980: $3,500,000

COGNIZANT INSTALLATIONS/LOCATION OF PROJECT: Various Locations

COGNIZANT HEADQUARTERS OFFICE: Office of the Comptroller

SUMMARY PURPOSE AND SCOPE:

These resources will provide for minor facility construction at NASA field installations and Government-owned industrial plants supporting NASA activities. Each project included in this program is estimated not to exceed a cost of $250,000 and involves either the construction of new facilities or additions to facilities. The FY 1981 request of $4,000,000 will improve the usefulness of NASA's physical plant by changing the utilization of or augmenting the capabilities of various facilities. Included in this request are those programmatic and institutional projects considered essential to the accomplishment of mission objectives.

PROJECT JUSTIFICATION:

The configuration of NASA's physical plant necessarily responds to changes in utilization and adaptations required by changes in technology or in mission needs. Additionally, demands are generated by research, development, test, and similar activities. Specific justification for each minor construction project is provided by center under "PROJECT COST ESTIMATE."

PROJECT DESCRIPTION:

Included in the FY 1981 minor construction program are those facility projects supporting institutional or technical facility needs which could be adequately identified at the time of submission of this budget estimate. Items of work totalling $4,000,000 are included in this resource request and have been distilled from a list totaling about $6,000,000. The selection was based on the relative urgency of each item and the expected return on the investment. During the course of the year, some rearrangement of priorities may ensue, requiring changes in some of the items to be accomplished. Such changes will be accommodated within the resources allocated.

These projects represent requirements that must be met in this time frame to support institutional goals and programmatic objectives.

a. Utility Distribution Systems	240,000
b. Technical Buildings/Structures	1,325,000
c. General Purpose Buildings	2,195,000
d. Pavements and Drainage	240,000

PROJECT COST ESTIMATE:

A. Ames Research Center (ARC)	400,000
1. Construction of Wind Tunnel Blade Sanding Shop	240,000

These resources provide for construction of a 5,000-square foot (460 square meter) building to house the Wind Tunnel Blade Sanding Shop. This steel frame building will be located north of Building N-229B with access from 7th Street. The Wind Tunnel Blade Sanding Shop is a metal finishing shop where all of the Center's wind tunnel blades, models, and other surface critical research equipment are finished by craftsmen using a variety of abrasives and polishes. The existing shop is totally inadequate for this function because it is too small and provides no covered space for storing blades during the finishing process. Blades now must be stored outside. Also the existing shop is in a high noise area requiring the use of ear protection during wind tunnel operations.

2. Construction of Shop and 2nd Floor Offices in Building N-211..... 160,000

These resources provide for construction of a 1,550-square foot (144 square meter) two-story addition within Building N-211. Room 157, a high bay area, will be converted into a two-floor structure. The first floor will remain as shop space and will be refitted with electrical and pneumatic utilities and an overhead crane. The second floor will house personnel from the Aircraft Maintenance Branch. There is a critical need to provide adequate shop space for aircraft component bench-checks and aircraft equipment support. Space in Building N-211 is presently inadequate and there is no suitable shop available where aircraft components can be bench-checked or serviced.

B. Dryden Flight Research Center (DFRC)..... 245,000

1. Construction of Support Shop..... 245,000

These resources provide for construction of a 3,200-square foot (300 square meter) pre-engineered metal building for support shop operations. The facility will be a single story structure on a concrete floor slab with a 12-foot (3.6 meter) eave height. Heating, lighting, air-conditioning, toilet facilities and a wet pipe sprinkler system are included in this project. The Space Power Battery Shop and the Experimental Projects Facility presently located in a portion of Shop Building 4806 are in dire need of additional space to effectively support program requirements associated with Remotely Piloted Research Vehicle (RPRV) missions. The support shop, presently located in Building 4806, will be relocated to this new building and the vacated space will be used for space power battery shop and experimental projects facility expansion.

C. Goddard Space Flight Center (GSFC)..... 850,000

1. Construction of Addition to Spacecraft Operations Facility, Building 14..... 130,000

This project adds approximately 1,600 square feet (150 square meters) to the west portion of the Spacecraft Operations Facility, Building 14. This addition will be one story in height, on a concrete slab, and with energy efficient walls finished to match the existing building. The work also includes electrical power, lighting, and a HVAC system. The addition is needed to provide an all weather passage for operating and maintenance personnel, and improved security from Building 14 to the Network Control Center (NCC). Space is provided for vending food service for essential personnel who operate these two facilities three shifts a day, seven days a week, remote from other food service facilities. This facility is necessary at this time due to the operations in the NCC and the increased number of personnel in the area.

2. Construction of Addition to Visitor Center, Building 88..... 240,000

These resources provide for construction of a 7,000-square foot (650 square meter) addition to the Visitor Center (Building 88). This addition will be of steel frame construction, insulated, and will match the existing building. Also included will be the necessary electrical power, lighting, and HVAC systems. This project is required at this time to provide additional indoor space to protect delicate display items and an assembly area for briefing large groups on NASA's programs. The present exhibit area is too small for the available displays and for the assembly of large tour groups.

3. Construction of Access Roads..... 240,000

These resources will provide for construction of approximately 11,000 linear feet (3,350 meters) of access roads for emergency vehicles in the Optical Tracking Ground Plane Facilities (200), Magnetic Test Facility (300), and Propagation Test Facility (500) areas. Work will include clearing, grading, drainage, and construction of a 6-inch (15 centimeter) thick, 12-foot (3.7 meter) wide roadway of crushed run gravel. The project was recommended by a fire protection survey which identified the need for additional access for emergency vehicles to these remote facilities in wooded areas. As an example, a major fire at the Magnetic Test area could result in a loss of valuable research equipment valued at over a million dollars.

4. Construction of Ductbank..... 240,000

These resources provide for construction of approximately 4,000 linear feet (1,219 meters) of underground 12-way ductbank for signal and communication cables. The ductbank will connect Buildings 3/14 with Buildings 6, 11, and 21 and will be routed along Roads 2, 1A, and 4. This work also includes the construction of masonry manholes. Communication ducts connecting these buildings were constructed in 1968 and are now being fully utilized. An additional ductbank is required to connect the Space Telescope Science Operations Center (STSOC) and other research facilities in Building 21 to Buildings 3/14. The increased use of computers and data processing equipment in these buildings requires the installation of additional communications ducts for effective use of research equipment. This project is required at this time to relieve the overburdened communications network and to provide for the planned growth of equipment in these facilities.

D. Jet Propulsion Laboratory (JPL)..... 950,000

1. Construction of Addition to Space Science Facility 186..... 230,000

These resources provide for the construction of a 2,400-square foot (220 square meter) addition to Building 186. The addition will be constructed over a basement which presently houses closed circuit television

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(CCTV) distribution and video terminal rooms. The architecture/structure will be similar to the adjacent Space Sciences Division Building and will incorporate the basement as its foundation and mechanical room. Not included in this project are special sound control treatment or equipment and special lighting. At present nearly all JPL CCTV programming is accomplished in the Von Karman Auditorium, Building 186, where the CCTV control room with a minimum capability light studio is located. Inadequate for color television production and too limited in space, this facility cannot meet growing technical requirements.

Virtually all major JPL locations can receive color television programming for project operations, informational programs, training and educational programs, major announcements, and emergency instructions. The proposed new building addition will be the center for all such programming at JPL. Major future programs which may be supported by the use of the CCTV addition include Mariner Jupiter/Saturn/Uranus, Shuttle mission operations, and Voyager.

2. Construction of Addition to Technical Services Facility E-83, ETS..... 240,000

These resources provide for construction of a 1,530-square foot (142 square meter) addition to the Technical Services Facility (TSF) at Edwards Test Station (ETS). The addition provides space for consolidation of the chemical laboratory function, instrumentation calibration and repair, and transducer calibration work common to the entire ETS site. Construction includes a concrete slab on grade, concrete block walls, truss joist steel roof framing with insulation, built-up roofing, air-conditioning and electrical power. Chemical and instrumentation functions are now in trailers and World War II stucco sheds scattered about the ETS site. Completion of this addition will result in improved control of these functions and is key to demolition of old maintenance intensive buildings at Edwards Test Station.

3. Construction of Warehouse, ETS..... 240,000

These resources provide for construction of a 4,675-square foot (434 square meter) light steel frame structure. The structure will be used as a warehouse to provide general and bonded storage for intermittently used test and launch gear, spaceflight components, and backup assemblies for space testing programs. The building will have a concrete floor, warehouse lighting, heating, ventilating, and fire protection. The walls and roofs will be insulated. A 15-foot (4.6 meter) clear height under the roof framing will allow for stacking of storage racks and the use of material handling equipment. The building is so sited that should additional space be required, two more bays at 1,150 square feet (107 square meters) per bay could be added. Consolidation of this equipment in an indoor facility for protection from the weather will improve efficiency of flight tests. This equipment is now stored in operational buildings and on the ground in outside uncovered areas where it is subject to damage and deterioration. There is no other building at ETS that can effectively provide these necessary warehousing needs.

4. Construction of Addition to General Office Facility 111..... 240,000

These resources provide for an increase in the office space capacity of the first floor, east wing, of Building 111. A new north wall for this building will be constructed about 25 feet (7.6 meters) north of the existing front wall, enclosing an additional 2,100 square feet (195 square meters) for needed office space. In conjunction with this, 1,344 square feet (125 square meters) of existing office space will be remodeled to form a total open space of 3,444 square feet (320 square meters) suitable for use of the flexible "landscape" office system. The new roof, exterior walls and windows are designed to be architecturally compatible with the present building. A separate air-conditioning system will be provided as well as new ceilings, floorings and finishes to match the existing building. The majority of the available "office type" space on the first floor of the east wing of Building 111 is occupied by the Documentation Section. This section is composed of writers, editors, artists, publication and reproduction specialists who are responsible for the preparation and production of all the laboratory's internal and external scientific and technical information products, including proposals, displays, reports, brochures, etc. Coordination and layout space are critical factors in meeting schedules. Lack of adequate space has necessitated housing ten essential personnel in a remote trailer installation and some 15 other writers and editors in Building 200 at the extreme southern limits of the lab. This facility addition will permit the consolidation of the various documentation functions and promote a more efficent operation.

E. Johnson Space Center (JSC)..... 80,000

1. Construction of Addition to Life Systems Laboratory, Building 7..... 80,000

These resources provide a 1,250-square foot (116 square meter) addition to the east side of Building 7. The existing wall of the liquid oxygen storage area will be increased in height by approximately 5 feet (1.5 meters). A new south wall, approximately 14 feet (4.3 meters) high and 38 feet (12 meters) long, with a 10-foot by 14-foot (3.0 meter by 4.3 meter) roll-up door for gas trailer access, will be added. The new area will then be covered by extending the roof of the existing storage area. Existing wall openings and gates will be blocked to provide for protection from the weather. Also, ventilation and electrical service will be provided. This additional space is necessary for a test buildup working area. Building 7 currently contains three altitude chambers and one ambient pressure enclosure. With the addition of the Shuttle Environmental Control Life Support System (ECLSS) Test Article and the Orbiter Airlock Simulator, there is insufficient covered area to provide for both storage of test support hardware and a place for uninterrupted access to large test equipment.

F. Langley Research Center (LaRC)..... 640,000

1. Construction of an Addition to Building 1209..... 235,000

These resources provide for construction of a one-story addition on the northeast side of Building 1209. The addition will provide approximately 3,600 square feet (330 square meters) of space and will include the necessary heating, ventilating and air conditioning (HVAC) and electrical requirements. Exterior finish materials will match the existing face brick and window design. This project is necessary to provide space for a word processing system, the Research Facilities Engineering Division (RFED) Microprocessor Laboratory, central engineering files, and engineering project offices. The word processing system is presently located in trailers. The RFED Microprocessor Laboratory and central files have expanded beyond the space available. In addition, small project offices are needed for personnel who are temporarily housed in this building for various short-term projects.

2. Construction of Addition to Building 1205..... 170,000

These resources provide for construction of a new 800-square foot (75 square meter) addition on the east side of Building 1205. The enclosed brick structure will house a new 115,000-pound (52,200 kilogram) fatigue testing machine. Three hydraulic pumps presently located in Building 1205 and a new 35-gallon per minute (2.2 liters/per second) hydraulic pump will also be installed in this addition. The small size of the existing pump room makes it difficult to service the pumps. Further, space does not exist for the new pump unit and fatigue testing machine. This facility will be used by the Structural Integrity Branch to test the fatigue life and strength of composite materials.

3. Construction of Pointing Control Lab, Building 1232..... 235,000

These resources provide for construction of approximately 2,700 square feet (250 square meters) of space in the high bay area of Building 1232. Construction will include the addition of a test chamber for safely testing high speed rotational equipment and the installation of an enclosed vibration free test bed. The vibration free test bed will be for verification testing of the Annular Suspension and Pointing System (ASPS) and preflight ground testing of the system with its attached payload. Mission models for the 1980-1990 time frame indicate that a significant number of shuttle-borne experiments will require payload auxiliary pointing systems to satisfy mission requirements. These pointing systems are used to accurately align experiments using objects in space as a reference. A pointing control laboratory is required to develop the advanced technology associated with these devices. In addition, it will permit functional verification of system operation prior to commitment for flight operations.

G. National Space Technology Laboratories (NSTL)..... 435,000

1. Construction of Addition to Central Heating Plant, Building 3204..... 200,000

These resources will provide for a 3,600-square foot (330 square meter) addition to Building 3204 and 1,790 square yards (1,500 square meters) of paving for parking space, access road, and driveway to consolidate operation and maintenance personnel and equipment for the utility control system, high temperature hot water system, and heating, ventilating, and air-conditioning (HVAC) system. This addition consists of a concrete slab-on-grade extension of the existing building walls and roof, and installation of partitions and utilities to provide office areas and shop/storage space. The parking area will be asphalt over compacted shell base. This addition is necessary to provide for a more effective and efficient HVAC operation. Over the past few years, the NSTL population and utilization of facilities have increased, resulting in an increase in the number of service calls received daily. In order to accomplish the maintenance operations within reduced institutional funding, a more effective management control of maintenance resources is required. The operations personnel, tools, work/shop and storage areas are currently separated into two buildings, one mile apart. This centralization will allow maximum cross utilization of personnel and equipment as well as better operational response to trouble calls.

2. Construction of Addition to Data Engineering Building 1110..... 235,000

These resources will provide for an addition of 4,300 square feet (400 square meters) to Building 1110. The construction will include a slab on grade; reinforced concrete exterior panels, demountable interior walls of metal studs, and vinyl covered plaster board; vinyl tile floor; heating, ventilation, and air-conditioning; and electrical utilities. The NSTL Technical Support Contractor's computer operation, photographic services, and reproduction services are currently operating in crowded areas. The computer operation programmer offices are in two trailers with a total of 2,000 square feet (190 square meters). These trailers are over 15 years old and thus increasingly difficult to maintain. The roof leaks on to equipment during frequent rains, and the environmental conditions are not satisfactory. The reproduction services presently occupy 1,720 square feet (160 square meters) of space in Building 1105. A recent safety survey determined that the area is not adequate to accommodate the existing equipment because of dangerously narrow aisles. The photographic services currently utilize 540 square feet (50 square meters) of a hallway for work area. This addition will provide for the relocation of the computer programmers from trailers and the relocation of reproduction services from the crowded, unsafe, and scattered areas. The space vacated in Building 1105 will be used by the photography section to clear the hallway of equipment and resolve the overcrowded conditions. This project will correct existing safety concerns, allow the disposal of two temporary trailer units, and provide improved operational support, especially of the Earth Resources and Space Shuttle Programs which are the primary users of the photographic and reproduction services.

H. Wallops Flight Center (WFC)..... 205,000

1. Construction of Aircraft Support Building..... 125,000

This project provides a 3,200-square foot (297-square meter) insulated pre-engineered steel building. Construction work will include the installation of a heating system, electrical power, and lights. Also included is the demolition of Building D-49, a 28-year old masonry block building which has deteriorated, shows evidence of structural failure of the foundation and walls and would require extensive rehabilitation. The new building will be located near aircraft hangar D-1. It will be used for the storage of aircraft parts used in support of research aircraft operations and will provide space for the aircraft hangar booster fire water pump.

2. Construction of Addition to Equipment Storage Building (N-222)..... 80,000

This project provides an addition of approximately 1,200 square feet (110 square meters) on the west side of the Equipment Storage Building (N-222). The work will include four roll-up doors, electrical power, lights, and a heating system. An open storage addition of 1,200 square feet (110 square meters) on the east side of the building will also be provided. The existing building will be reroofed and will have a roll-up door installed. These additions are required to provide suitable storage for large research equipment. The roll-up door is necessary to improve mechanical equipment operations in the existing building. Reroofing is required due to the deterioration of this 21 year old building.

I. Various Locations..... 195,000

1. Construction of Addition to Operations Building DSS-43..... 195,000

These resources provide for the construction at Deep Space Station-43 (DSS-43) in Canberra, Australia, of a 400-square foot (37 square meter) addition to the Operations Building 42/43 to house station frequency and timing equipment in a controlled, highly reliable environment. The building additions will include a computer room, HVAC equipment with electronic controls, a fire protection system, and an air lock to isolate the timing room from the main operations building. The deep space network master frequency standard at each station consists of various cesium or hydrogen masers which require extremely precise control of temperature, air currents, air cleanliness, magnetic environment, and vibration. The present hydrogen maser is housed in a basement reproduction room at DSS-43. This room was designed with standard HVAC equipment and electrical power which is unstable and unreliable for proper performance of the station's master frequency standard.

TOTAL..... 4,000,000

FUTURE CoF ESTIMATED FUNDING REQUIRED TO COMPLETE THIS PROJECT:

It is estimated that between $3 million and $5 million per year will be required for the continuation of this essential minor construction work.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

SUMMARY

FACILITY PLANNING AND DESIGN

	Amount	Page No.
Regular Requirements:	8,400,000	
Master Planning	300,000	CF 13-2
Sustaining Engineering Support	1,500,000	CF 13-2
Preliminary Engineering Reports and Related Special Engineering Support	2,450,000	CF 13-5
Final Design	4,150,000	CF 13-6
Other Requirements:	1,600,000	
Spacelab/Payloads Facility Planning and Design	650,000	CF 13-7
Energy Reduction Analysis and Support	950,000	CF 13-7
Total	10,000,000	

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1981 ESTIMATES

PROJECT TITLE: Facility Planning and Design	
	FY 1981 CoF ESTIMATE: $10,000,000
FY 1979: $10,650,000	FY 1980: $14,000,000

The funds requested in this estimate are required to provide for the following advance planning and design activities related to facilities activities and projects.

a. The accomplishment of necessary development and master planning for field installations and, where not otherwise provided for, the provision of continuing engineering support and special engineering management and other services.

b. The preparation of preliminary engineering reports, cost estimates, and design and construction schedules.

c. The preparation of final construction plans, specifications, and associated cost estimates and schedules that are required to implement construction projects.

d. The accomplishment of facilities siting and other investigations, studies and reports.

Regular requirements encompass the basic purposes outlined above. The "Other Requirements," while also in support of these purposes, cover those special needs related to large, complex projects or specific programs considered to represent high potential future construction requirements and for which early definition is essential. The large projects require more planning and longer lead time than is normally involved. Much of this planning must be completed prior to inclusion of the project in a budget request.

1. REGULAR REQUIREMENTS..... 8,400,000

A. Master Planning..... 300,000

Provides for the updating and further development of existing master plans for the field installations, including facility studies and site investigations. Documentation will define facility parameters within which subsequent engineering efforts will be based for future development. Provides for the documentation of existing plans where actions or deviations from previous plans have not been recorded for the various field installations.

Master plans at the various field installations are generally updated at cyclic 3-year intervals. Approximately one-third of the field installations are involved in any one fiscal year, keeping the level of effort relatively modest and constant. These plans provide for the orderly consideration of the allocation, proper arrangement, and efficient correlation of land areas and structures to serve the purpose of the various installations. Representative master planning activity candidates for FY 1981 are:

(1) Goddard Space Flight Center

A major update to incorporate land use interfaces with latest Agricultural Research Center planning, proposed consolidation of test sites, and future construction plans.

(2) Wallops Flight Center

A major update of inventory base and land/facility utilization plans and rehabilitation program planning.

(3) Dryden Flight Research Center

An update to involve facility utilization planning for the Dryden facilities during the early operational period of the Shuttle, as well as updating the inventory data base.

B. Sustaining Engineering Support..... 1,500,000

Provisions for facility studies and specific engineering support continue in importance as evidenced in recent years, and must be given high priority throughout FY 1981. These efforts are important due to the unpredictable cost situation which currently exists and may continue; cost trends in construction materials

and fuels; the continuing importance of energy conservation and efficiency; and the operation and maintenance cost for the physical plant. This includes provisions for maintaining a current engineering data base and updated construction specifications for utilization by the various field installations.

The following items are included in the FY 1981 requirements:

(1) Building Research Advisory Board Support

Covers annual support to the Federal Construction Council's (FCC) operations and provides for special studies that the Council will perform throughout FY 1981 to help advance the science and technology of Federal Government building and construction. The FCC is a committee of the Building Research Advisory Board, National Academy of Sciences, and its activities are supported by several Federal Agencies including NASA.

(2) Utilities Services/Rates Analysis

Provides for continuous services in support of utilities procurement and utility systems. This includes technical counseling, surveillance, and recommendations with regard to utility rates, contract negotiations, and systems operations and control. These services are an annual requirement and continue to be important, with continuing increases in energy costs.

During the last fiscal year, these resources have enabled the Agency to achieve fair and reasonable rates in several major utility contract negotiations. Valuable technical assistance from the expertise that these resources provided, at Ames Research Center (ARC) and Langley Research Center (LaRC), resulted in minimizing the impact of sharply higher utility rates.

It is anticipated that one or two major utility contracts per year will require such expert technical input as utility contract renewals move through a normal cycle throughout the Agency. During FY 1981, we expect contract negotiations to occur at Lewis Research Center (LeRC) and Michoud Assembly Facility (MAF). The potential increase in natural gas costs may result in the requirement for additional contract negotiations.

These resources will provide for an updating of our system for forecasting utility costs and rates, so that better and more reliable utility budget requirements can be established. The accuracy and credibility of these forecasts impact the Agency's planning of other resources.

Significant use of these services is the technical maintenance of NASA's utility control and management system which requires close coordination and technical input in order to insure proper use and function of the Agency's investment in utility control and management systems.

These and other similar utility system services are provided for by these resources in order to properly manage this function.

(3) Design Specifications Update and Support

Provides for the continuation of engineering services to update and refine the Agency-wide construction specification system. This system combines a catalog of preapproved standard construction specifications, and a cost effective program for selective retrieval and printout of bid specifications. These standard specifications are used by architect-engineer firms to produce bid documentation which is uniform throughout the Agency and easily updated.

(4) Facility Operation and Maintenance Analysis

Provides for continued engineering support for implementing improvements at NASA field installations relative to manpower utilization, work control systems, preventive maintenance, facilities management and reporting systems. Improvements will also involve techniques to identify where and how increases in productivity are possible by using earlier, reliable measurement methods. Included in this activity are field surveys to be conducted on a priority basis at selected NASA field installations to evaluate the effectiveness of the operations and maintenance management systems.

(5) Value Engineering Cost Validations and Analyses

Provides for engineering services to improve cost-effectiveness of facility projects by subjecting project design criteria, specifications and working drawings for specific material components and systems to a detailed independent review by engineering specialists in the particular area of involvement. Also provides services necessary to accurately predict and validate facility costs which will aid in resources planning for the various field installations.

(6) Facilities Utilization Analyses

Provides for the analyses of Agency-wide facilities utilization data covering: (1) office and other types of building space; (2) designated major technical facilities; and (3) special studies comparing the utilization of technical facilities which are similar in type or capability, such as wind tunnels. Such

analyses provide for the review of data assembled in various formats, thereby permitting: (1) insights into and development of better methods of identifying underutilized facilities; (2) improved techniques of quantifying level of facilities use; and, (3) actions for improved facilities utilization. Work provides for review of each installation's inventory data base in support of the facilities utilization program. Surveys are necessary to validate the reported data in relation to a specific problem or need, and to assist in providing a credible foundation for plans to improve the utilization of facilities.

(7) Engineering Handbook Update

Provides guidance to field installations on a standardized approach to facilities engineering. The Handbook is used as a source of basic policy and criteria for in-house engineering and work performed by architect-engineer firms. New criteria is continually being developed and/or revised. The Handbook must be modified on a progressive basis.

(8) Environmental Studies

Provides for the identification of potential environmental problems or the quick resolution of any related controversies at the NASA field installations. These conditions may be brought about by:

- New Federal, state and local environmental regulations, emission standards and environmental management planning programs that must be considered at various installations;
- Changes resulting from new or expanded program activities, new facilities, or major site expansions at NASA installations; and,
- Changes that take place in the external environmental conditions at NASA installations.

Early identification of potential environmental problems and quick resolution of these and related controversies at the installations are important. Project managers and facility planners require up-to-date, accurate information to comply with legal and regulatory requirements.

C. Preliminary Engineering Reports and Related Special Engineering Support..... 2,450,000

(1) Preliminary Engineering Reports (PER's)..... (1,700,000)

Preparation of PER's, investigations, and project studies related to proposed facility projects in the FY 1983 and FY 1984 Construction of Facilities programs are provided for by this estimate. These reports

are required to permit the early and timely development of the most suitable project to meet the stated functional need. Reports provide basic data, cost estimates and schedules relating to future budgetary proposals. This request provides for PER work associated with proposed construction except as provided for in "Other Requirements" (Paragraph 2) for Spacelab/Payload. In the FY 1983 program, updated PER's are required for an estimated $20-25 million of construction. PER's are required for new projects estimated at approximately $34-40 million. The estimated cost for the FY 1983 PER effort is $1,700,000.

An additional $750,000 has been included in this line for the completion of new PER's for approximately $35-40 million of construction projects which will be high priority candidates for inclusion in the FY 1984 Construction of Facilities program. The activity associated with FY 1984 will be confined to the most urgent and clear-cut priority candidates, and will be undertaken on a limited basis in an attempt to obtain earlier and better definition of programs. It is felt that this will permit better budget estimates, earlier design completion and, thereby, result in better and less costly projects. Subject to validation of the success of this endeavor, we plan to increase the level of early detailed review of such candidate projects in future years. This activity is made essential by the extensive lead time now associated with PER work and the more limited Center capabilities to manage such work on the compressed schedule we have adhered to in the past. This early initiation of PER effort was first provided for in the FY 1980 Budget. It is expected that three to four years experience will be needed to fully assess its effectiveness.

(2) Related Special Engineering Support..... (750,000)

Investigations and project studies related to proposed facility projects to be included in the subsequent Construction of Facilities programs are provided for by this estimate. Such studies have taken on an increased importance in recent years and involve documentation and validation of "as built" conditions, survey/study of present condition of such items as roofing and cooling towers, utility plant condition and operational modes, analysis and support of environmental impact assessments and statements and other like studies. These studies are required to allow for the timely development of projects to meet the stated functional needs and to provide basic data, cost estimates and schedules for related future budgetary proposals.

D. Final Design..... 4,150,000

The amount requested will provide for the preparation of designs, plans, drawings, and specifications necessary for the accomplishment of projects other than Spacelab and Payloads. Amounts required for those efforts are included under "Other Requirements" (Paragraph 2). Projects involved are planned for inclusion in the FY 1982 and FY 1983 programs. This is in accordance with the overall plan discussed earlier in the "Preliminary Engineering Reports" section to obtain better facilities on line earlier at a lower cost.

The request will provide for final design work associated with construction proposed for the FY 1982 Program, estimated to cost $45 to $55 million, and for $15 to $20 million of high potential projects proposed for the FY 1983 program. The amount included for FY 1982 candidates and for residual requirements of this nature which have accumulated from prior years' final design activities is $4,200,000. For FY 1983, $1,150,000 is included and the supporting rationale is much the same as that set out in the PER estimate.

2. OTHER REQUIREMENTS..... 1,600,000

Other facilities planning and design requirements are generated by potential future projects, large in size and of a complex nature. Those in this particular request are primarily associated with future space programs which require a long planning cycle. Early and progressive design work is essential to ultimately ensure the best design, cost estimate and schedule. These projects then require planning effort and associated design lead time well beyond that normally associated with general type facility projects. These requirements must be provided for beyond the regular and most recurrent facility planning and design needs.

A. Spacelab/Payload Facility Planning and Design..... 650,000

The requirement is for the preparation of Preliminary Engineering Reports (PER's), facility site investigations, design of facility projects, and studies to determine facility capabilities required to support the operational phase of the Space Shuttle Transportation System pertaining to Spacelab/payloads. Included are facility requirements for the integration and checkout of Spacelab/payloads, upper stage vehicles, and housing and maintenance of associated flight and support equipment. Projects forecast for FY 1982 include a facility to house and maintain the payload canister and transporter, replacement of payload ground communications cabling, possibly a hydrazine propellant loading capability, and additional payload user support capabilities.

B. Energy Reduction Analysis and Support..... 950,000

Provides resources for the third phase of requirements for energy management and reduction analysis in response to a continuing effort to reduce energy consumption. Many recent national energy developments and considerations continue to introduce a need to improve the management of the Agency's energy resources, such as (1) the increased need and urgency to conserve energy as an essential element of good business and economic viability; (2) the continuing focus and emphasis accorded to energy reduction in building and facilities as an outgrowth of the requirements of Executive Order No. 12003 and the National Energy Conservation Policy Act (NEPCA); and, (3) the continuing emphasis on these requirements as mandated by Executive Orders and by the national energy situation. This FP&D requirement covers those special needs which are related to complex facility studies, analyses, and other preliminary activities leading to the better identification of cost and

energy effective facility projects and improved energy management. These preliminary activities are essential and vital to the total effort of effective future energy reduction, and must be undertaken on a priority basis if near-term and long-term energy reduction goals and improved energy management are to be attained.

NASA has continuously intensified its efforts to identify, study and develop new energy reduction initiatives and improved energy management techniques which have resulted in sound and effective facility projects, improved facility operations and better energy awareness. It is anticipated that the resultant projects and operation changes will reduce and/or limit future energy consumption through improved efficiency and, at the same time, minimize the impact of rapidly rising energy costs. Experience to date, continues to demonstrate that these planning resources can lead to appreciable energy reductions and can direct limited investment resources toward the most prudent and cost effective modifications to facilities on a priority basis. An anticipated additional 7 percent to 10 percent reduction in NASA's total energy consumption can be achieved with in an estimated additional utility cost savings of between $7-$10 million per year in terms of average FY 1979 energy costs. These resources are essential and continue to be the key to timely identification of future facility investments. If not accomplished in a timely manner, additional utilities costs and other costs will be required in future years.

(1) Provides for engineering support, studies and analyses to update energy criteria and design methodologies, operation and maintenance procedures, research testing procedures, facility energy impacts of new programs, and the evaluation of the energy effectiveness of prior investments. This is essential in maintaining the Agency's energy reduction mode and insuring the validity of energy reduction efforts. These resources will also provide for residual efforts and completion of studies already underway.

(2) Provides for technical services, studies, analyses, and planning for the use of alternate energy sources to substitute for the scarcer fossil fuels. As availability of some forms of fossil fuel becomes difficult and more costly to acquire, the substitution of these fuels with waste products, solar, wind, biomass, etc., becomes more essential and cost effective. The increased utilization of coal in an energy efficient and pollution acceptable manner is also included in the effort. These alternate sources of energy require deliberate and careful planning and analysis if prudent and reasonable future investments are to be made.

TOTAL..... 10,000,000

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES

VOLUME III

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RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 1981 ESTIMATES

GENERAL STATEMENT

The Research and Program Management appropriation funds the performance and management of research, technology and test activities at NASA installations, and the planning, management and support of contractor research and development tasks necessary to meet the Nation's objectives in aeronautical and space research. Objectives of the efforts funded by the Research and Program Management appropriation are to (1) provide the technical and management capability of the civil service staff needed to conduct the full range of programs for which NASA is responsible, (2) maintain facilities and laboratories in a state of operational capability and manage their use in support of research and development programs, and (3) provide effective and efficient technical and administrative support for the research and development programs. For FY 1981, an appropriation of $1,047,154,000 is requested.

More than 22,500 civil service personnel at ten installations and Headquarters are funded by the Research and Program Management appropriation. This civil service workforce is NASA's most important resource, the strength on which the future of space and aeronautics research activities depend. Seventy-five percent of the Research and Program Management appropriation is needed to provide for salaries and related costs of this civil service workforce. About two percent is for travel which is vital to manage successfully the Agency's in-house and contracted programs. The remaining amount of the Research and Program Management appropriation provides for the research, test and operational facility support, and for related goods and services necessary to operate successfully the NASA installations and to accomplish efficiently and effectively NASA's approved missions.

Each of the ten NASA installations are assigned certain principal roles of fundamental importance in meeting NASA's overall program goals. These roles reflect the intrinsic competence of the installations on the basis of demonstrated capabilities and capacities. They are summarized as follows:

Ames Research Center: Principal roles are short haul aircraft and rotorcraft systems technology, computational fluid dynamics, planetary probes, and life sciences.

Dryden Flight Research Center: Principal roles are aeronautical flight testing, research and operations, as well as providing a contingency landing site for Space Shuttle flights.

Goddard Space Flight Center: Principal roles are the development and operation of earth orbital flight experiments and automated spacecraft to conduct scientific investigations and demonstrate practical applications; the management of the tracking and data acquisition activities for earth orbital missions; and management of the Delta launch vehicle program.

Johnson Space Center: Principal roles are management of the integrated Space Shuttle program and the Orbiter development project; astronaut and mission specialist selection and training; Space Shuttle mission planning, operation and control; and application of remote sensing to agricultural assessments and other earth resources uses.

Kennedy Space Center: Principal roles are the launch of payloads on expendable launch vehicles; the launch of Space Shuttle development and test flights; and preparation for the operational phase of the Space Transportation System.

Langley Research Center: Principal roles are long haul aircraft systems technology, emphasizing fuel conservation, safety and environmental effects; aerospace structures technology; environmental quality monitoring by remote sensing; and advanced space systems technology.

Lewis Research Center: Principal roles are aeronautical and space propulsion technology; space communications research and technology; space and terrestrial energy systems research and technology; and management of the Centaur expendable launch vehicle program.

Marshall Space Flight Center: Principal roles are management of the Space Shuttle main engine, solid rocket booster and external tank projects; management of NASA's development activities on the Spacelab and Inertial Upper Stage projects; management of large automated spacecraft projects such as the Space Telescope and the High Energy Astronomy Observatory; experiments in materials processing in space; and solar heating and cooling technology development and verification for the Department of Energy.

National Space Technology Laboratories: Principal roles are the support of Space Shuttle engine development and testing; regional earth resources research and technology transfer; and support functions for other Government agencies located there.

Wallops Flight Center: Principal roles are management and launch of sounding rockets and balloons; and operation of an instrumented flight range for aeronautical and space research.

The 1981 budget provides the necessary resources to apply these in-house capabilities to appropriate program activities. Detailed data on funding requirements is provided in the section on each installation. A summary description of, and the funding required by functional category, are as follows:

1. Personnel and Related Costs ($779,991,000): Includes salaries and benefits for NASA permanent and temporary civil service people, and for personnel of other Government agencies detailed to NASA. This category also includes supporting personnel costs, such as moving expenses (excluding the associated travel of people), recruiting and personnel investigation services provided by the Office of Personnel Management, and the training of NASA civil service employees.

2. Travel ($20,825,000): Includes the cost of transportation, per diem, and other associated expenses required for the direction, coordination and management of all NASA program activities; for contract management; for flight mission support; for travel to overseas development, launch and tracking sites; for meetings and technical seminars; and for relocation.

3. Facilities Services ($124,971,000): Includes rental of real property; the cost of maintenance, repair and related activities; engineering; custodial services; minor modifications and alterations; and utilities services.

4. Technical Services ($47,496,000): Includes the cost of general purpose automatic data processing for management activities; the dissemination of scientific and technical information derived from the research and development programs; education and informational programs; shops and other essential technical services.

5. Management and Operations Support ($73,871,000): Includes the cost of administrative communications; printing and reproduction; administrative supplies; general purpose materials and equipment; transportation of equipment and supplies; medical services and other support.

SUMMARY OF THE BUDGET PLAN BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
Personnel and Related Costs	709,055	727,176	768,462	779,991
Travel	18,061	19,797	19,005	20,825
Facilities Services	99,783	113,190	112,353	124,971
Technical Services	42,059	42,288	40,806	47,496
Management and Operations Support	64,850	62,449	65,560	73,871
Total	933,808	964,900	1,006,186	1,047,154

SUMMARY OF CHANGES FROM THE 1980 BUDGET ESTIMATE TO THE 1980 CURRENT ESTIMATE

The changes that have occurred in NASA's Research and Program Management plans in the past year are summarized as follows:

1. A net increase in the total level of the R&PM plan of $41,286,000 which reflects the reduction in the appropriation request through Congressional action, the effect of civil service pay raises in 1980, and the partial absorption of such cost increases in 1980.

	(In thousands of dollars)
1980 Budget estimate	964,900
Congressional action	-5,000
1980 Appropriation	959,900
Increased pay costs effective October 1979, pursuant to Executive Order 12165	51,486
Partial absorption of increased pay costs through savings in personnel costs	-5,200
1980 Current estimate	1,006,186

2. The number of employees in full-time permanent positions currently planned for the end of 1980 is 22,613, an increase of 50 above that shown in the 1980 budget. The increase results from the need to augment the Space Shuttle development workforce as the first development and operational launches approach. The costs in 1980 for these additional people are included above.

BASIS OF THE 1981 ESTIMATE

The budget estimate for 1981 of $1,047,154,000, an increase of $40,968,000 over the current 1980 plan, provides for the personnel and related costs for 100 additional permanent full-time employees; the full year effect of currently negotiated rate increases in support contracts; increased utility rates; and increased costs of supplies, materials and equipment, which continue to rise faster than economy efforts can offset. The Research and Program Management appropriation request for 1981, by functional category, is summarized as follows:

1. Personnel and Related Costs ($779,991,000): The 1981 estimate for Personnel and Related Costs is based on an increase of 100 permanent full-time civil service employees over 1980. This increase is the final increment of the build-up related to Space Shuttle (75) and the full staffing of the Office of the NASA Inspector General (25). Of the 75 additional positions related to the Space Shuttle and related activities, 25 will be at Johnson Space Center, 10 at the Kennedy Space Center, and the balance at Headquarters. These positions will be used to augment the program control and monitoring function, as well as provide key technical review augmentations both in the field and in Headquarters. The 25 additional personnel for the Office of the NASA Inspector General will, in keeping with past NASA practice, be assigned to the Headquarters complement with duty stations in the field. The increase in funding of $11,529,000 from the current 1980 plan to the 1981 request results from the cost of the additional permanent full-time personnel, the full year effect of 1980 pay increases and the net of within-grade and career advances, and turnover savings.

2. Travel ($20,825,000): The 1981 estimate represents an increase over the current 1980 plan of $1,820,000. The increase is needed to meet 1981 program milestones. The travel of civil service personnel to contractor plants, launch and tracking sites, technical meetings and seminars for the accomplishment and coordination of technical matters is an essential element in the success of NASA's research and development programs.

3. Facilities Services ($124,971,000): The 1981 estimate, representing an increase of $12,618,000 over the 1980 current estimate, is the net result of the full year effect of currently negotiated support contractor wage rates, utility rates (that are only partially offset by a further reduction of 6.8 percent in consumption), and the cost rates for supplies, materials and equipment.

4. Technical Services ($47,496,000): The increase of $6,690,000 in 1981 is needed to provide for the full year effect of price increases in the goods and services required in this functional category.

5. Management and Operations Support ($73,781,000): The $8,311,000 increase in this functional category results from the full year effect of previously negotiated support contractor wage rates and goods and services costs, and provision for the replacement of one small administrative aircraft.

In summary, the FY 1981 budget requirement is $1,047,154,000, to provide for a civil service workforce of 22,713 permanent positions at the end of the year and to support the activities at ten NASA installations and Headquarters, consistent with the research and development and construction of facilities program plans.

A supplemental appropriation of $46,286,000 is required in FY 1980 to partially meet the additional costs resulting from approved civil service pay raises.

DETAIL OF CONTENTS BY FUNCTION

The content of each functional category is explained in greater detail in this section, and the specific requirements for each installation are covered in their representative sections in this volume.

PERSONNEL AND RELATED COSTS

A. COMPENSATION AND BENEFITS:

1. Compensation:

a. Permanent Positions: This part of Personnel and Related Costs covers the salaries of the full-time permanent civil service workforce, and is the largest part of the functional category. As noted above, the 1981 funds will provide for 22,713 full-time permanent employees, representing an increase of 100 over the 1980 current plan.

b. Other Than Full-time Permanent Positions: This category includes the salaries of NASA's nonpermanent workforce. Programs such as students participating in cooperative training, summer employment, youth opportunity, and temporary clerical support, are covered in this category.

c. Reimbursable Detailees: In accordance with existing agreements, NASA reimburses the parent Federal organization for the salaries and related costs of persons detailed to NASA.

d. Overtime and Other Compensation: Overtime, holiday, post and night differential, and hazardous duty pay are included in this category. Also included are incentive awards for outstanding achievement and superior performance awards.

2. Benefits: In addition to compensation, NASA makes an employer's contribution to personnel benefits as authorized and required by law. These benefits include contributions to the Civil Service Retirement Fund, employees' life and health insurance, and social security contributions for nonpermanent personnel. Payments for severance pay are made to former employees involuntarily separated through no fault of their own.

B. SUPPORTING COSTS:

1. Transfer of Personnel:

Relocation costs, such as the expenses of selling and buying a home, and the movement and storage of household goods are provided under this category.

2. Office of Personnel Management Services:

The Office of Personnel Management is reimbursed for certain activities such as security investigations on new hires, recruitment advertising, and career-maturity surveys.

3. Personnel Training:

Training is provided within the framework of the Government Employees Training Act of 1958. Part of the training costs consist of courses offered by other Government agencies, and the remainder provides for training through nongovernment sources.

TRAVEL

A. Program Travel:

The largest part of travel is for direction, coordination and management of program activities. The complexity of the programs involved and the geographical distribution of NASA Installations and contractors and subcontractors throughout the entire United States impose the requirement for this category of travel. As projects reach the flight stage, support is required for prelaunch activities, including overseas travel to launch and tracking sites. The amount of travel required for this purpose is directly related to both the number and complexity of the launches.

B. Scientific and Technical Meeting Travel:

Travel to scientific and technical meetings and seminars permits employees engaged in research and development to participate at both Government-sponsored and nongovernment-sponsored seminars. This participation allows personnel to benefit from exposure to technological advances in the field which arise outside NASA, as well as allowing personnel to present both accomplishments and problems to their associates. Many of the Government-sponsored meetings are working panels convened to solve certain problems for the benefit of the Government.

C. Management Operations Travel:

Management and operations travel includes travel for the direction and coordination of general management matters and travel by officials to review the status of programs. It includes travel by functional managers in such areas as personnel, financial management and procurement. This category also includes the cost of travel in and around the Installations; travel of unpaid members of research advisory committees; and initial duty station, permanent change of assignment, and other family travel expenses.

FACILITIES

A. Rental of Real Property:

Rental of real property includes the rental of building space directly by NASA or through the General Services Administration to meet offsite office, warehousing, and other requirements which cannot otherwise be provided for in existing buildings at the NASA Installations. Most of the funding is required for rental of the NASA Headquarters complex of buildings in the District of Columbia, and nearby Maryland and Virginia that are either Government-owned or leased for which NASA must provide rental payments to the General Services Administration in accordance with P.L. 92-313. Also included in this item is the rental of trailers required to accommodate special short-term needs.

B. Maintenance and Related Activities:

Maintenance and related activities includes the recurring day-to-day maintenance of facilities (grounds, buildings, structures, etc.) and equipment which is accomplished by non-Civil Service personnel. This involves the mowing and care of grassy areas, care of trees and shrubs, elevators, cranes, pressure vessel inspections, painting and protective coatings, general buildings maintenance, and the maintenance of installed mechanical, electrical, and other systems. In addition, this item includes feasibility studies, project design, construction supervision, inspection, and other institutional engineering functions. Included also, are any applicable costs associated with recurring facility work as well as materials, hardware, and equipment used in facility maintenance activities whether accomplished by Civil Service personnel or contractors. In the case of equipment, related maintenance and other services are reflected for office, shop, laboratory and other facilities equipment as well as administrative intercommunications and television monitoring equipment.

C. Custodial Services:

Custodial services include janitorial and building cleaning services; pest control; fire protection services; security services including badging and identification; lock and safe repair; trash and refuse handling; window blinds and light fixture cleaning; light fixture replacement; and laundry and dry cleaning of facility-related items.

D. Utilities Services:

Utilities services include the purchase of utilities including electricity, natural gas, fuel oil, coal, steam, propane, and other fuel commodities as well as water and sewage treatment services. Also included are the related operating costs of the utility plants and systems and the cost of plant maintenance.

TECHNICAL SERVICES

A. Automatic Data Processing:

1. Equipment:

This category provides for the lease, purchase and maintenance of general purpose data processing equipment which supports institutional operations at each installation. Excluded is equipment dedicated to specific research or to operational systems which is funded from the Research and Development appropriation.

2. Operations:

Operations services include programming, computer operations and related services. Institutional-type applications include payroll, personnel data, logistics, and procurement records and reports.

B. Scientific and Technical Information and Educational Programs:

1. Libraries:

The technical libraries are established to provide Installation staffs with books, periodicals, technical reports and other documentation.

2. Education and Information Programs:

The educational and informational programs provide for the documentation and dissemination of information about the agency's programs to the general public, the educational community at the elementary and secondary levels, and the mass communications media. Assistance to the mass communications media includes the assembly and exposition of newsworthy material in support of requests, and takes such form as press kits, news releases, television and radio information tapes and clips, and feature material.

C. Shop Support and Services:

Shop support and services include general fabrications shops, reliability and quality assurance activities, safety, photographic services, graphics, and audio visual material.

MANAGEMENT AND OPERATIONS

A. Administrative Communications:

Included in this category are costs of leased lines; long distance tolls; teletype services; and local telephone service.

B. Printing and Reproduction:

Included in this category are the costs for duplicating, blueprinting, microfilming, and other photographic reproductions. Also included in this category are Government Printing Office printing costs, contractual printing and the related composition and binding operations.

C. Transportation:

Transportation services include the operation and maintenance of all general purpose motor vehicles used by both civil service and support contractor personnel. The cost of movement of supplies and equipment by commercial carriers are also in this category.

D. Installation Common Services:

Installation common services include support activities at each installation such as: occupational medicine and environmental health; mail service; supply management; patent services; administrative equipment; office supplies and materials; operation of photocopy equipment; chart and related art work; and postage.

DISTRIBUTION OF PERMANENT POSITIONS BY INSTALLATION

Installation	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Johnson Space Center	3,504	3,445	3,469	3,494
Kennedy Space Center	2,193	2,187	2,191	2,201
Marshall Space Flight Center	3,636	3,561	3,561	3,561
National Space Technology Laboratories	104	103	103	103
Goddard Space Flight Center	3,482	3,440	3,440	3,440
Wallops Flight Center	398	395	395	395
Ames Research Center	1,666	1,653	1,658	1,658
Dryden Flight Research Center	480	461	461	461
Langley Research Center	3,005	2,990	2,980	2,980
Lewis Research Center	2,858	2,835	2,835	2,835
Headquarters	1,505	1,493	1,520	1,585
Total, Permanent Positions	22,831	22,563	22,613	22,713

SUMMARY OF BUDGET PLAN BY INSTALLATION
(Thousands of Dollars)

Johnson Space Center	152,930	156,466	162,881	170,688
Kennedy Space Center	123,314	128,149	131,861	141,385
Marshall Space Flight Center	149,007	148,884	157,599	160,377
National Space Technology Laboratories	4,488	4,689	4,899	5,108
Goddard Space Flight Center	127,910	131,197	135,805	139,335
Wallops Flight Center	15,806	16,330	17,085	18,977
Ames Research Center	62,712	65,839	69,801	71,469
Dryden Flight Research Center	19,068	19,791	21,702	21,681
Langley Research Center	106,643	110,258	116,040	119,145
Lewis Research Center	87,457	95,800	97,825	101,360
Headquarters	84,473	87,497	90,688	97,629
Total	933,808	964,900	1,006,186	1,047,154

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES

RESEARCH AND PROGRAM MANAGEMENT

DISTRIBUTION OF PERMANENT POSITIONS BY PROGRAM

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
SPACE TRANSPORTATION SYSTEMS	6,575	6,482	6,475	6,490
Space Shuttle	4,987	4,355	4,535	3,894
Space Flight Operations	1,213	1,792	1,600	2,280
Expendable Launch Vehicles	375	335	340	316
SPACE SCIENCE	2,246	2,085	2,093	2,069
Physics and Astronomy	1,721	1,589	1,589	1,568
Planetary Exploration	250	238	232	226
Life Sciences	275	258	272	275
SPACE AND TERRESTRIAL APPLICATIONS	2,132	2,206	2,200	2,202
Space Applications	2,041	2,131	2,110	2,115
Technology Utilization	91	75	90	87
AERONAUTICS AND SPACE TECHNOLOGY	5,666	5,576	5,684	5,773
Aeronautical Research and Technology	3,723	3,772	3,733	3,772
Space Research and Technology	1,371	1,256	1,352	1,382
Energy Technology	572	548	599	619
SPACE TRACKING AND DATA SYSTEMS	786	786	754	724
Tracking and Data Acquisition	786	786	754	724
Subtotal, Direct Positions	17,405	17,135	17,206	17,258
Center Management and Operations Support Positions	5,426	5,428	5,407	5,455
Total, Permanent Positions	22,831	22,563	22,613	22,713

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES
RESEARCH AND PROGRAM MANAGEMENT
DISTRIBUTION OF BUDGET PLAN BY FUNCTION BY INSTALLATION
(Thousands of Dollars)

FUNCTION	Total NASA	Johnson Space Center	Kennedy Space Center	Marshall Space Flight Center	National Space Technology Laboratories	Goddard Space Flight Center	Wallops Flight Center	Ames Research Center	Dryden Flight Research Center	Langley Research Center	Lewis Research Center	Headquarters
Personnel and Related Costs												
1979 Actual	709,055	116,657	69,184	119,453	3,040	107,900	10,476	51,456	14,179	88,191	74,251	54,268
1980 Budget	727,176	118,522	70,502	119,961	3,151	110,150	10,749	53,514	14,270	89,940	80,524	55,893
1980 Current	768,462	126,065	74,888	128,051	3,374	115,011	11,361	56,661	15,176	95,405	82,203	60,267
1981 Estimate	779,991	128,612	76,554	127,967	3,444	115,638	11,440	57,113	15,142	95,782	84,262	64,037
Travel												
1979 Actual	18,061	3,309	2,061	2,558	131	2,384	276	1,285	339	1,947	1,002	2,769
1980 Budget	19,797	3,781	2,368	2,684	99	2,672	406	1,313	415	2,154	1,208	2,697
1980 Current	19,005	3,631	2,115	2,604	137	2,542	325	1,353	394	1,899	1,169	2,836
1981 Estimate	20,825	4,035	2,255	2,982	147	2,712	347	1,446	400	2,021	1,244	3,236
Facilities Services												
1979 Actual	99,783	15,602	26,608	11,443	1,125	9,574	3,317	6,185	2,449	8,803	9,565	5,112
1980 Budget	113,190	17,667	31,421	12,395	1,173	10,288	3,398	7,439	2,661	10,192	10,894	5,662
1980 Current	112,353	15,922	30,392	11,825	1,173	10,547	3,586	7,804	3,185	10,914	11,312	5,693
1981 Estimate	124,971	18,385	34,198	12,881	1,286	11,816	3,771	8,736	3,150	12,537	12,307	5,904
Technical Services												
1979 Actual	42,059	5,901	6,615	6,341	49	2,599	575	844	408	2,296	681	15,550
1980 Budget	42,288	7,006	6,987	5,588	41	2,325	524	909	458	2,032	429	15,989
1980 Current	40,806	6,100	6,617	6,287	41	2,449	537	866	665	1,802	885	14,557
1981 Estimate	47,496	7,529	7,611	6,687	43	3,076	963	924	789	2,453	1,043	16,378
Management and Operations												
1979 Actual	64,850	11,461	18,846	9,012	143	5,453	1,162	2,942	1,693	5,406	1,958	6,774
1980 Budget	62,449	9,490	16,871	8,256	225	5,762	1,253	2,664	1,987	5,940	2,745	7,256
1980 Current	65,560	11,163	17,849	8,832	174	5,256	1,276	3,117	2,282	6,020	2,256	7,335
1981 Estimate	73,871	12,127	20,767	9,860	188	6,093	2,456	3,250	2,200	6,352	2,504	8,074
TOTAL												
1979 Actual	933,808	152,930	123,314	149,007	4,488	127,910	15,806	62,712	19,068	106,643	87,457	84,473
1980 Budget	964,900	156,466	128,149	148,884	4,689	131,197	16,330	65,839	19,791	110,258	95,800	87,497
1980 Current	1,006,186	162,881	131,861	157,599	4,899	135,805	17,085	69,801	21,702	116,040	97,825	90,688
1981 Estimate	1,047,154	170,688	141,385	160,377	5,108	139,335	18,977	71,469	21,681	119,145	101,360	97,629

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED APPROPRIATION LANGUAGE

RESEARCH AND PROGRAM MANAGEMENT

For necessary expenses of research in government laboratories, management of programs and other activities of the National Aeronautics and Space Administration, not otherwise provided for, including uniforms or allowances therefor, as authorized by law (5 U.S.C. 5901–5902); awards; *purchase (for replacement only, of one aircraft, for which partial payment may be made by exchange of at least one existing administrative aircraft and such other existing aircraft as may be considered appropriate)* hire, maintenance and operation of administrative aircraft; purchase (not to exceed [thirty-two] *thirty-six* for replacement only) and hire of passenger motor vehicles; and maintenance and repair of real and personal property, and not in excess of $75,000 per project for construction of new facilities and additions to existing facilities, repairs, and rehabilitation and modification of facilities; [$959,900,000] *$1,047,154,000: Provided,* That contracts may be entered into under this appropriation for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year: *Provided further,* That not to exceed $25,000 of the foregoing amount shall be available for scientific consultations or extraordinary expense, to be expended upon the approval or authority of the Administrator and his determination shall be final and conclusive. *(42 U.S.C. 2451, et seq.; Department of Housing and Urban Development—Independent Agencies Appropriation Act, 1980; additional authorizing legislation to be proposed.)*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND PROGRAM MANAGEMENT

Program and Financing (in thousands of dollars)

Identification code 80-0103-0-1-999	Budget plan			Costs and obligations		
	1979 actual	1980 est.	1981 est.	1979 actual	1980 est.	1981 est.
Program by activities:						
Direct program:						
1. Space transportation systems	389,638	415,886	435,154	390,823	415,886	435,154
2. Scientific investigations in space	170,113	115,900	120,300	120,014	115,900	120,300
3. Space and terrestrial applications	110,451	128,700	133,000	107,252	128,700	133,000
4. Space research and technology	67,572	74,600	79,300	66,927	74,600	79,300
5. Aeronautical research and technology	178,474	199,500	207,700	176,615	199,500	207,700
6. Energy technology	24,439	28,300	30,400	24,409	28,300	30,400
7. Supporting activity	43,121	43,300	41,300	43,053	43,300	41,300
Total direct program	933,808	1,006,186	1,047,154	929,093	1,006,186	1,047,154
Reimbursable program:						
1. Space transportation systems	1,131	1,440	1,700	1,125	1,440	1,700
2. Scientific investigations in space	105	50	50	105	50	50
3. Space and terrestrial applications	5,006	7,780	4,180	4,580	7,780	4,180
5. Aeronautical research and technology	762	440	390	760	440	390
6. Energy technology	14,849	14,960	12,890	14,770	14,960	12,860
7. Supporting activity	11,818	11,330	12,790	11,749	11,330	12,790
Total reimbursable program	33,673	36,000	32,000	33,489	36,000	32,000
Total program costs, funded	967,481			962,582	1,042,186	1,079,154
Change in selected resources (undelivered orders)				4,899		
10.00 Total	967,481	1,042,186	1,079,154	967,481	1,042,186	1,079,154
Financing:						
Offsetting collections from:						
11.00 Federal funds				−27,837	−28,672	−30,015
14.00 Non-Federal sources				−5,786	−7,328	−1,935
25.00 Unobligated balance lapsing				261		
Budget authority				**934,069**	**1,006,186**	**1,047,154**
Budget authority:						
40.00 Appropriation				936,469	959,900	1,047,154
40.01 Appropriation rescinded (Public Law 95-7, 92 Stat. 798)				−2,400		
43.00 **Appropriation (adjusted)**				**934,069**	**959,900**	**1,047,154**
44.20 **Supplemental for civilian pay raises**					46,286	
Relation of obligations to outlays:						
71.00 Obligations incurred, net				933,808	1,006,186	1,047,154
72.40 Obligated balance, start of year				74,276	80,798	83,184
74.40 Obligated balance, end of year				−80,798	−83,184	−87,838
77.00 Adjustments in expired accounts				−2,279		
90.00 Outlays, excluding pay raise supplemental				925,007	958,750	1,041,264
91.20 Outlays from civilian pay raise supplemental					45,050	1,236

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RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 1981 ESTIMATES

LYNDON B. JOHNSON SPACE CENTER

DESCRIPTION

The Lyndon B. Johnson Space Center is located approximately 20 miles southeast of downtown Houston, Texas. Total NASA-owned land at Houston site consists of 1,620 acres. The Center also utilizes an additional 54,080 acres at the White Sands Test Facility, Las Cruces, New Mexico. The total capital investment of the Lyndon B. Johnson Space Center, including fixed assets in progress and contractor-held facilities at various locations and the White Sands Test Facility, as of September 30, 1979, was $733,877,000.

CENTER ROLES AND MISSIONS

The Johnson Space Center (JSC) was established in November 1961, in response to the need for NASA to designate a primary Center to manage the design, development and manufacture of manned spacecraft; for selection and training of astronaut crews; and the conduct of manned space flight missions. It was necessary to focus this responsibility in a Federal laboratory since the Government was to be the customer, consumer and facility owner of an activity which was viewed as possessing considerable risk and much uncertainty because of the total lack of previous experience. This need continued as the Nation proceeded towards more ambitious undertakings such as the Apollo program, the Skylab program, the Apollo-Soyuz Test Project and the current Space Shuttle program. In order to meet this responsibility, JSC has developed unique areas of recognized technical excellence within the civil service staff and facilities of superior merit; that is, major technical facilities which constitute a national resource. The principal and supporting roles are:

PRINCIPAL

Manned Vehicles - development of manned space vehicles and associated supporting technology, including:

Space Shuttle - development of the Orbiter and lead Center for management of the Shuttle system. Providing sustaining engineering logistical support for Space Transportation System (STS) hardware. Includes Shuttle configuration management, Shuttle sustaining engineering and Orbiter operational procurement.

Advanced Missions - focus is on orbital systems and advanced transportation systems.

Environmental and Crew Support Systems - develop and demonstrate Environmental Control and Life Support Subsystems (EC/LSS) and Extra Vehicular Activity (EVA) systems suitable for the space transportation systems and other advanced needs.

Food Systems Technology - develop nutritional requirements and food processing systems in support of human space flight.

Environmental Effects Analysis - manage efforts to develop the data base and conduct analyses to ascertain any environmental impact of STS operations.

Supporting Technology Advanced Developments - development of prototypes, long lead time systems and new procedures and software for advanced systems.

Operations - operational planning, crew selection and training, medical operations, space transportation system flight control, experiment/payload flight control for attached payloads and STS utilization planning/payload accommodation studies.

Life Sciences:

Medical Research - establish human baseline data, investigate and develope countermeasures to solve space medicine problems, and develop information techniques and equipment to support medical operations and medical experiments.

Spacelab Payloads - development of Spacelab life sciences research capability through common operating research equipment development. Define, develop and integrate inflight biomedical experiments. Provide for the integration of dedicated life science Spacelab experiments and integration for human studies experiments.

Lunar and Planetary Geosciences - develop and maintain the technical discipline base for lunar and planetary geosciences and extraterrestrial sample handling techniques.

Resource Observations - provide a discipline base for resource observations applications, including airborne techniques and space-based flight sensors. Currenc emphasis includes the application of Landsat and other data to agricultural crop forecasting.

SUPPORTING

Technology Experiments in Space - management of Orbiter experiments program. Definition and development of experiments in areas consistent with other JSC space roles.

Energy Systems - conduct Satellite Power Systems definition activities.

SUMMARY OF RESOURCES REQUIREMENTS

FUNDING PLAN BY FUNCTION

		1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)			
I.	Personnel and Related Costs	116,657	118,522	126,065	128,612
II.	Travel	3,309	3,781	3,631	4,035
III.	Facilities Services	15,602	17,667	15,922	18,385
IV.	Technical Services	5,901	7,006	6,100	7,529
V.	Management and Operations	11,461	9,490	11,163	12,127
	Total, fund requirements	152,930	156,466	162,881	170,688

Distribution of Permanent Positions by Program

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Direct Positions				
Space Transportation Systems	2,581	2,539	2,535	2,542
Space shuttle	2,210	1,907	2,000	1,563
Space flight operations	371	632	535	979

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Space Sciences	151	133	151	152
Planetary exploration	44	39	41	40
Life sciences	107	94	110	112
Space and Terrestrial Applications	193	206	200	214
Space applications	188	202	195	209
Technology utilization	5	4	5	5
Aeronautics and Space Technology	34	30	40	46
Aeronautical research and technology	4	3	5	8
Space research and technology	22	7	17	20
Energy technology	8	20	18	18
Subtotal, direct positions	2,959	2,908	2,926	2,954
Center Management and Operations Support Positions	545	537	543	540
Total, permanent positions	3,504	3,445	3,469	3,494

PROGRAM DESCRIPTION

	Permanent Positions (Civil Service)
SPACE SHUTTLE	1,563

The 1981 staffing provides for continuation of design, development, test and evaluation activity a schedule consistent with the major program milestones including the first manned orbital flight the subsequent orbital flight tests. Activities will continue consistent with a phased delivery the total Orbiter fleet. Procurement of necessary initial flight and ground support equipment will continued.

The Space Shuttle Program Office of the Lyndon B. Johnson Space Center (JSC) has program management responsibility for program control, overall systems engineering, and Space Shuttle system integration. The Space Shuttle Program Office (SSPO) provides management of the "Lead Center" functions as related to the Space Shuttle program and the overall systems management and integration of all elements of the program. The Space Shuttle Orbiter Project Office provides overall management of the design, development, test and production of the Orbiter system. This includes management of various elements of the total Orbiter system (e.g., structures, propulsion, power, avionics, etc.) and to lower elements within the subsystems.

In order to adequately integrate all vehicle systems into an efficient operating system, many detailed interfaces and functional performance features must be identified and defined. Specific interface control documents are identified and established including both flight systems and flight to ground systems. General capability and performance criteria are established for special areas of consideration such as electromagnetic compatibility and lightning protection. For proper systems operations, systems performance data and operational information are prepared such as operational data books, mission requirement documents, etc.

Although major Shuttle flight system elements have been individually managed through designated Shuttle element project offices and related provisioning contractors, a relatively large quantity of supporting equipment is supplied to the program through other elements of JSC. Examples of such equipment are: extravehicular mobility unit, portable oxygen system, closed circuit television, survival radio sets, dosimetry, crew equipment, photographic camera systems, and bioinstrumentation. Each represents a multitude of engineering, management, and evaluation activities. These include definition of requirements, establishment of contract, management of contractor projects, evaluation of design and performance, and provisioning of equipment in a certified "ready for use" configuration. Mission use of equipment also requires on-site processing for preparation and related reconditioning for sequential missions.

Throughout the Orbiter program, particular attention is given to prediction of vehicle performance in each area of function, to analysis of design, establishment and conduct of necessary tests and rectification of actual versus predicted performance difference. Since the Orbiter represents an integrated complex of technical and engineering disciplines, specific test, evaluation and analysis subtasks have been assigned to the variety of technical organizations at JSC. Included in these tasks are: providing technical expertise in the Orbiter life support systems; performing engineering analysis, design definition, performance evaluation, and breadboard testing for communications and tracking systems ground testing; providing expertise in guidance, navigation, control, instrumentation and electrical power distribution; management and operation of environmental test chambers; analysis, evaluation and component testing of the Orbiter hydraulics system, auxiliary power unit, orbital maneuvering system components, reaction control engine performance, reaction control system engine

value leak detection techniques and development of initiator firing units; analysis and laboratory testing for vehicle attachment and separation systems; design analysis of total Shuttle systems, Shuttle/payload interface design, crew station evaluation and design, Shuttle airlock design evaluation, etc.; conduction of engineering analysis to determine overall vehicle performance characteristics in the area of aerodynamic performance, flight characteristics, performance, and dynamics including aeroelasticity.

The successful flight and operational performance of the Space Shuttle is dependent on the proper functioning of integrated electronic equipment. Collectively, these are termed the Integrated Avionics System. Avionics provide the Shuttle pilots and crew with the total assessment and command capability necessary to manage, fly and operate the vehicle. Because of the criticality of this system, very close attention is given to the identification of performance requirements, systems design, and integrated performance.

A variety of avionic elements are included within the Space Shuttle system, each of which requires the attention of a group of technical experts. These elements include: guidance, navigation and control, data processing, communication and tracking; instrumentation, displays and controls, solid rocket booster control and recovery interface, power and control, and external tank propellant control and instrumentation.

Avionics and software testing and checkout in the Electronics Systems Test Laboratory and the Shuttle Avionics Integration Laboratory have effectively supported the Approach and Landing Test (ALT) effort, and will continue through the Orbital Flight Testing (OFT) and into the operations era. Their purpose is to verify the functional performance of Shuttle Integrated Avionics System and validate the system design and verify compatibility of the various radio frequency communication links.

For OFT crew training, the Orbiter Aeroflight Simulator (OAS) was upgraded to the Orbiter 102 configuration to become the second crew station (motion base) in the Shuttle Mission Simulator (SMS) complex. The fixed base is the other crew station with final systems delivery set for 1980. This complex is the primary flight crew training facility and is supplemented by a number of part task trainers and specialized training devices. Training operations began in early 1979 using the motion base portion of the SMS, and full integrated simulations were conducted with the SMS tied into the Mission Control Center in April 1979. The current training schedule requires 40 to 65 training hours per week (between the two crew stations). Involved in simulator operations are the simulator readiness tests, operation of the simulators during training exercises, documentation of abnormal operations identified in the simulator performance or configuration, and correcting problems and system malfunctions. In addition, design and program modifications must be implemented to maintain configuration with Orbiter vehicle modifications and Shuttle program changes.

The Mission Control Center (MCC) update involves the management of the design, development, integration, and testing of all MCC software required to support the Shuttle Orbital Flight Test (OFT) program. This includes modifications to old programs, new or replacement programs, their integration in the MCC, the integration of the MCC software and hardware, and software of the MCC for simulation, training, and actual flight operations. Orbital Flight Test is a major design change to the MCC software and requires new programs for the telemetry, command, tracking, and communications programs.

Orbital Flight Support includes a wide variety of planning activities ranging from operational concepts and techniques to detailed systems operational procedures and checklists. Tasks include flight system and software handbooks, flight rules, detailed crew activity plans and procedures; development of mission control center and network systems requirements; and operations input to the initial planning for the selection and operation of Shuttle OFT payloads.

Specific OFT flight planning activity encompasses the flight design, flight analysis, and software activities. The flight design tasks include: developing nominal and contingency profiles on a preflight basis; supporting the crew training simulations; and development of flight techniques for OFT. Specific OFT flight design products include conceptual flight profiles and operational flight profiles which are issued at launch minus twelve and three months, respectively, for each flight. The OFT software activities include the development, formulation, and verification support for the guidance, targeting, and navigation systems software requirements in the Orbiter and MCC. In addition, the flight dependent data located in the erasable memory (mission-to-mission changes) is developed from the flight design process for incorporation into the Orbiter software and MCC systems.

Orbiter Software Development provides software required for the Shuttle Orbiter Avionics (onboard) general purpose computers. This task involves the generation of the specifications; the design, development, code and test; and integration and verification of the primary avionics software systems which are loaded into the onboard computers. These computers are used for crew training in the Shuttle Mission Simulator and for the actual space flight mission. In addition, this task provides software for Orbiter vehicle tests conducted at the Shuttle launch sites (Kennedy Space Center and the Western Space and Missile Center), and in the Shuttle Avionics Integration Lab.

	Permanent Positions (Civil Service)
SPACE FLIGHT OPERATIONS	979

JSC's support of the Spacelab development effort includes establishing and controlling Shuttle interface with the Spacelab, for overall safety requirements for the Shuttle/Spacelab combination,

and support of MSFC in the performance of its assigned responsibilities. JSC is responsible for crew training in conjunction with flight hardware, and the development and operation of Shuttle/Spacelab simulators and trainers as well as Spacelab support software resident in the Orbiter general purpose computer.

The Mission Control Center is being upgraded MCC-II and Payload Operations Control Center (POCC) for the high flight density of STS operations, payload support, and secure DOD operations. Design and implementation necessary for this upgrade includes the display, control, data handling and interface, communications, and computer hardware/software systems which are being replaced, modified, and/or supplemented. This upgrade will provide mission support for up to three Orbiters simultaneously (two inflight and one on pad or simulation), Spacelab and attached payload command and control, and ability to separate a secure data string for DOD Shuttle mission support.

The Shuttle Mission Simulator (SMS) complex and procedures training facility will be implementing reconfiguration tools (hardware and software systems) to permit support of the high flight rate of the 1980's. The capability for near-continuous training of a number of flight crews for different types of missions, with different payload requirements and on different Orbiters, will require management and utilization of a very high volume of data. Therefore, automated tools are essential to support this pace of training. In addition, simulator system upgrades will continuously be made to keep up with changes to the Orbiters.

Orbiter avionics software development in the STS Operations era will provide for payload support. This will include general capabilities for Spacelab, Inertial Upper Stage (IUS), and Spinning Solid Upper Stage (SSUS), with flexibility available to implement specific payload requirements as optional services.

In addition, the task will provide for rapid handling of mission-to-mission software changes (flight dependent data in erasable memory) and associated verification on a "near production line" basis because of the greater mission rates. In order to accommodate the production line type of work, emphasis is being placed on software tools and the associated automatic data processing equipment (ADPE) hardware which now comprise the Software Development Lab (SDL) and the transition of support into a Software Production Facility (SPF).

Flight design for operations includes: the identification of operational requirements for the design of planned and improved spacecraft systems; the development of flight techniques for utilization of these systems; and the development of nominal and contingency flight profiles for all Shuttle missions. This will include conceptual level profile development and analysis, beginning about two years before the flight, and operational profile development and analysis, accomplished immediately prior to

the flight. As in OFT, the software activities for operational flights also include the continued development, definition, and verification support of the guidance, targeting, and navigation systems software requirements in the Orbiter and MCC. Software changes for Orbiter improvements will upgrade vehicle capabilities and performance.

The advanced programs objective is to provide technical as well as programmatic data for the definition and evaluation of potential future space programs and systems. In support of these activities, advanced studies are conducted to obtain significant performance and reliability improvements, to reduce future program risks and development costs through the effective use of new technologies, and to examine concepts and techniques which can reduce STS operations costs and mission turnaround times. In 1981, the advanced studies effort will assess the technology maturity for a Space Operations Center and examine innovative design concepts which would allow modular development of such a center. A Satellite Services Systems Analysis will be conducted to survey capabilities of proposed equipment to enhance deployment, retrieval, and servicing of payloads. Technology developments in support of Power Extension Package definition and development will be completed. Engineering and supporting studies will be conducted for all of these major disciplines.

	Permanent Positions (Civil Service)
PLANETARY EXPLORATION	40

The Center supports the agency's Planetary Exploration program in the area of geosciences where a strong, active research group is required to support future programs, to provide curatorial support, to assist in information dissemination and to interact with outside scientists. To provide this support the research group must make an active contribution to our knowledge of the compositions, structures and evoluntionary histories of the solid bodies of the solar system. Therefore, the Center has an ongoing program of analysis of planetary materials and of remote sensing data, a theoretical studies program and a program which is involved in the development of remote sensing instrumentation. The definition of geoscience requirements for future planetary flight missions is an important role for the geoscience group which is involved in extensive cooperation with the planetary science community.

LIFE SCIENCES	112

The Johnson Space Center has the lead role in evaluating human physiological changes associated with the space environment and providing effective countermeasures to assure crew health and optimal performance. The scientific activities are to define, develop and integrate biomedical experiments for life sciences payloads. Additionally, these experiments are designed to utilize the space environment to accomplish medical and biological research.

The medical activities provide for medical contingencies in flight involving onboard health services, training for crewmen, ground-based medical support and medical evaluation of proposed crewmembers. These objectives are supportive of the Center's responsibility for assuring astronaut health and safety, both during flight and on the ground. The accomplishment of these objectives requires a well defined and continuing program that incorporates medical research, operations, laboratory support and clinical medicine.

The bioengineering activities provide integration of dedicated life sciences, Spacelab experiments and integration for human experiments. To this end, experiments will be selected, and experiment hardware development will be initiated. JSC is responsible for mission management of the Office of Space Science payload which includes integration of equipment to the pallet, integrating the payload into the Orbiter, and real time mission support while in orbit.

	Permanent Positions (Civil Service)
SPACE APPLICATIONS	209

The resource observations discipline is divided into two major areas: technology development and applications projects, and flight projects. JSC's responsibility entails the conduct and implementation of major tasks in each of these areas.

1. Technology development and applications projects use remotely sensed data for agricultural crop identification, crop acreage and yield estimation, forest mapping and inventory, soil moisture measurement, and vegetation cover monitoring. Studies of data systems and techniques, applicable to these and other applications, are also being conducted.

2. Flight project responsibilities at JSC include the airborne instrumentation research project and Shuttle payload instrument development. The Large Format Stereo Camera is being developed for flight on the Shuttle. Responding to airborne measurement requirements, generated by NASA research and cooperative programs with the Departments of Agriculture, Interior, Defense, Commerce and Energy and various state agencies, JSC develops and implements an aircraft support plan. Involved is the testing, maintenance, and operation of a wide variety of remote sensors which provide data to investigators. Three aircraft, capable of data acquisition from 500 to 63,000 feet, are operated; a Lockheed C-130, a General Dynamics WB-57F, and a Bell 206B helicopter. They are maintained at nearby Ellington Air Force Base.

	Permanent Positions (Civil Service)
TECHNOLOGY UTILIZATION	5

The Technology Utilization program transfers new knowledge and innovative technology resulting from NASA's research and development programs for application in industry, medicine and important public sector areas such as urban development. The Technical Planning Office at JSC provides program office direction for the Technology Utilization program at JSC and provides engineering support to analyze the feasibility of space application to ground-based operations, such as: telecare, feeding the elderly, and bioisolation garment.

AERONAUTICAL RESEARCH AND TECHNOLOGY..... 8

JSC is continuing its efforts in fire testing aircraft fuselage sections fabricated with newly developed materials. This project provides the aircraft industry with test data and results of flammability tests on fuselage components based on full-scale fire testing. In addition, JSC is evaluating the Electromechanical Flight Control concept as an eventual replacement for aircraft hydraulic systems. Also, Fiber Optical Systems are being examined to develop a stand-alone optical multiplexer/demultiplexer component capable of bidirectional, full duplex operation with 16 channels.

SPACE RESEARCH AND TECHNOLOGY..... 20

Systems and design studies are being performed as follows: develop technology, fabricate and test a Synthetic Aperture Imaging Radar (SAR); research fuel cell and electrolysis cell technology to demonstrate suitability to large orbital energy conversion and storage requirements; identify viable propulsion system designs and propellant alternatives which could replace hydrazine fuel in a second generation Shuttle auxiliary propulsion system; collect data, using the Shuttle Development Flight Instrumentation that will augment the research and technology base for future spacecraft design; and, develop an instrumentation package which will provide flight mechanics data for the determination of aerodynamic coefficients from Orbiter flight data.

ENERGY TECHNOLOGY..... 18

Engineering manpower will be used for Space Solar Power System definition. This will involve in-house engineering definition studies and contract management. The studies will involve a systematic comparative assessment of power conversion options (photovoltaic versus thermal, silicon versus gallium arsenite, etc.); major systems trades such as the location of the space construction activity (low

earth orbit versus geosynchronous orbit); and critical systems definition (rotary joint, phase control, etc.). Also, the studies will provide for a second iteration of elements and emphasize techniques of space construction, construction base definition, logistics and operations, and definition of required development program.

	Permanent Positions (Civil Service)
CENTER MANAGEMENT AND OPERATIONS SUPPORT.....	540

Center Management and Operations Support is defined as that support or service being provided to all JSC organizations which cannot be directly identified to a specific benefitting program or project. The Civil service personnel involved are:

Director and Staff - The Center Director, Deputy Director and immediate staff, e.g., Legal, Patent Counsel, Equal Opportunity, Technical Planning, and Public Affairs.

Management Support - Includes a wide range of activity categorized as business management support for programs and functional organizations for the entire Center. Specific functions include resource and budget management, program control, contracting and procurement, personnel management, property management, financial management, resource control, and management systems and analyses.

Operations Support - This is a broad spectrum of activity that is required to maintain and operate facilities, buildings, and equipment; and to provide the normal housekeeping services and logistics support for the personnel who manage and conduct the affairs of the Center. Specific activities are: maintenance and operation of all buildings and facilities; data processing and computer support; reliability and quality assurance; Centerwide security and protection; fire protection; custodial services; logistics support including transportation, supplies, etc.; medical care of employees; and, photographic and graphic support.

RESOURCE REQUIREMENTS BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
I. PERSONNEL AND RELATED COSTS	116,657	118,522	126,065	128,612
Summary of Fund Requirements				
A. Compensation and Benefits				
1. Compensation				
a. Permanent positions	102,749	103,366	110,210	112,208
b. Other than full time permanent positions	1,043	1,598	1,761	1,806
c. Reimbursable detailees	1,656	1,993	2,087	2,107
d. Overtime and other compensation	601	755	864	885
Subtotal, Compensation	106,049	107,712	114,922	117,006
2. Benefits	9,991	10,200	10,458	10,861
Subtotal, Compensation and Benefits	116,040	117,912	125,380	127,867
B. Supporting Costs				
1. Transfer of personnel	159	145	170	175
2. Personnel training	458	465	515	570
Subtotal, Supporting Costs	617	610	685	745
Total, Personnel and Related Costs	116,657	118,522	126,065	128,612

Explanation of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
A. Compensation and Benefits	116,040	117,912	125,380	127,867
1. Compensation	106,049	107,712	114,922	117,006
a. Permanent Positions	102,749	103,366	110,210	112,208

The funds shown above will support 3,494 permanent positions in 1981. Permanent personnel staffing increases by 24 positions in 1980 from the budget estimate and by 25 positions from 1980 to 1981, but the funding increases in both years are due in large part to the October 1979 pay increases.

Basis of Cost for Permanent Positions

In 1981, the cost of permanent positions will be $112,208,000. This increase of $1,998,000 over the 1980 level results from the following:

Cost of permanent positions in 1980		110,210
Cost increases in 1981		+2,932
Within grade and career advances:		
Full year effect of 1980 actions	+929	
Partial year effect of 1981 actions	+1,016	
Full year effect of 1980 pay increases	+102	
Cost of additional permanent positions	+885	
Cost decreases in 1981		-934
Turnover savings and abolished positions:		
Full year effect of 1980 actions	-478	
Partial year effect of 1981 actions	-96	
One less paid day in 1981	-360	
Cost of permanent positions in 1981		112,208

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
b. Other than full time permanent positions				
1. Cost	1,043	1,598	1,761	1,806
2. Workyears	114	160	183	190

The 1981 plan includes 190 workyears which will support the following programs:

Distribution of Other than Full Time Permanent Workyears

Programs	Workyears
Cooperative training	93
Summer employment	28
Opportunity programs	46
Other temporary employment	23
Total	190

The increase in workyears from the 1980 budget to the 1980 current estimate reflects the new White House Research Apprenticeships program, the continuation of the part time program, and a build-up in the nonbaccaluareate cooperative program. The increase in 1981 is due to the scheduled build-up of the White House Research Apprenticeships program and the nonbaccalaureate cooperative program.

c. Reimbursable detailees	1,656	1,993	2,087	2,107

The military personnel detailed to JSC on a reimbursable basis are individuals experienced in manned flight and related fields. Each individual performs a function essential and critical to current and future programs.

Individuals with knowledge, experience, and with a flight background are essential to the manned flight programs. The individuals most readily available within the Government ranks, who meet these criteria, are military personnel. The additional requirement for keeping the military informed on manned space flight technology is also essential.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		

One civilian employee, experienced in the field of medicine, is also detailed on a reimbursable basis to JSC.

The increases in the 1980 current estimate and in 1981 are due to the October 1979 pay increases.

d. Overtime and other compensation	601	755	864	885

Overtime in 1980 and 1981 will be used primarily for preparing the Space Shuttle Orbital Flight Tests, and will cover such activities as crew training, trajectory optimization, data reduction, operations in the integration laboratory, and related support activities. In addition, there are numerous source selection boards, earth resources application system verification programs, and other activities that necessitate extensions of the normal duty hours. The increases in 1980 from the budget to the 1980 current estimate, and in 1981 are due primarily to the October 1979 pay increases.

Benefits	9,991	10,200	10,458	10,861
Following are the amounts of contribution by category:				
Civil Service Retirement Fund	7,322	7,288	7,714	7,951
Employee life insurance	297	410	310	325
Employee health insurance	1,825	1,892	1,802	1,854
Workman's compensation	516	573	590	687
FICA	28	36	40	42
Severance pay	--	1	2	2
Other benefits	3	--	--	--
Total	9,991	10,200	10,458	10,861

The increase from the 1980 budget estimate to the 1980 current estimate is due primarily to the effect of the October 1979 pay increase. The increase in 1981 is due to additional personnel and increased Workman's compensation which is based on bills received from the Department of Labor.

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	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
B. Supporting Costs	617	610	685	745
1. Transfer of personnel	159	145	170	175

Provides for continuing recruitment and transfer of personnel essential to JSC's missions. Funds required for the transfer of personnel in 1981 remain level with 1980.

2. Personnel training	458	465	515	570

These funds provide the means to maintain proficiency in various skills, to provide the necessary training for those employes with technological expertise to keep abreast of the state of the art in their respective fields, and to meet career development and upward mobility needs. The increase in the 1980 current estimate and in 1981 is due to training vital to the implementation of the Civil Service Reform Act.

II. TRAVEL	3,309	3,781	3,631	4,035
Summary of Fund Requirements				
A. Program Travel	2,865	3,265	3,134	3,492
B. Scientific and Technical Development Travel	120	115	130	142
C. Management and Operations Travel	324	401	367	401
Total, Travel	3,309	3,781	3,631	4,035

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		

Explanation of Fund Requirements

A. Program Travel	2,865	3,265	3,134	3,492

Program travel is specifically required for the accomplishment of the center's mission and accounts for 87 percent of the travel budget for 1981. The decrease in 1980 from the budget to the current estimate reflects a reduction in travel to implement Section 112 of Public Law 96-86. Travel to support Space Shuttle development and production is required to continue through 1981 at approximately the same level expected in 1980. However, travel requirements will increase, particularly in the area of payload development and the generation, review, and interchange of the thermal, structural, and dynamic mathematical models required for integration of the various payloads with the Shuttle and with each other.

B. Scientific and Technical Development Travel	120	115	130	142

Scientific and technical development travel permits employees to participate in meetings and technical seminars with other representatives of the aerospace community. This participation allows them to benefit from exposure to technological advances outside JSC, as well as to present both accomplishments and problems to their associates. Many of these meetings are working panels convened to solve certain problems for the benefit of the Government. Symposia and technical seminars related to the earth observation program and lunar samples are a major requirement in this area. The level of travel in 1981 is expected to remain approximately the same as that in 1980.

C. Management and Operations Travel	324	401	367	401

Management and operations travel is used for the direction and coordination of general management matters. It includes travel in such areas as personnel, financial management, and procurement activities; travel of the Center's top management to NASA Headquarters and other NASA centers; and local transportation. The decrease in the 1980 current estimate from the 1980 budget estimate reflects reduced travel in 1980 to implement Section 112 of Public Law 96-86. The increase in 1981 is related to the increased Shuttle effort.

III. FACILITIES SERVICES	15,602	17,667	15,922	18,385

The Johnson Space Center (JSC) is located on 1,620 acres with a complex of laboratory and office type buildings, as well as test facilities. This complex encompasses 2,799,141 gross square feet of building

space in 22 major buildings. Also included are 11 major technical facilities. This physical plant supports an average daily on-site population of approximately 7,100 to 7,500 personnel. Many of the test facilities are utilized on schedules involving more than one shift or during off-peak hours.

These budget estimates also include resources associated with the physical plant requirements of the White Sands Test Facility (WSTF) and for facilities used at Ellington Air Force Base (EAFB).

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
Summary of Fund Requirements				
A. Maintenance and Related Services				
1. Facilities	5,238	6,717	4,420	6,187
2. Equipment	--	394	--	--
Subtotal	5,238	7,111	4,420	6,187
B. Custodial Services	3,195	3,086	3,450	3,851
C. Utility Services	7,169	7,470	8,052	8,347
Total, Facilities Services	15,602	17,667	15,922	18,385
Explanation of Fund Requirements				
A. Maintenance and Related Services	5,238	7,111	4,420	6,187
1. Facilities	5,238	6,717	4,420	6,187

This activity involves not only the facilities of JSC at Houston, but also at White Sands Test Facility (WSTF) and Ellington Air Force Base (EAFB). It provides essentially a continuation of that level of effort provided in 1980. The reduction from the 1980 budget estimate to the 1980 current estimate reflects selected deferrals of facility projects into 1981. The 1981 estimate provides for these deferrals and the cost of negotiated support contract wage increases. Major types of support in this area are:

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
a. Maintenance and operation of facilities (156 workyears).....				5,172

This activity includes routine maintenance and facilities support for applicable facilities at JSC and its component installations at WSTF and EAFB. Also included are such activities as support for utility systems, administrative office alterations, and painting.

b. Grounds maintenance (24 workyears).....				440

This provides for mowing and edging of 540 acres of improved land and mowing only of another 775 acres of unimproved land. Also included is cultivation, mulching, fertilizing, insect control, and care of trees and shrubs.

c. Facilities design engineering (20 workyears).....				575

This effort involves engineering design, drafting, and specifications preparation for construction of facilities; minor construction and repair projects; and other facility and system design and modification tasks.

2. Equipment.....	--	394	--	--

This funding provides for maintenance and repair of office equipment and closed circuit TV maintenance and operation. This has now been reclassified as Installation Common Services.

B. Custodial Services.....	3,195	3,086	3,450	3,851

This activity involves support contractor effort at JSC to provide security guard services, janitorial services, fire fighting, and ambulance services. The increase from 1980 estimate to the 1980 current estimate is partially due to an increase of four workyears of support contractor effort for increased security requirements during the Space Shuttle missions. The increase in 1981 is due to negotiated support contract wage increases.

1. Janitorial services (151 workyears).....				1,968

This activity provides janitorial services to some 2.55 million square feet of floor space, including highly specialized services to cleanroom areas. Also included are such activities as light bulb replacement, trash removal, and laundry services.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
2. Fire protection services (26 workyears).....				653

This activity will provide for fire protection and other related activities for JSC property and personnel, including:

a. Industrial safety and inspections including insuring compliance with OSHA regulations.
b. Maintenance of alarms and fixed fire fighting equipment.
c. Technical interface with the Houston Fire Department for actual fire fighting activities.

3. Security services (61 workyears).....				1,230

This activity includes the protection of personnel at JSC and involves:

a. Protection of all Government facilities and equipment.
b. Badging of all on-site personnel and official visitors.
c. Protecting classified information.
d. Maintaining area surveillance and traffic control.

C. Utilities Services.....	7,169	7,470	8,052	8,347

This category includes purchased utilities and 44 workyears of support contractor effort for the operation and maintenance of the utility distribution system at JSC. The commodity costs are as follows:

1. Electricity (148,079 MWH).....	5,569
2. Natural gas (233,105 cubic feet).....	1,036
3. Water and Sewage.....	318

The increase from the 1980 budget estimate to the 1980 current estimate primarily reflects rate increases for natural gas and electricity. The increase in 1981 reflects these and further rate increases, partially offset by reductions resulting from conversions from natural gas to electricity and JSC's continuing conservation efforts.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
IV. TECHNICAL SERVICES	5,901	7,006	6,100	7,529
Summary of Fund Requirements				
A. Automatic Data Processing				
1. Equipment	2,355	2,300	2,453	2,703
2. Operations	1,577	2,540	1,608	2,530
Subtotal	3,932	4,840	4,061	5,233
B. Scientific and Technical Information				
1. Library	100	96	96	103
2. Education and Information	1,309	682	1,385	1,561
Subtotal	1,409	778	1,481	1,664
C. Shop Support and Services	560	1,388	558	632
Total, Technical Services	5,901	7,006	6,100	7,529
Explanation of Fund Requirements				
A. Automatic Data Processing	3,932	4,840	4,061	5,233

This activity provides accounting and management information to satisfy requirements of NASA management and external authority. Included is support of all JSC administrative functions and the lease and maintenance costs of all multiuse ADP equipment within JSC's Central Computer Facility. The decrease in 1980 from the budget to the current estimate reflects 1979 experience with pre-FMOF requirements and a change in the phasing of the contract funding plan in the Operations area, partially offset by increased lease costs in the Equipment category. The increase in 1981 is due primarily to negotiated support contractor wage increases in the Operations area.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
1. Equipment	2,355	2,300	2,453	2,703

Covered herein are the purchase and maintenance costs of all JSC-owned ADP equipment and the lease costs of all leased ADP hardware within the Central Computer Facility. These hardware systems include four Univac 1108's, one Univac 1110, one Univac 9300, one IBM 360/22, one CDC 3200, and one Mohawk (data entry) computer system. Also included is associated peripheral equipment such as two microfilm processors, various terminals, and keypunch equipment.

2. Operations	1,577	2,540	1,608	2,530

This category provides for computer programming, operations, keypunch, and other support personnel involving 70 workyears of support contractor effort. The ADP systems supported include institutional management, finance and accounting, procurement, contract status and tracking, personnel management, and utility tracking.

B. Scientific and Technical Information	1,409	778	1,481	1,664

This activity, requiring 69 support contractor workyears, provides for the operation of the technical library at JSC, a public affairs educational and informational program, and support to the Center in provision of various scientific and technical information services. The increase in 1980 from the budget to the current estimate is due to the reclassification of public affairs audio-visual support to this category from Shop Support and Services. The increase in 1981 is due to an anticipated increase in support contractor wages.

1. Library	100	96	96	103

Six support contractor workyears provide cataloging and indexing services and provide initial distribution of publications in the operation of the JSC Technical Library. This includes, on a monthly basis, cataloging of approximately 170 books, indexing of approximately 730 reports, and distributing about 50,000 publications.

2. Education and Information	1,309	682	1,385	1,561

The funding in this category provides for 63 support contractor workyears to support a JSC public affairs program. Included are motion picture production, from script to screen; film clip preparation; exhibit management and refurbishment; visitor orientation tours; lecturing; mail answering services; and other public affairs activities.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
C. Shop Support and Services	560	1,388	558	632

These funds provide for 24 workyears of support contractor effort to provide JSC with support in areas such as graphics, publications, audio-visual material, microfilm and microfiche, and editorial services for JSC publications. Graphic materials are prepared for use in presentations and senior management reviews. Various kinds of film are processed, and reproductions and reprints made. The decrease from the 1980 budget estimate to the 1980 current estimate is due to the reclassification of selected public affairs audio-visual support to the Scientific and Technical Information category. The increase in 1981 is due to negotiated support contractor wage increases.

V. MANAGEMENT AND OPERATIONS	11,461	9,490	11,163	12,127
Summary of Fund Requirements				
A. Administrative Communications	2,713	2,437	2,690	2,788
B. Printing and Reproduction	1,131	761	997	997
C. Transportation	773	825	923	966
D. Installation Common Services	6,844	5,467	6,553	7,376
Total, Management and Operations	11,461	9,490	11,163	12,127

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			

Explanation of Fund Requirements

A. Administrative Communications	2,713	2,437	2,690	2,788

Communications support for JSC and WSTF consist of local telephone service, long distance telephone service, and various kinds of other communications services. The 1980 current estimate is higher than the 1980 budget estimate due to a 21 percent rate increase in local telephone exchange services experienced in 1979, partially offset by a decrease in costs for use of the Federal Telecommunications System (FTS). The level of support in 1981 is the same as that in 1980.

1. Local telephone service..... 1,690

The major part of this category provides for 3,360 Centrex lines and 6,503 telephone instruments at JSC. Also included are 292 telephones at WSTF and local telephone service at Draper Labs, Cambridge, MA.; Grumman, Bethpage, NY; and SAMSO, El Segundo, CA. About 128 local circuits at JSC and two at WSTF for fire alarms, burglar alarms, public address systems, and other specialized uses are also included in this category.

2. Long distance telephone service..... 954

This category includes the cost for FTS, commercial toll calls, two dedicated voice circuits between WSTF and Las Cruces, NM, and two teletype circuits between JSC and GSA in Austin, TX.

3. Other communications services (one workyear)..... 144

These funds provide specialized services such as teletype and wire news services. In addition, the operation and maintenance of a closed circuit TV system is provided along with eight radio networks for fire, security, custodial, and other uses.

B. Printing and Reproduction.....	1,131	761	997	997

JSC's basic printing requirements are handled by maintaining an on-site printing plant operated by JSC personnel. This printing plant produces approximately 50,000,000 units of printing each year. In

addition to this on-site printing plant, JSC must also purchase from private firms, through Government Printing Office contracts, about 54,600,000 units each year. This purchased printing is a combination of overflow requirements that cannot be handled on-site, and printing which requires greater or different capabilities than those available at the on-site plant. The increase from the 1980 budget estimate to the 1980 current estimate and in 1981 reflects the transfer of Space Shuttle related printing from contractor effort to the on-site plant.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
C. Transportation	773	825	923	966

Transportation functions at JSC involve seven workyears of support contractor effort. Also included are administrative aircraft maintenance costs and lease of trucks from GSA. The 1980 current estimate is higher than the 1980 budget estimate due to unexpected Space Shuttle related requirements in most work areas. The level of effort for these services in 1981 is expected to be the same as that in 1980.

D. Installation Common Services	6,844	5,467	6,553	7,376

These services, requiring 170 workyears of support contractor effort, support center management and staff activities, provide medical services, and cover various installation support services. These are representative areas in which the increased Space Shuttle activities have great impact. The 1980 current estimate and the 1981 estimate are higher than the 1980 budget estimate due to this impact and reflect 1979 experience.

1. Center management and staff functions..... 38

   This category covers patent searches and applications.

2. Medical services..... 1,460

   Two major types of medical service are provided, occupational medicine and environmental health.

   a. Occupational medicine (33 workyears)..... 1,060

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		

Occupational medicine consists of the operation of the JSC on-site clinic, emergency assistance at EAFB, providing physicals for JSC personnel at Downey, CA., medical consultation and crew test support.

b. Environmental health (13 workyears)..... 400

This category includes industrial hygiene , radiological health, and an environmental health laboratory.

3. Installation support services..... 5,878

a. Administrative supplies, materials and equipment..... 2,754

This category includes all supplies, materials and equipment, and their lease and maintenance costs, that are used to support administrative functions at the Center and at WSTF.

b. Cataloging of supplies and equipment (20 workyears)..... 335

This effort is required for identification and cataloging of requests for supplies into the proper Federal Supply Groups, placing orders on the proper Federal Schedule Contracts, maintaining a stores stock catalog, and other related activities.

c. Warehousing and storage (58 workyears)..... 971

This category includes the operation of a central receiving depot for supplies; a warehousing function, including bonded storage and storage of hazardous materials; and a stock issuance service.

d. Postage..... 482

This category covers the payments to the U.S. Postal Service for postage on official mail.

e. Moving and hauling (38 workyears)..... 636

	1980		1981
1979 Actual	Budget Estimate	Current Estimate	Budget Estimate
	(Thousands of Dollars)		

This effort is required to handle the shipping and packing of supplies and equipment both locally and for long distance movement; the moving and hauling of items within the Center; and the delivery of supplies, materials, and equipment purchased from local suppliers.

f. Forms distribution (eight workyears)..... 136

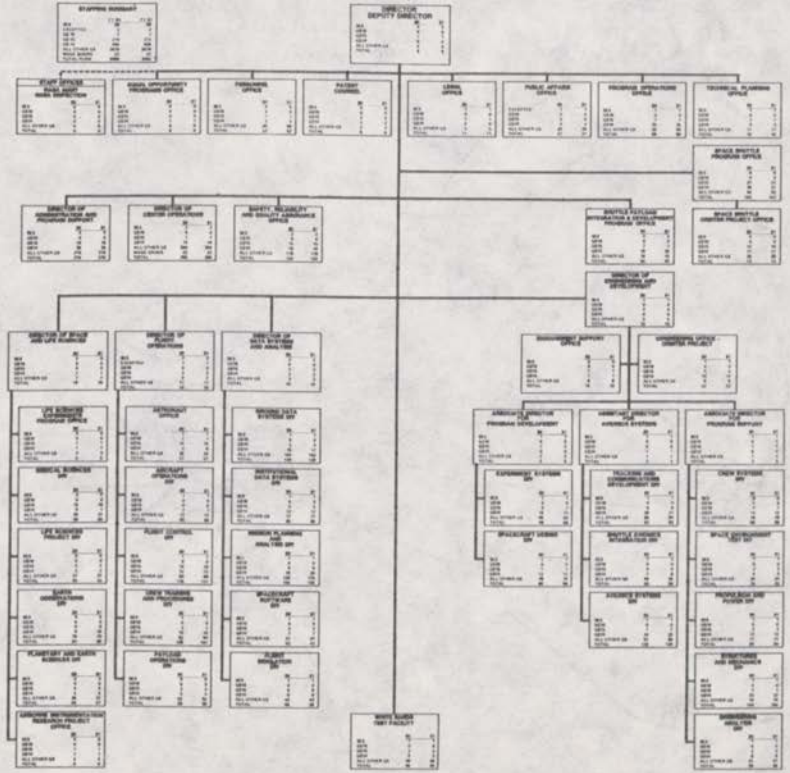
This category covers the support contractor effort required for the distribution of approximately 600,000 forms and publications each year.

g. Administrative support..... 564

Included herein is the cost of local transportation within the JSC area provided by GSA, the JSC share of operating costs at EAFB, the costs of stenographic services and the costs of torts and claims.

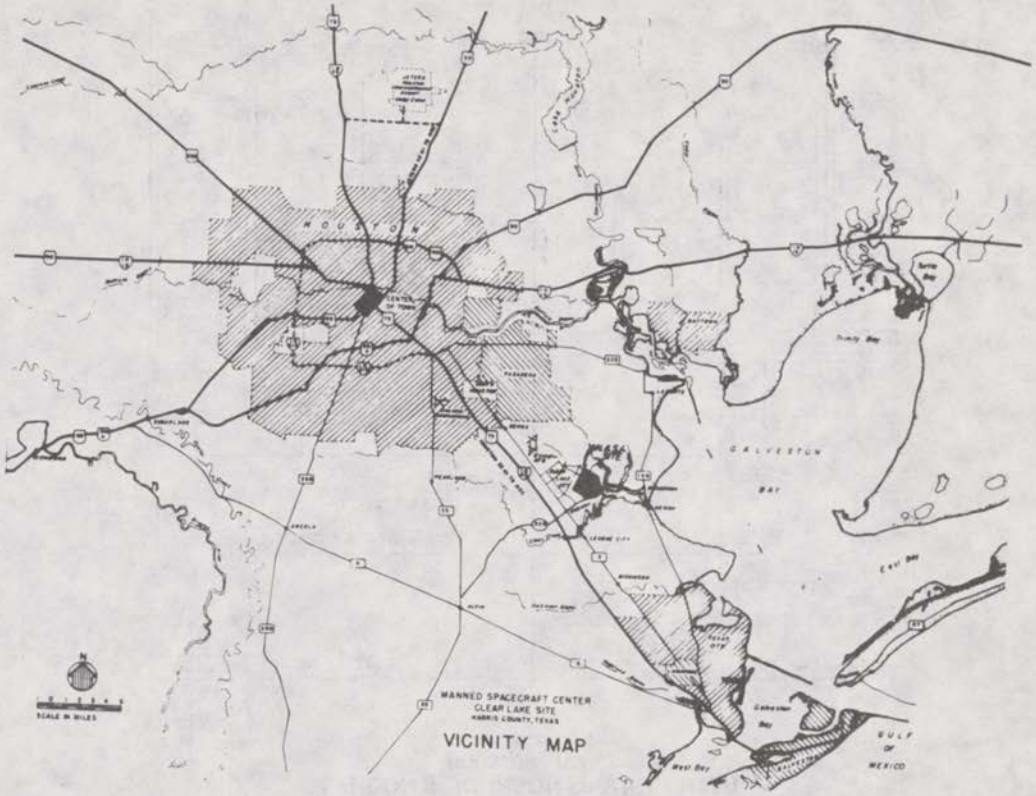
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LYNDON B. JOHNSON SPACE CENTER
HOUSTON, TEXAS

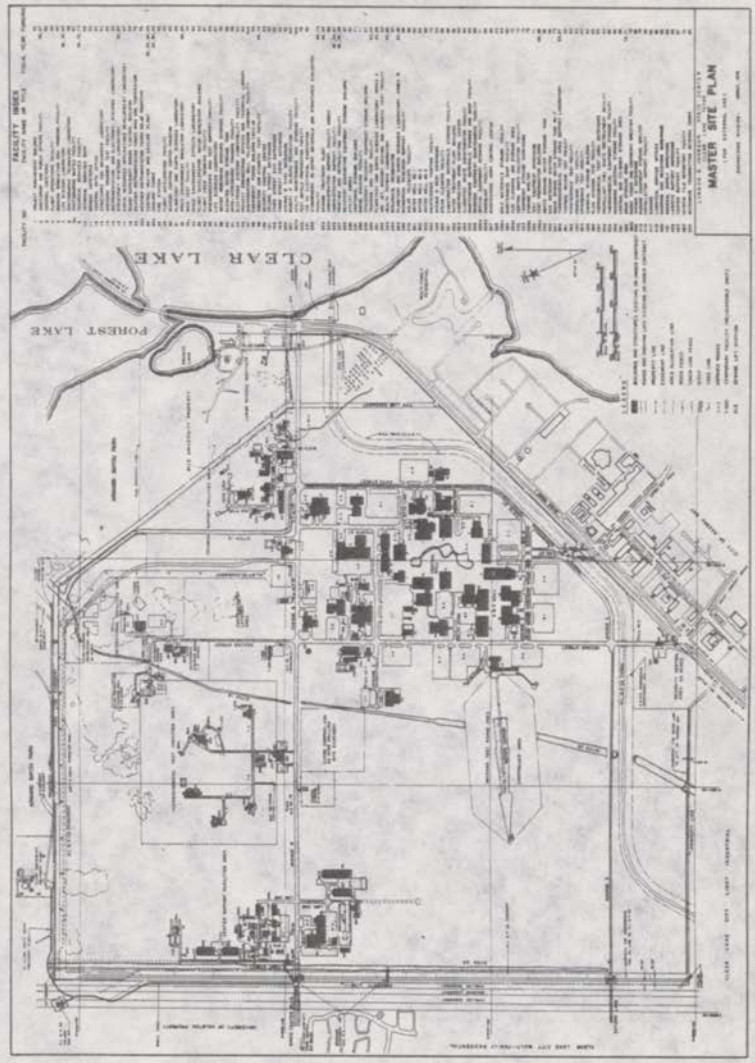


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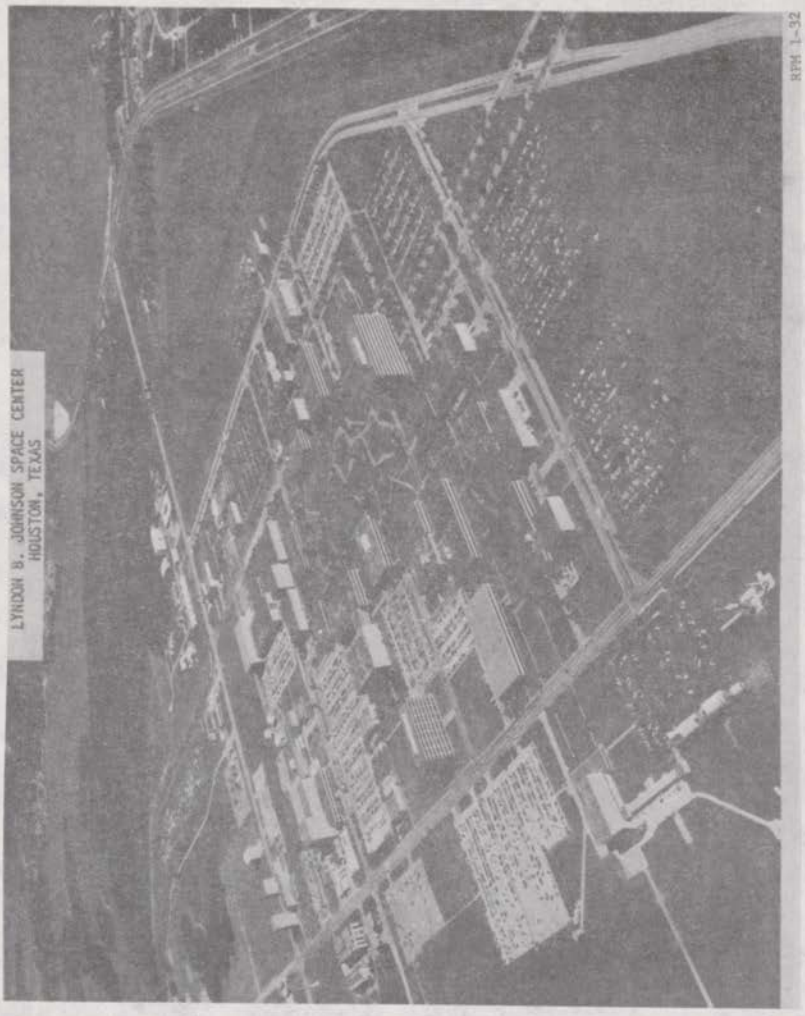
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Houston, Texas 77058



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RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 1981 ESTIMATES

JOHN F. KENNEDY SPACE CENTER

DESCRIPTION

The John F. Kennedy Space Center is located approximately 50 miles east of Orlando, Florida. The total land and water area occupied by the installation is 139,305 acres. NASA owns 82,943 acres of that total. The remainder is comprised of the Banana River Causeway Easement (271 acres), the Indian River Causeway Easement (296 acres), and Florida-owned submerged lands with Deed of Dedication (55,795 acres).

Expendable launch vehicle operations are conducted at both the Air Force's Eastern Space and Missile Center, Florida, and the Western Space and Missile Center at Vandenberg Air Force Base, California, which is located six miles west of Lompoc, California. Space Shuttle flights will begin at KSC in 1980 and at Vandenberg in 1984.

The NASA capital investment at the Kennedy Space Center and Vandenberg Air Force Base, including fixed assets in progress and contractor-held facilities as of September 30, 1979, was $1,836,425,000.

CENTER ROLES AND MISSIONS

The Kennedy Space Center (KSC) was established at Cape Canaveral, Florida, in July 1962 to serve as the primary NASA center for the test, checkout, and launch of space vehicles. This site was chosen because of its unique geographical characteristics, climate, local growth capability, accessibility, and availability. The Center has since grown to become the major Free World launch site with a unique civil service staff of unparalleled expertise in the field of test, checkout, and launch of space vehicles and in the design of associated ground support equipment. The technical facilities developed at KSC represent a recognized national resource. The principal roles are:

Space Transportation System (STS) Ground Operations - includes launch operations, Solid Rocket Booster (SRB) retrieval, STS refurbishment and turnaround, Levels I and II integration, Spacelab Level III and IV integration, integrated logistics and transportation and postlanding operations, and flight line medical and biomedical support.

STS Sustaining Engineering - includes configuration management, operational hardware accommodations and modifications.

Expendable Launch Vehicle Operations - includes launch preparation and checkout for the current inventory of launch vehicles.

SUMMARY OF RESOURCES REQUIREMENTS

FUNDING PLAN BY FUNCTION

		1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)			
I.	Personnel and Related Costs	69,184	70,502	74,888	76,554
II.	Travel	2,061	2,368	2,115	2,255
III.	Facilities Services	26,608	31,421	30,392	34,198
IV.	Technical Services	6,615	6,987	6,617	7,611
V.	Management and Operations	18,846	16,871	17,849	20,767
	Total, fund requirements	123,314	128,149	131,861	141,385

Distribution of Permanent Positions by Program

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Direct Positions				
Space Transportation Systems	1,609	1,624	1,603	1,614
Space shuttle	1,225	1,146	1,223	1,217
Space flight operations	232	342	237	254
Expendable launch vehicles	152	136	143	143

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Space Science	2	2	8	8
Physics and astronomy	--	--	6	6
Life sciences	2	2	2	2
Space and Terrestrial Applications	8	8	8	8
Space applications	6	6	6	6
Technology utilization	2	2	2	2
Aeronautics and Space Technology	1	1	1	--
Energy technology	1	1	1	--
Subtotal, direct positions	1,620	1,635	1,620	1,630
Center Management and Operations Support Positions	573	552	571	571
Total, permanent positions	2,193	2,187	2,191	2,201

PROGRAM DESCRIPTION

	Permanent Positions (Civil Service)
SPACE SHUTTLE	1,217

The Kennedy Space Center (KSC) has been assigned the Launch and Landing Project of the Space Shuttle program. Major roles for the accomplishment of this responsibility include launch systems development and Space Transportation Systems (STS) ground operations. In the performance of these roles, 1981 will represent a period of continuing activity at KSC in preparation for fully operational Shuttle. Orbiter 102 will be used for the first manned orbital flight in 1980, and preparations will be in progress for three additional orbital test flights during 1981, plus the first operational flight.

Construction of new launch support facilities and modification of most existing facilities will be complete with installation and checkout of remaining support equipment in preparation for scheduled flights. Major facilities involved are:

Shuttle Landing Facility (SLF)

The installation and checkout of operational systems will be completed and along with the ground support equipment previously installed will support Shuttle landings after the fourth orbital flight test.

Orbiter Processing Facility (OPF)

Integration and checkout of all ground support systems in the Low Bay Annex and High Bay 2 will continue in preparation for arrival of the second Orbiter at KSC in 1982.

Vehicle Assembly Building (VAB)

Modification of support systems and equipment will continue in preparation for the Solid Rocket Boosters and External Tanks as well as full Shuttle integrated operations. Installation and checkout of support equipment in High Bays 1 and 2 will commence in 1982.

Mobile Launch Platforms (MLP)

Support equipment installation and checkout of MLP 2 which began in 1980 will continue.

In addition to the activity involving major facilities, KSC will continue the design, acquisition, and installation of equipment to be used in support of the Shuttle. This includes not only that equipment provided by KSC contractors but also that to be supplied by the development contractors as part of their flight vehicle contract. KSC will also continue the refurbishment of selected existing support equipment for reuse on the Shuttle program.

A unique category of support equipment is the Launch Processing System (LPS). This automated checkout system, conceived and developed by KSC, is a major innovation in the checkout and launch of sophisticated space vehicles. This system will provide automated checkout capability for the Shuttle vehicle, along with engineering data for operations and management decisions and will support the test and checkout of the first orbital flight.

Another major role for KSC in the Shuttle program, in addition to ground systems development, is that of ground operations. This includes the test and checkout of each flight element as it arrives at KSC for development flight testing, the integration of the Orbiter, External Tank and Solid Rocket Boosters into

the Shuttle vehicle and integrated testing of the stacked configuration, propellant loading, and launch. Subsequent to landing, KSC will refurbish the Orbiter in preparation for the next mission. Also included is retrieval, disassembly, and refurbishment of the expended solid rocket boosters. Since the initial orbital flight test launches will land at Dryden Flight Research Center (DFRC), provisions will be made for the ferrying of the Orbiter back to KSC (for maintenance and launch).

	Permanent Positions (Civil Service)
SPACE FLIGHT OPERATIONS	254

The conduct of the space flight operations program at KSC includes Spacelab, Inertial Upper Stages, Payload support and multimission support that may be assigned for Shuttle flight operations.

KSC's role in the Spacelab program is similar to that of the Shuttle, that is; KSC is responsible for launch site development and for ground operations. With delivery of the Spacelab engineering model in 1980 and Spacelab flight equipment, KSC will continue the additional task of analytical engineering. Responsibility for this task of ensuring that the experiments to be mounted on or in the Spacelab are compatible with the Spacelab, with each other, and with safety requirements will transfer to KSC for the third Spacelab mission. The first Spacelab flight unit will be delivered in early 1981 with preparations for the first flight in 1982.

The upper stages consist of the Inertial Upper Stage (IUS) and the Spinning Solid Upper Stage (SSUS). The IUS and SSUS are expendable, propulsive stages intended for use in the deployment of Shuttle transported payloads to high energy orbits not attainable by the Shuttle alone.

The IUS is being developed by the Air Force and delivery of the first flight unit is expected in 1981. KSC will be responsible for mating the Spacecraft to the IUS. Design review of the IUS integration activities will continue in 1981 with the first flight scheduled in 1981.

Under current plans the SSUS will be developed, checked out and mated to a payload by the SSUS commercial developer. KSC will have responsibility for integration of the SSUS and its payload and then into the Shuttle payload bay.

KSC will provide facilities and support to the various payload developers and experimenters during processing at KSC. Thus, KSC, in concert with other NASA organizations must analyze potential payload requirements, identify payload facility capability at KSC, and prepare documentation for potential payload users. Based on experience gained during the Expendable Launch Vehicle program, KSC will monitor the

payload activity from conception, participate in design reviews to ensure compatibility with KSC facilities, and provide support coordination during the payload checkout and launch at KSC.

	Permanent Positions (Civil Service)
EXPENDABLE LAUNCH VEHICLES	143

KSC is responsible for the launch preparation and checkout of the current inventory of expendable launch vehicles. This includes the Atlas Centaur and Delta. Launches at both the Eastern Space and Missile Center and the Western Space and Missile Center are the responsibility of KSC. Fifteen launches are scheduled for 1981.

PHYSICS AND ASTRONOMY	6

Beginning in 1980, KSC is responsible for planning and coordinating the Level IV integration and launch site support of mission experiments for Spacelab Mission 3 and beyond. Interfaces will be established and maintained with the NASA discipline program offices, the Principal Investigators, and appropriate engineering groups to assure that scientific objectives of the mission are met.

LIFE SCIENCES	2

In 1981 KSC will continue its support role in the definition, development, and integration of biomedical experiments into Shuttle payloads for life sciences research. Included is the responsibility for providing and managing a Life Science Principal Investigator Support Facility and assisting in the conduct of life sciences synchronous ground control experiments and procedures required for life sciences payloads. These experiments are designed to use the environment of space to accomplish medical and biological research for the benefit of man through technological advancement of the state of the art.

772

	Permanent Positions (Civil Service)
SPACE APPLICATIONS	6

In the field of applications, KSC will continue in 1981 with the resources observation surveys, involving environmental monitoring, and in developing methods of sensing and predicting weather and climatic conditions.

In the area of specialized application tasks, KSC will be performing studies related to requirements, procedures, and techniques of processing space applications payloads for Spacelab.

TECHNOLOGY UTILIZATION	2

The objectives of the Technology Utilization program at KSC are to encourage the use of and to expedite the application of new NASA technology in other sectors, and to impart a better understanding of the technology transfer process and its potential impacts.

CENTER MANAGEMENT AND OPERATIONS SUPPORT	571

Center Management and Operations Support is defined as the support or services being provided to all Kennedy Space Center organizations which cannot be directly identified to a benefitting program or project. The civil service personnel involved are:

Director and Staff - The Center Director, Deputy Director and the immediate staff, e.g., Legal, Patent Counsel, Equal Opportunity, Public Affairs (includes operation of the Visitors Information Center and its related NASA tours activity), and Safety.

Management Support - Includes a wide range of activity categorized as management support for programs and functional organizations for the entire Center. Specific functions include resource and budget management, program control, contracting and procurement, personnel management, property management, financial management resources control and management information systems and analysis.

Operations Support - This is a broad spectrum of activity that is required to maintain and operate facilities, buildings, and equipment; and to provide the normal housekeeping services and logistics support for the personnel who manage and conduct the affairs of the Center. Specific activities are:

Maintenance and operation of all buildings and facilities
Data processing and computer support

RESOURCE REQUIREMENTS BY FUNCTION

		1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
			(Thousands of Dollars)		
I.	PERSONNEL AND RELATED COSTS	69,184	70,502	74,888	76,554
	Summary of Fund Requirements				
A.	Compensation and Benefits				
1.	Compensation				
a.	Permanent positions	61,459	62,396	66,459	67,780
b.	Other than full time permanent positions	825	986	922	956
c.	Reimbursable detailees	145	26	49	35
d.	Overtime and other compensation	486	428	585	712
	Subtotal, Compensation	62,915	63,836	68,015	69,483
2.	Benefits	6,005	6,133	6,343	6,521
	Subtotal, Compensation and Benefits	68,920	69,969	74,358	76,004

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
B. Supporting Costs				
1. Transfer of personnel	96	258	255	255
2. Personnel training	168	275	275	295
Subtotal, Supporting Costs	264	533	530	550
Total, Personnel and Related Costs	69,184	70,502	74,888	76,554

Explanation of Fund Requirements

A. Compensation and Benefits	68,920	69,969	74,358	76,004
1. Compensation	62,915	63,836	68,015	69,483
a. Permanent Positions	61,459	62,396	66,459	67,780

The funds will support 2,201 permanent positions in 1981. Permanent personnel staffing increases slightly from 1980 to 1981, but the funding increases in both years are due primarily to the October 1979 pay increase.

Basis of Cost for Permanent Positions

In 1981 the cost of permanent positions will be $67,780,000. The increase results from the following:

Cost of permanent positions on 1980		66,459
Cost increases in 1981		+2,222
Within grade and career advances:		
Full year effect of 1980 actions	+740	
Partial year effect of 1981 actions	+809	
Full year effect of 1980 pay increases	+146	
Change in reimbursable activity	+178	
Cost of ten additional permanent positions	+349	

Cost decreases in 1981		-901
Turnover savings and abolished positions:		
Full year effect of 1980 actions	-590	
Partial year effect of 1981 actions	-89	
One less paid day in 1981	-222	
Cost of permanent positions in 1981		67,780

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
b. Other than full time permanent positions				
1. Cost	825	986	922	956
2. Workyears	93	113	114	119

The 1981 plan includes 119 workyears which will support the following programs:

Distribution of Other than Full Time Permanent Workyears

Program	Workyears
Cooperative training	64
Summer employment	21
Opportunity programs	19
Other temporary employment	15
Total	119

The increase in workyears from the 1980 budget estimate to the 1980 current estimate reflects the new White House Research Apprenticeships program which is offset in part by the discontinuation of the Worker Trainee Opportunity program. The decrease in the cost estimate is due to a change in skill mix in the temporary programs. The increase in 1981 is due to the scheduled build-up of the White House Research Apprenticeships program.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
c. Reimbursable detailees	145	26	49	35

Provides funding for the services of a software applications officer in support of the Space Shuttle program. The increase from the 1980 budget estimate to the 1980 current estimate reflects the continuation of Shuttle requirements of the Department of Defense until the First Manned Orbital Flight (FMOF). The decrease in 1981 reflects the termination of these requirements.

d. Overtime and other compensation	486	428	585	712

The funding increase from the 1980 budget estimate to the 1980 current estimate is due to the slip in the scheduled launch date for FMOF. This provides additional workhours to provide for the critical scheduling of Shuttle preparation efforts. The increase in 1981 is due to expected overtime to meet the orbital flight test launch schedule.

2. Benefits	6,005	6,133	6,343	6,521
Following are the amounts of contribution by category:				
Civil Service Retirement Fund	4,365	4,425	4,670	4,728
Employee life insurance	253	274	266	266
Employee health insurance	1,169	1,211	1,211	1,211
Workman's compensation	197	197	170	290
FICA	21	26	26	26
Total	6,005	6,133	6,343	6,521

The increase from the 1980 budget estimate to the 1980 current estimate is due primarily to the effect of the October 1979 pay increase. The increase in 1981 is due to additional personnel and increased Workman's compensation which is based on billings received from the Department of Labor.

B. Supporting Costs	264	533	530	550
1. Transfer of personnel	96	258	255	255

Provides for continuing recruitment and transfer of personnel essential to KSC's Space Transportation Systems missions. Funds required for the transfer of personnel in 1981 remain level with 1980. The 1981 estimate provides for 57 relocations at an average cost of $4,500 each.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
2. Personnel training	168	275	275	295

These funds provide the means to maintain proficiency in various skills, to provide the necessary training for those employees with technological expertise to keep abreast of the state of the art in their respective fields, and to meet career development and upward mobility needs. The increase in 1981 is due to training vital to the implementation of the Civil Service Reform Act.

II. TRAVEL	2,061	2,368	2,115	2,255
Summary of Fund Requirements				
A. Program Travel	1,060	1,209	1,054	1,177
B. Scientific and Technical Development Travel	13	12	12	12
C. Management and Operations Travel	988	1,147	1,049	1,066
Total, Travel	2,061	2,368	2,115	2,255
Explanation of Fund Requirements				
A. Program Travel	1,060	1,209	1,054	1,177

Program travel is directly related to the accomplishment of KSC's mission and accounts for approximately 52 percent of the Center's travel budget. Program travel has reflected the Center's involvement in the design and manufacturing of Space Shuttle ground system equipment, design and construction of Shuttle facilities, and the activation of systems manufactured at off-site locations.

During 1980 and 1981, our effort will be directed toward the test, checkout, and launch of the First Manned Orbital Flight (FMOF). Travel to Dryden Flight Research Center, the landing site of the Orbital Flight Tests (OFT), will be required. However, the 1980 current estimate is lower than the 1980 budget estimate due to the slip in the launch date for FMOF and the other OFT flights.

The Spacelab hardware delivery schedule calls for the Engineering Model to be delivered in 1980 and the first flight unit in early 1981. Support of this schedule will cause significant travel to Europe in 1980 to participate in combined procedures development and to run subsystems and systems tests of the Engineering Model. Additional travel will be required in the development of operational software to be run on the Engineering Model and the first flight unit. The travel will continue in 1981 to support continuing systems tests on the Engineering Model and the tests that will be performed on the flight unit prior to its delivery to KSC. Also, the operational software development will continue on through the delivery of the flight unit to KSC.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
B. Scientific and Technical Development Travel	13	12	12	12

Scientific and technical development travel permits employees to participate in meetings and technical seminars with other representatives of the aerospace community. This participation allows them to benefit from exposure to technological advances outside KSC, as well as to present both accomplishments and problems to their associates. Many of these meetings are working panels convened to solve certain problems for the benefit of the government. It is planned that 1981 travel will be at the same level as 1980.

C. Management and Operations	988	1,147	1,049	1,066

Management and operations travel is used for the direction and coordination of general management matters. It includes travel in such areas as personnel, financial management, and procurement activities; travel of the Center's top management to NASA Headquarters and other NASA Centers; and local transportation. The decrease from the 1980 budget estimate to the 1980 current estimate reflects a reduction in travel to implement Section 112 of Public Law 96-86. The increases in both 1980 and 1981 from 1979 are due to increased requirements for local travel brought about by the significant increases in on-site population for Shuttle OFT preparations.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
III. FACILITIES SERVICES	26,608	31,421	30,392	34,198

Kennedy Space Center (KSC) is located on 139,305 acres and has a complex of facilities which are made up of test and office buildings, as well as launch operations facilities. This complex encompasses 5,337,276 gross square feet of building space, including 13 major buildings. Also included are 14 major technical facilities. This plant supports an average daily on-center population which has grown to approximately 13,000 personnel. Many of the test facilities are utilized during off-peak hours or on more than one shift. A substantial increase in services is required in 1981 to meet the needs of Shuttle support activities and the increasing on-site population. The budget estimate also reflects the needs of KSC's component installation on Vandenberg Air Force Base (VAFB).

Summary of Fund Requirements

A. Rental of Real Property	1	110	210	140
B. Maintenance and Related Services				
1. Facilities	6,849	6,841	6,738	7,884
2. Equipment	544	847	673	665
Subtotal	7,393	7,688	7,411	8,549
C. Custodial Services	10,257	12,450	12,076	14,494
D. Utility Services	8,957	11,173	10,695	11,015
Total, Facilities Services	26,608	31,421	30,392	34,198

Explanation of Fund Requirements

A. Rental of Real Property	1	110	210	140

This provides for the rental of off-site facilities for news and receptions center activities associated with launches and other major public events. The increase from the 1980 budget estimate to the 1980 current estimate is due to cost escalation; the decrease in 1981 reflects a decline in guest related activities after the first few Space Shuttle flights have been accomplished.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
B. Maintenance and Related Services	7,393	7,688	7,411	8,549
1. Facilities	6,849	6.841	6,738	7,884

This activity involves the operation and maintenance of applicable facilities at KSC, Cape Canaveral Air Force Station (CCAFS), and VAFB. The size, complexity, and wide geographical dispersion of these facilities places heavy demands on facilities services. The decrease from the 1980 budget estimate to the 1980 current estimate is due to the deferral of some facility projects and purchases of supplies and materials. These deferrals are reflected in the growth in 1981 which is due also to increased intra-center moves as KSC prepares for the fully operational mode of Space Shuttle activities.

a. Maintenance and operation of facilities (153 workyears)..... 4,591

This activity includes, in addition to the normal activities associated with facility maintenance or management of direct maintenance personnel, the responsibilities for space utilization, utility rate studies and analysis, as well as corrosion control and cathodic protection activities.

In addition, there are minor facility related services for such items as payment of certification fees for facility maintenance at VAFB, and internal moves of personnel and related plant rearrangements.

b. Grounds maintenance (37 workyears)..... 1,144

This involves the provision of grounds maintenance and related supplies and equipment as well as reimbursement to the Air Force for the maintenance of NASA facilities at CCAFS.

c. Facilities design engineering (28 workyears)..... 836

This effort involves inspecting, siting, and other engineering functions associated with institutional facilities.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		

d. Supplies and facilities equipment..... 604

These funds provide for building materials, hardware, metals, plumbing supplies, electrical materials, and general maintenance and operating materials.

e. Routine facilities work (16 workyears)..... 709

Minor construction, repair, and alteration projects are included in this category.

2. Equipment..... 544 847 673 665

This funding provides for 18 workyears of support contractor effort and related supplies and equipment required for maintenance and repair of heavy equipment items. The decrease from the 1980 budget estimate to the 1980 current estimate is due to reduced equipment purchases consistent with 1979 experience.

C. Custodial Services..... 10,257 12,450 12,076 14,494

The demand for these services will continue to increase, especially for janitorial, fire protection, and security services in 1981 as the Space Shuttle program continues through Orbital Flight Tests (OFT). An increase of 59 workyears from 1979 is reflected in the 1980 current estimate and the estimate for 1981.

1. Janitorial services (117 workyears)..... 2,744

This activity provides janitorial services to some two million square feet of KSC floor areas, including highly specialized services to cleanroom areas.

2. Fire protection services (113 workyears)..... 3,341

This activity will provide for fire protection service for KSC property and personnel, including:

a. Support of increasing hazardous tests and operations and Shuttle Orbiter landings.
b. Performing fire drills and fire inspections of facilities and equipment.
c. Providing fire protection instructions.
d. Fighting fires.

This estimate reflects the full activation of both KSC fire stations for Shuttle operations.

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	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
3. Security services (254 workyears)				6,527

This activity includes the protection of personnel and property at KSC and involves:

a. Support of increasing hazardous tests and operations.
b. Badging of all on-site personnel and official visitors.
c. Safeguarding flight hardware and other items of high intrinsic value arriving for OFT.
d. Protecting classified information.
e. Maintaining area surveillance and traffic control.

4. Other related activities				1,882

These activities are as follows:

a. Janitorial services and security services performed on NASA facilities at CCAFS for which the Air Force is reimbursed.
b. Pest control services for KSC which involves five workyears of support contractor effort.
c. Laundry services at both KSC and VAFB.
d. Provision of supplies and equipment related to custodial services.

D. Utilities Services	8,957	11,173	10,695	11,015

The major utility service at KSC is electrical energy purchased from Florida Power and Light Company through an Air Force contract. Fuel oil is purchased from a local supplier. Steam service is provided by the Air Force at CCAFS. Water services are purchased from the City of Cocoa and sewage treatment is accomplished on-site.

At VAFB, utility services are purchased through the Air Force.

Utility plant operations and maintenance and utility distribution systems maintenance are provided in this activity, which also covers reimbursement to the Air Force for these services. These services involve 71 work-years of support contractor effort. The commodity costs are as follows:

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
1. Electricity (184,100 MWH)				7,076
2. Fuel Oil (2,195,000 gallons)				989
3. Steam (51,700 lbs.)				334
4. Water and Sewage				113
5. VAFB - all utilities				170

The decrease from the 1980 budget estimate to the 1980 current estimate is a reduction in electricity and fuel oil rate estimates and a reduction of ten support contractor workyears, reflecting 1979 experience. The 1981 increase is due to higher utility rates. Contractor workyears are level.

IV. TECHNICAL SERVICES	6,615	6,987	6,617	7,611
Summary of Fund Requirements				
A. Automatic Data Processing				
1. Equipment	731	464	823	878
2. Operations	3,292	3,456	3,453	3,588
Subtotal	4,023	3,920	4,276	4,466
B. Scientific and Technical Information				
1. Library	365	377	374	404
2. Education and Information	1,651	2,311	1,420	2,156
Subtotal	2,016	2,688	1,794	2,560
C. Shop Support and Services	576	379	547	585
Total, Technical Services	6,615	6,987	6,617	7,611

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
A. Automatic Data Processing	4,023	3,920	4,276	4,466

These funds provide for the cost of general management ADP programs including the lease, purchase, and maintenance of ADP equipment and programming and operations services.

1. Equipment	731	464	823	878

The funding shown here provides for the maintenance and lease of KSC's Honeywell 635 and supporting equipment.

The increase from the 1980 budget estimate to the 1980 current estimate is primarily due to the lease of a Honeywell 66-60 dedicated to the Center's computerized supply management system. The increase in 1981 reflects increased costs for the same equipment plus minor amounts for maintenance of the financial management system.

2. Operations	3,292	3,456	3,453	3,588

One hundred and thirty eight support contractor workyears provide programming services for payroll, general accounting, supply reports, procurement, contract reports, technical support information retrieval, preventive maintenance reports of vehicle components and ground support equipment, contract surveillance reports, status reports for the KSC Personnel Office, security reports, and resources and financial management reports.

The 1981 increase is due to wage increases, partially offset by a reduction of eight workyears as programming of the financial management system nears completion.

B. Scientific and Technical Information	2,016	2,688	1,794	2,560

This funding provides for operation of a technical library at KSC and for various technical and administrative documentation services throughout the center, including support to Public Affairs' educational and informational program.

1. Library	365	377	374	404

Sixteen support contractor workyears are required to operate the KSC library facilities. The cost includes technical reports and literature in hard copy and microfiche; scientific, technical, and management books and periodicals; military, federal, and professional society specifications and standards are also included. The contractor also operates a Space Shuttle/Spacelab documents repository which catalogs, classifies, and indexes documents for storage and retrieval; and provides document reference and distribution services. This category also includes supplies used by the contractor. In 1981, the increase is due to wage escalation; workyears are level.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
2. Education and Information	1,651	2,311	1,420	2,156

The funding in this category provides for 75 support contractor workyears to prepare publications pertaining to the receipt, checkout, and launch of space vehicles, Space Shuttle/Spacelab activities, design engineering functions, and the institutional support. Subject matter covers tracking, facility modifications, booster recovery, earth resources, future programs, launch processing, vehicle tests, checkout operations, safety procedures, materials analysis, radiological controls, and contingency plans.

Public Affairs support provides for the gathering and dissemination of information about the agency's programs to the mass communications media, the general public, and to the educational community at the elementary and secondary levels. It also includes photographic support at Vandenberg Air Force Base, which is primarily for public affairs activities.

The decrease from the 1980 budget estimate to the 1980 current estimate reflects an alteration in the phasing of the support contract plan, as well as a reclassification of photographic services to the Shop Support category. The 1981 estimate reflects the full year cost of a ten workyear increase in the support contract which was initiated in 1980 due to Shuttle requirements.

C. Shop Support and Services	576	379	547	585

These funds provide for a support contractor to perform technical support services, such as exercising coordinative control support activities to assure a constant state of readiness to support test/launch operations. It includes disaster and hurricane planning performed on centerwide basis through coordination with the KSC Emergency Preparedness Officer (one workyear), and training of all KSC personnel engaged in hazardous occupations (five workyears).

The increase from the 1980 budget estimate to the 1980 current estimate is due to a reclassification of photographic services from the Education and Information category. The increase in 1981 is due to wage escalation.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
V. MANAGEMENT AND OPERATIONS	18,846	16,871	17,849	20,767
Summary of Fund Requirements				
A. Administrative Communications	2,744	2,359	2,554	2,617
B. Printing and Reproduction	4,376	3,706	3,816	5,002
C. Transportation	2,822	2,735	3,416	4,141
D. Installation Common Services	8,904	8,071	8,063	9,007
Total, Management and Operations	18,846	16,871	17,849	20,767
Explanation of Fund Requirements				
A. Administrative Communications	2,744	2,359	2,554	2,617

These funds provide for the costs of local telephone service, Federal Telecommunications System (FTS), long distance tolls, and teletype services in support of all NASA and contractor personnel located at KSC, Cape Canaveral Air Force Station (CCAFS), and Vandenberg Air Force Base (VAFB). The increase from the 1980 budget estimate to the 1980 current estimate provides for additional services associated with an increased on-site contractor population.

1. Local telephone service	1,779

This category provides for the total KSC population, including contractors, and includes the administrative telephone switchboard, single line telephones for special areas, telephones acoustically coupled for data transmission, and local exchange lines for Brevard and Orange County locations.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
2. Long distance telephone service				812

NASA contractors and other institutions who conduct official business with KSC are widely dispersed throughout the United States. KSC utilizes FTS and other leased lines to minimize costs. Service is provided to authorized users, including on-site contractors. Paid long distance and GSA leased lines are in this category.

3. Other communications services				26

These funds provide specialized services such as teletype and wire news services. In addition, the lease and maintenance of various small electrical/electronic systems such as printers which support major communications systems are included.

B. Printing and Reproduction	4,376	3,706	3,816	5,002

This category includes the printing of test and checkout procedures, launch countdowns, microfilming, engineering drawings, telemetry data, and other related technical and administrative material.

The estimate for administrative printing includes long lead time items such as forms production and minor efforts, such as the KSC house organ, and miscellaneous special requirements for duplicating, photostating, blueprinting, microfilming, and other photographic reproductions. Services are performed by other government agencies or by commercial printing firms under contract to the Government Printing Office (GPO). The 1980 current estimate is higher than the 1980 budget estimate due to an 18 workyear increase in support contractor effort initiated to meet the increasingly heavy demand of Space Shuttle activities. The 1981 estimate reflects the full year cost of this additional effort.

1. Scientific and technical printing (104 workyears)				3,619

This level of support contractor effort is required to print or reproduce an average of 10.8 million units per month. Supplies used by the contractor and replacement equipment are included in this category.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		

2. Administrative printing..... 456

This estimate includes the cost of services provided through the GPO, Patrick Air Force Base, and VAFB.

3. Office copiers..... 927

This provides for office copier service to the total on-site population, civil service and contractor. Copiers are located in central service centers and individual offices where workload justifies assignment. This arrangement has proven to be an economical way of providing the service.

C. Transportation.....	2,822	2,735	3,416	4,141

The center provides a centralized motor pool, operated by GSA, for civil service and support contractor personnel. The movement of supplies and equipment by commercial carrier is included in this area. This category also includes the operation of heavy equipment, and related supplies and materials, and aircraft operations. The increase from the 1980 budget estimate to the 1980 current estimate is due to an increased reliance on transportation capabilities related to supply operations. This shift is reflected in the Installation Common Services category. The increase in 1981 is due to an increase of four support contractor workyears to cover increased supply activity associated with increasing on-site population and Space Shuttle activity, as well as support contract wage escalation.

1. Truck rental..... 2,147

This category provides for 545 cargo-type vehicles.

2. Common carrier and related services (32 workyears)..... 1,329

This effort is required to perform the transportation management functions, which include coordination, check, inspection, document control of all shipments, and delivery of in-bound shipments. The balance of this requirement is supplies used by the support contractor; minor contracts for off-site packing and crating services; landing fees, maintenance and repair, and supplies and equipment associated with the administrative aircraft.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
3. Heavy equipment (11 workyears)				665

This support contractor effort is required to operate KSC-owned heavy equipment such as tractors, cranes, trailers, and trucks. The balance is for supplies.

D. Installation Common Services	8,904	8,071	8,063	9,007

These funds provide for logistics services, mail and distribution services, medical services, Center management and staff activities, and a wide variety of minor contracts for special and one-time services. The decrease of the 1980 current estimate from 1979 reflects an eleven workyear decrease in supply management, which was reclassified as Transportation, and a change in contract phasing plans. The increase in 1981 is due to eleven additional workyears in supply management to support line item growth associated with increasing on-site population, as well as contractor wage increases.

1. Center management and staff functions 186

This category includes tort claims, notary public fees, court reporting costs, patent counsel representation, and equal opportunity activities.

2. Medical services 2,135

Two major types of medical services are provided, occupational medicine and environmental health.

a. Occupational medicine (62 workyears) 1,834

This effort is required to provide emergency and first aid care for the KSC workforce, guests, and tour visitors; health maintenance and counseling for civil service employees; and a variety of physical examinations and special programs for health maintenance, applied research, and job certification for civil service and contractor personnel. The contractor has also been charged with insuring Occupational Safety and Health Administration standards compliance for all KSC elements. The medical program operates on a three-shift basis to provide emergency and ambulance services and special standby service in support of hazardous tests and operations. This category also covers supplies and equipment used by the contractor and a minor contract at VAFB, primarily for physical examinations.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
b. Environmental health (nine workyears)				301

This category includes industrial hygiene, radiological health, and environmental sanitation. This includes water supply and distribution, sewage treatment and disposal, treatment and disposal of industrial wastes, solid waste management and disposal, selection and use of pesticides, and the surveillance of operations producing atmospheric, water, or soil pollution.

3. Installation support services				6,686
a. Supply services (136 workyears)				3,877

This support contractor effort provides a broad range of logistics services including receipt, storage, and issue of supplies and equipment, as well as maintaining various supply management systems.

b. Mail (37 workyears)				1,010

Mail and distribution services, provided by support contract, include distribution of inter-office mail, classified document control, operation of the KSC branch post office, and postage.

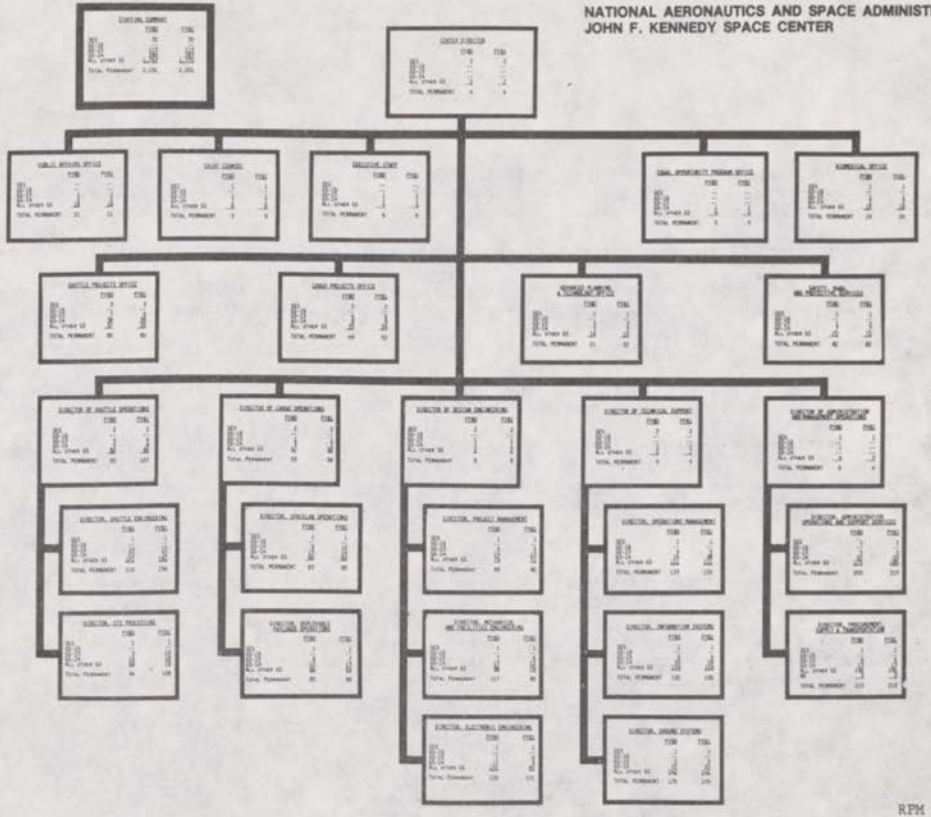
c. Office supplies				1,209

As an economy measure, KSC provides common support to the total on-site population, civil service and contractor. This category includes a wide variety of office supplies and materials.

d. Administrative equipment				590

This category covers lease, maintenance, and purchase of administrative equipment. Rentals are primarily for special purpose office equipment more economical to lease than purchase. Maintenance is provided for all government-owned administrative equipment in active service. Purchases are largely replacements of office machines such as typewriters and calculators.

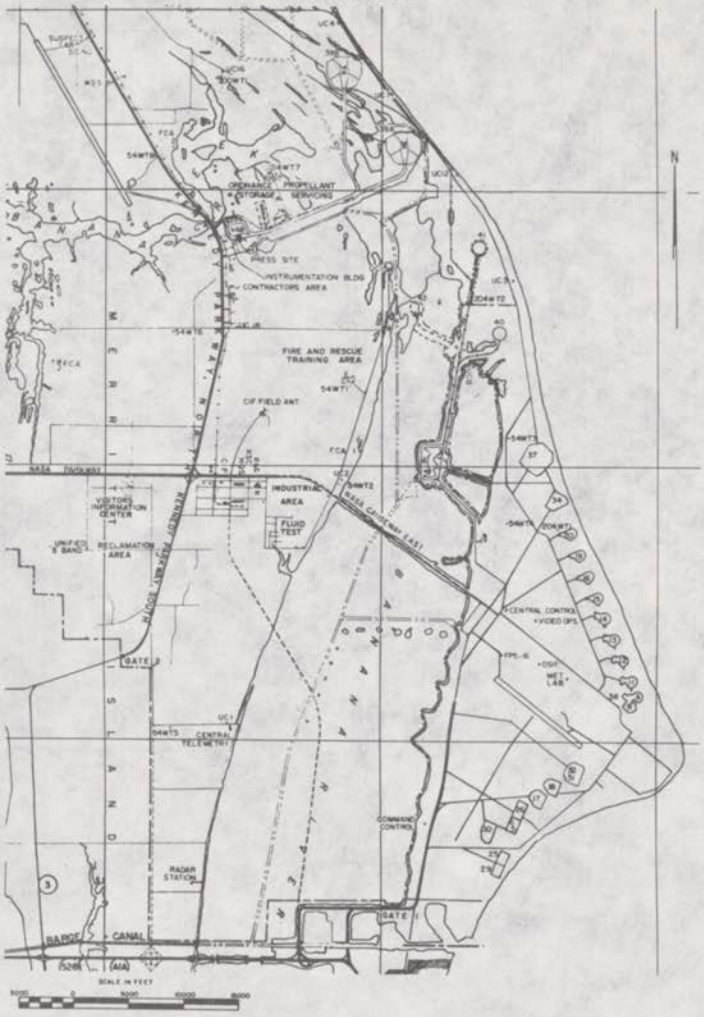
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
JOHN F. KENNEDY SPACE CENTER



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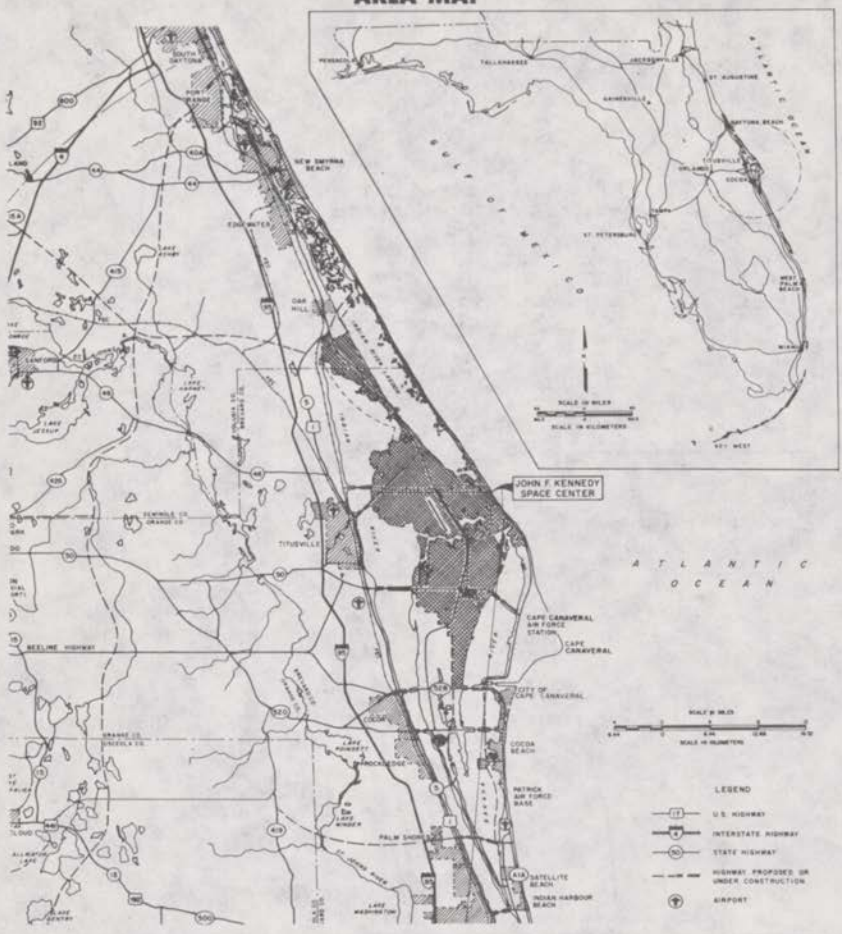
JOHN F. KENNEDY SPACE CENTER, NASA
FISCAL YEAR 1981 ESTIMATES
LOCATION PLAN

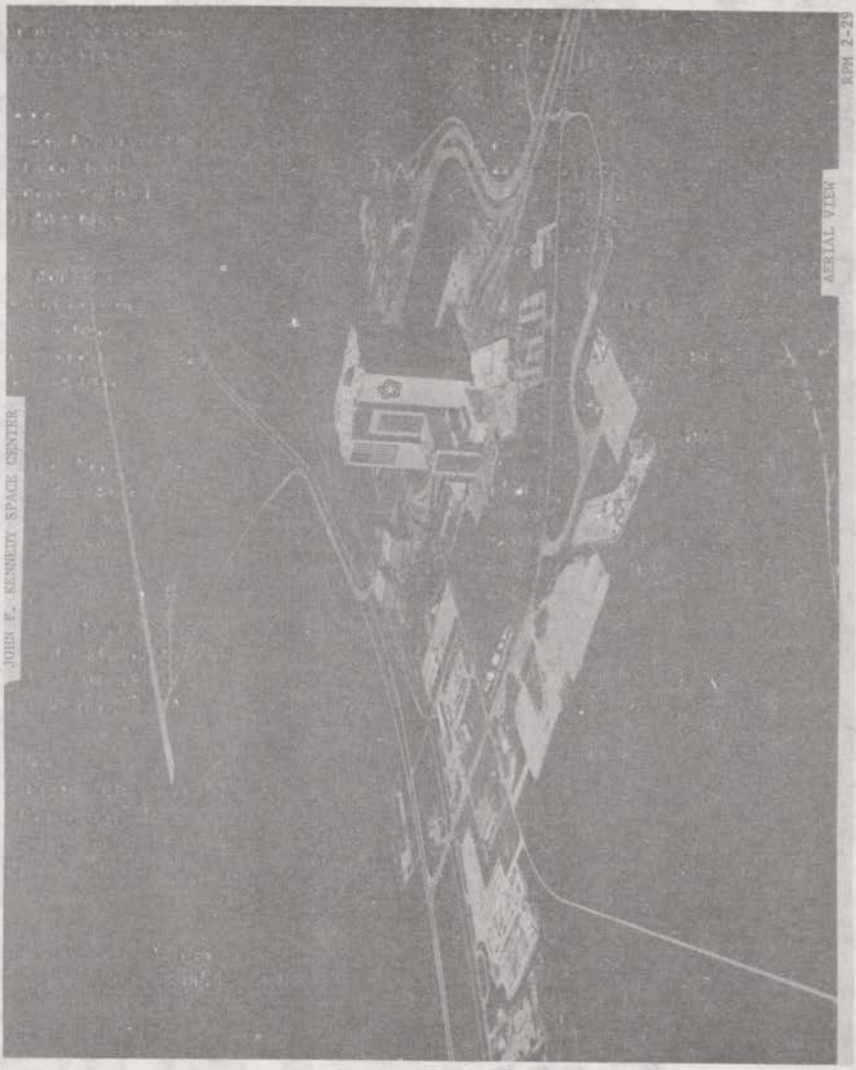
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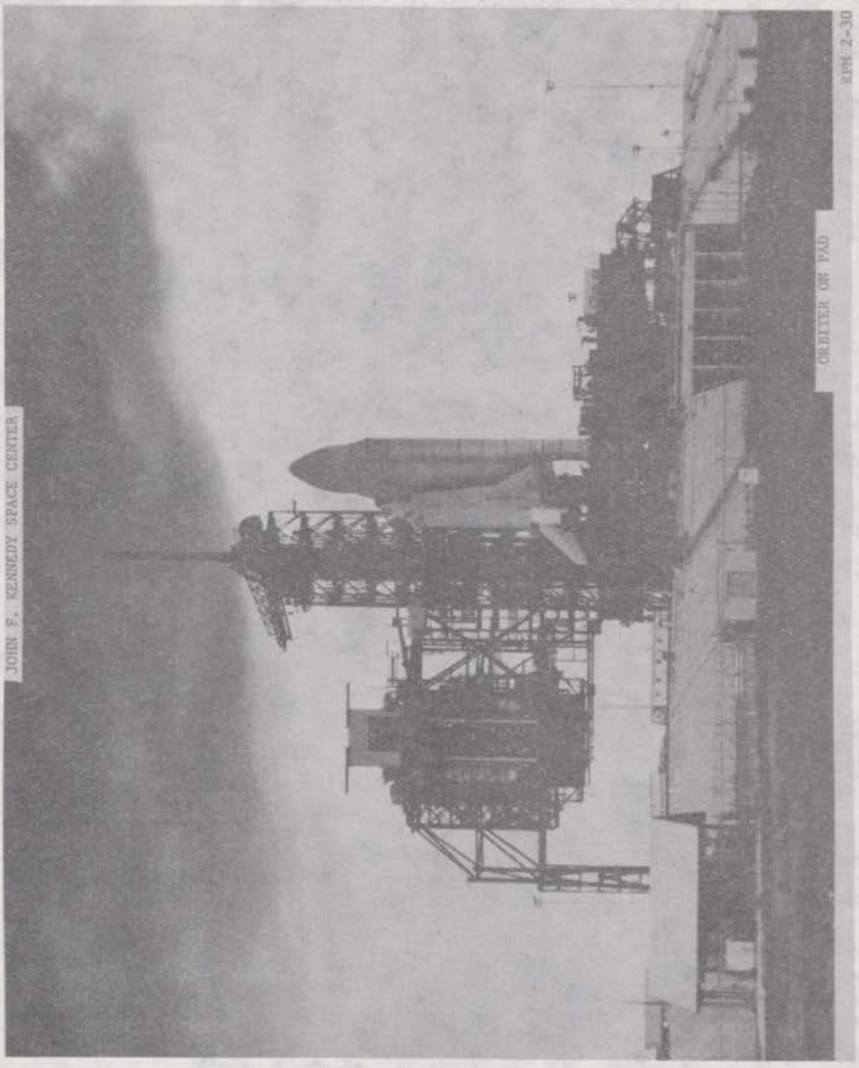


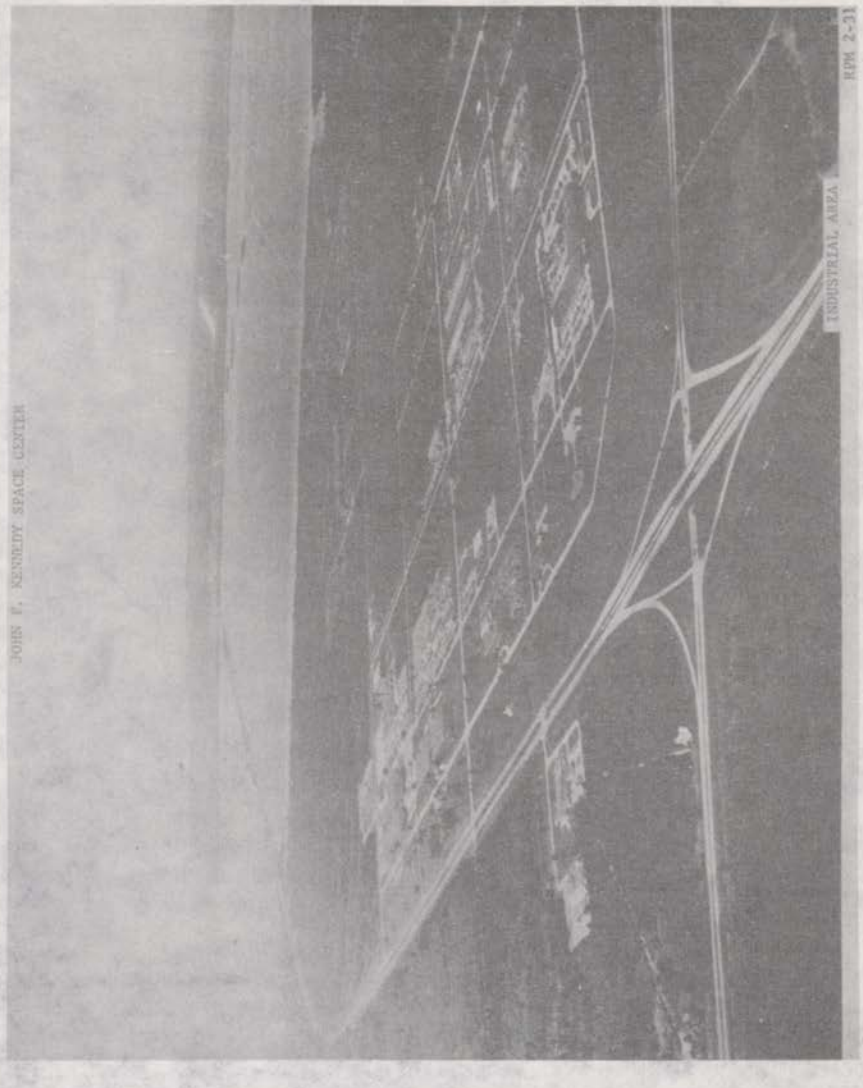
JOHN F. KENNEDY SPACE CENTER, NASA
FISCAL YEAR 1981 ESTIMATES
AREA MAP

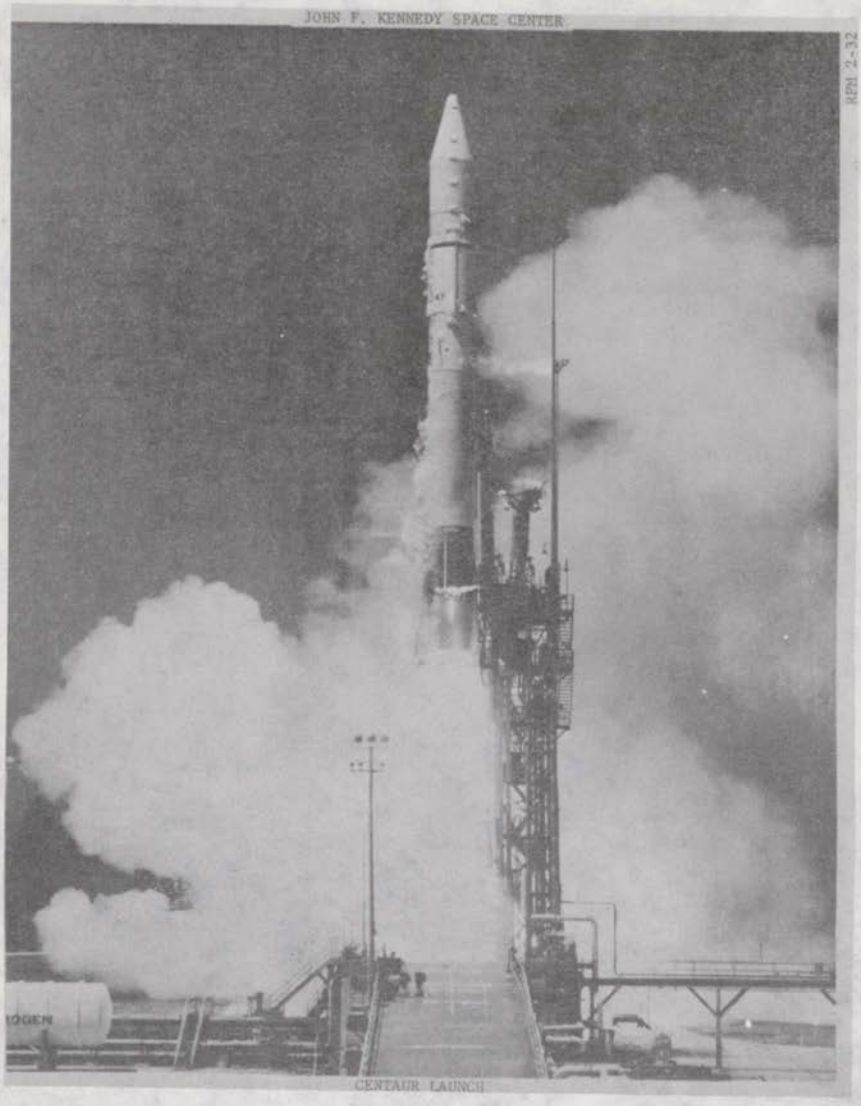
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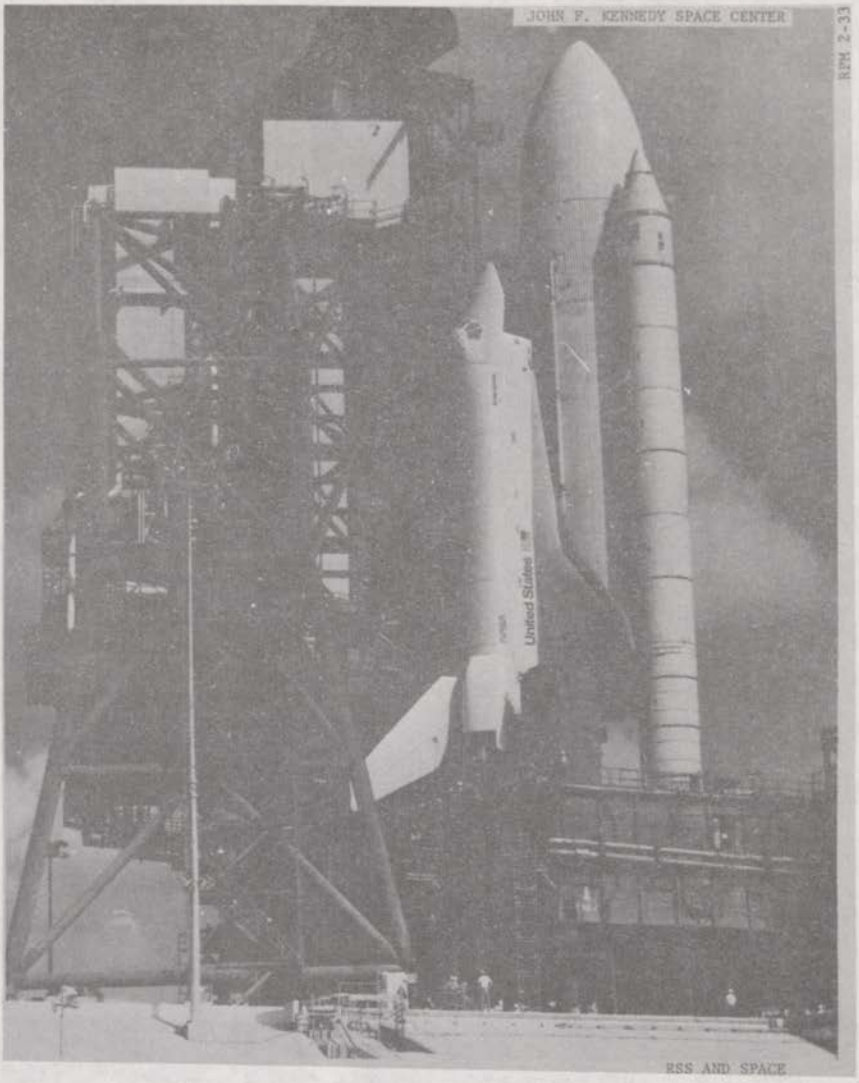



JOHN F. KENNEDY SPACE CENTER
AERIAL VIEW
KSC 2-25


JOHN F. KENNEDY SPACE CENTER
ORBITER ON PAD
KPN 2-30


JOHN F. KENNEDY SPACE CENTER
INDUSTRIAL AREA
KSC 2-31


JOHN F. KENNEDY SPACE CENTER
KSN 2-32
CENTAUR LAUNCH


JOHN F. KENNEDY SPACE CENTER
KPM 2-33
United States
RSS AND SPACE

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GEORGE C. MARSHALL SPACE FLIGHT CENTER

DESCRIPTION

Operations at the Marshall Space Flight Center (MSFC) are conducted at three primary locations:

The principal MSFC site is near Huntsville, Alabama, on Army property at the Redstone Arsenal. The Center occupies 1,841 acres under a nonrevocable use permit from the Army. Certain facilities such as the Redstone Arsenal Air Field and some utilities are used jointly by NASA and the Army. The Huntsville location is connected by deep water access to its component Michoud Assembly Facility via the Tennessee, Ohio, and Mississippi Rivers.

The Michoud Assembly Facility is located 15 miles east of New Orleans, Louisiana, where the External Tank for the Space Shuttle is being produced and where activities for other Federal agencies are conducted. The Michoud Facility occupies 832 acres and provides 3,563,304 gross square feet of space, including the main assembly plant which has an area of 43 acres under one roof. The facility is located on the Gulf Intracoastal Waterway and has deep water access via the Mississippi River.

The Slidell Computer Complex, located at Slidell, Louisiana, 20 miles northeast of the Michoud Assembly Facility occupies 14 acres and provides centralized computer services for MSFC, Michoud, the National Space Technology Laboratories, other NASA Centers, and associated contractors, as well as other Government agencies.

A number of the individual facilities at MSFC and its component installations are unique. The combined capability of the science and engineering laboratories, special development facilities, and test facilities, provide a unique national resource for the designing, developing, and testing of complex space systems. The total capital investment of the Marshall Space Flight Center and its installations in Louisiana, including fixed assets in progress, and contractor-held facilities at various locations as of September 30, 1979, was $738,512,000.

CENTER ROLES AND MISSIONS

The Marshall Space Flight Center serves as one of NASA's primary centers for the design and development of space transportation systems, orbital systems, scientific and applications payloads, and other systems for present and future space exploration. MSFC is the principal center within NASA for rocket propulsion systems; for the design and development of manned vehicle systems; for Spacelab mission management and payload definition; for design and development of large, complex, and specialized automated spacecraft; and development of the space processing activity base. MSFC has a primary role within NASA for the development and processing of science and

applications experiments and for the conduct of energy-related system studies. In addition, MSFC conducts a vigorous research and technology program and is involved in the study and definition of future programs, including significant roles contributing to the development of large, complex space structures, space propulsion systems, materials engineering, materials processing in space, power systems, guidance and control, fundamental electronics, and payload systems analysis and integration.

In addition to onsite activities at Huntsville, Alabama, MSFC manages the Michoud Assembly Facility at New Orleans and the Computer Complex at Slidell, Louisiana. Resident offices are maintained at other centers and in conjunction with major industrial sites in various locations throughout the Nation, and in Europe for the Spacelab program. The principal and supporting roles are:

PRINCIPAL

Propulsion Systems - design, development and procurement of major propulsion-oriented systems and subsystems. Current focus is on space transportation systems, including Space Shuttle main engine, solid rocket booster, external tank; and inertial upper stage in cooperation with the Air Force. Advanced program effort includes the solar electric propulsion systems, the heavy lift launch vehicle, and the orbital transfer vehicle.

Manned Space Vehicle Development - design, development and procurement of manned vehicle systems.

Spacelab - focus is on systems engineering management, development interface with the European Space Agency and procurement.

Advanced Studies - focus is on orbital systems, advanced transportation systems and space power systems.

Advanced Development - technology advances focused on the advanced missions identified above.

Space Transportation System (STS) Sustaining Engineering - provide sustaining engineering for MSFC developed STS hardware.

Spacelab Mission Management and Payload Definition - management of Spacelab missions 1, 2, and 3, and definition and development of combinations of payloads, facilities, experiments and instruments for missions as assigned.

Specialized Automated Spacecraft - design and development of large, complex and/or specialized automated spacecraft as assigned. Current focus is on spacecraft systems and experiment integration for Space Telescope, and spacecraft studies of the Advanced X-Ray Astrophysics Facility and the Gravity Probe-B.

Space Processing - develop space processing discipline base, enlisting user interest in potential applications, and developing and managing space processing experiments.

SUPPORTING

Space Vehicle Structures and Materials - contribute to the development of large, complex space vehicle structures and materials technology base.

Energy Technology - conduct energy-related system studies for reimbursable activity with primary focus on solar heating and cooling and advanced coal extraction technology.

Satellite Power System - conduct definition study activity.

SUMMARY OF RESOURCES REQUIREMENTS

FUNDING PLAN BY FUNCTION

		1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)			
I.	Personnel and Related Costs	119,453	119,961	128,051	127,967
II.	Travel	2,558	2,684	2,604	2,982
III.	Facilities Services	11,443	12,395	11,825	12,881
IV.	Technical Services	6,541	5,588	6,287	6,687
V.	Management and Operations	9,012	8,256	8,832	9,860
	Total, fund requirements	149,007	148,884	157,599	160,377

Distribution of Permanent Positions by Program

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Direct Positions				
Space Transportation Systems	1,873	1,859	1,842	1,878
Space shuttle	1,390	1,171	1,141	985
Space flight operations	483	688	701	893
Space Science	509	476	433	451
Physics and astronomy	509	476	433	451
Space and Terrestrial Applications	390	401	403	328
Space applications	379	390	392	317
Technology utilization	11	11	11	11
Aeronautics and Space Technology	259	214	289	310
Aeronautical research and technology	9	9	7	7
Space research and technology	103	94	119	119
Energy technology	147	111	163	184
Subtotal, direct positions	3,031	2,950	2,967	2,967
Center Management and Operations Support Positions	605	611	594	594
Total, permanent positions	3,636	3,561	3,561	3,561

	Permanent Positions (Civil Service)
SPACE SHUTTLE	985

The major MSFC Shuttle element assignments consist of: (1) the Space Shuttle Main Engine (SSME); (2) the Solid Rocket Booster (SRB); (3) the External Tank (ET); (4) planning, preparing and conducting major Shuttle systems tests; and (5) Shuttle system level analysis, test and integration tasks such as: ascent control and stability analysis; flight predictions; structural dynamic analysis and modeling; systems safety and risk analysis; and test, checkout and launch criteria requirements.

In 1981 the major emphasis will be shifting from development and ground testing to flight testing and design refinement. The Space Transportation System flight test (STS-1) is scheduled in 1980 with three additional STS flights scheduled during 1981. Significant effort will be required to provide flight hardware and to evaluate hardware and system performance for these early flights in preparation for the first operations flight (STS-5). Also, MSFC will be involved in production activities regarding the SSME and spares and equipment.

Some current test activities that will continue in 1981 are: (1) main engine system level testing at the National Space Technology Laboratories (NSTL) and at the Santa Susana Facility to provide full power level (FPL) certification and to demonstrate the engine flight life; (2) SSME Control Simulation Laboratory in the Systems Dynamic Laboratory will continue in operation to assist in flight planning and to investigate system failure modes and anomalies which may occur during orbital flight tests (OFT); and (3) Main Propulsion Test (MPT) program at NSTL will continue and the test facility/capability will be maintained to provide backup support to resolve problems which may occur during OFT. SRB refurbishment design and procedures will be verified during OFT to assure meeting the design reuse goals. The ET weight reduction activities will continue. Refinements in design will be pursued to reduce cost per flight, reduce weight, and improve overall Shuttle system performance. Continuing efforts in configuration management, interface control documentation, logistics, and ground operations will require significant effort. Support will be provided to the Air Force for activation of the Western Test Range.

SPACE FLIGHT OPERATIONS	893

The Space Flight Operations program includes Space Transportation System Operations; Space Transportation System Operations Capability Development; Development, Test and Mission Support; and Advanced Programs. The STS Operations Capability Development activity includes three major areas of effort: Spacelab, STS Upper Stages, and Thrust Augmentation. The Civil Service positions in 1981 are required to carry out the following program activities.

STS Operations

STS Operations is a major element of Space Flight Operations and starts with flight five (STS-5). During 1981 the activities will include the production and acquisition of hardware for operational flights . Typical functions will be production engineering, manufacturing, sustaining engineering, anomaly resolution, logistics and contract monitoring. The Operations phase will derive benefits from the OFT program efforts such as weight reduction and producibility charged to the Shuttle Design, Development, Test and Evaluation (DDT&E) phase. Also included in the Space Transportation System Operations activity is the Inertial Upper Stage flight hardware production for STS operational flights.

Spacelab

The Spacelab Engineering Model and Flight Unit will complete integration and testing in Europe and be delivered to NASA where integration and operational flow process verification will begin. NASA funded hardware and software activity will also be continued. Manufacturing and testing of the Spacelab Transfer Tunnel are scheduled for completion with delivery during 1981. Final assembly and delivery of Spacelab utility kits are also planned. Buildup, test, verification, integration and launch of the first OFT Pallet will occur as will similar activities for the second OFT Pallet. Activities supporting procurement of additional Spacelab flight hardware will be underway with some hardware deliveries scheduled and experiment installation and integration and checkout will be in process for Spacelab Mission-1.

Planned activities include development of system requirements, and interface definition and control, NASA hardware and software development, and preparation for Spacelab ground and flight verification on a schedule consistent with the milestones for Spacelab operational capability development which includes the first two Spacelab flights. The primary objectives of these flights, are to verify the Spacelab system and subsystems performance capabilities, verify Spacelab/Orbiter and Spacelab/experiment interface compatibility and to determine the Spacelab induced environment.

STS Upper Stages (Inertial Upper Stage - IUS)

MSFC is responsible for the IUS definition and control of the NASA and non-DOD requirements and for providing these to the Space and Missile Systems Organization (SAMSO) for incorporation into the IUS system development. In addition, MSFC, participating with SAMSO, will provide the management and technical evaluation of the IUS development contractor's design, development and test efforts to assure that the NASA-unique and non-DOD user requirements are incorporated.

The NASA-unique Inertial Upper Stage (IUS) development activities will continue and include completion of software design, integration and verification; spin motor qualification; vehicle and airborne support equipment detail design; and critical design review. Development of selected performance improvement options will continue. The first NASA two-stage vehicle is scheduled for delivery and launch, and the Twin/Spin production activities will continue for the first planetary mission scheduled in early 1983.

Thrust Augmentation

Study activities will continue to augment the payload capability of the basic Shuttle vehicle. Major activities will include development of detailed impacts of the selected liquid boost module concept and preliminary system design. Thrust Augmentation capability is scheduled to be available in mid-1985.

Advanced Programs

The Advanced Programs effort at MSFC includes the definition and implementation of in-house and contracted systems studies to establish the fundamental planning and decisionmaking data needed for the evaluation of future space program proposals. Major 1981 advanced studies activities include: 25KW Power System, Tether Satellite, Solar Electric Propulsion System (SEPS), fabrication of structural elements in space; studies of improved propulsion systems capable of using different propellants in the same system; continue concept studies of geostationary platforms and materials experimentation carriers/modules; and studies of advanced manipulator systems, remote controls, visual aids and sensory systems to augment the ability of humans to function efficiently in space.

	Permanent Positions (Civil Service)
PHYSICS AND ASTRONOMY	451

The Center provides leadership in the Agency's Space Science program for the High Energy Astronomy Observatory (HEAO), Space Telescope, and Spacelab Payload Missions 1 and 2; and provides supporting research and technology support to identify the new technologies required for future missions.

High Energy Astronomy Observatory (HEAO)

The High Energy Astronomy Observatory (HEAO) program is a series of three, large unmanned observatories developed under the direction of MSFC for performing scientific investigations in high energy astronomy. The principal efforts will be completing the HEAO-3 mission and conducting the HEAO-2 mission operations. Data reduction and analysis of all three missions will also be underway during this period, along with management of the HEAO Guest Investigator program. The extended HEAO program will also be underway, involving analysis of data from the extended HEAO-1 mission, and planning and accomplishment of HEAO-2 and HEAO-3 extension.

Chemical Release Module

The Chemical Release Module (CRM) is a Spacelab Facility which will be used to conduct investigations in atmospheric and space physics. The development contract is scheduled to be awarded in 1980, with the design, development, testing and evaluation being conducted during 1981.

Space Telescope

The objective of the Space Telescope (ST) project is to orbit a high optical quality 2.4-meter telescope system by the Space Shuttle in 1983 for use by the astronomical community in conjunction with NASA. MSFC is the lead center for the management of the Space Telescope project and has overall implementation responsibility to OSS for meeting cost, schedule, and technical performance of the project. MSFC is responsible for directing all NASA and contractors' efforts, for establishing and maintaining effective project management activities, and for preparing and maintaining the detailed technical specifications which will define the requirements for all elements of the project. This includes the technical assessment and evaluation of contracted activities for system engineering, design and development, and assembly and verification. In 1981, fabrication, assembly, and verification testing will proceed on all hardware elements of the ST program. During 1981, the Critical Design Review (CDR) to assure that the detail design is in accordance with the specifications, will be accomplished for the Support Systems Module.

Spacelab Payload Mission Management

MSFC is the lead center for the management and implementation of Spacelab Missions 1, 2, 3, OSTA-2, and Material Processing Pallet Mission, which begins with the definition and recommendation of the payload complement and ends with the dissemination of flight/mission-related data and materials required for experiment analysis and processing. During 1981, MSFC will continue to manage development of the experiment complements of Spacelab Missions 1 and 2. Supporting mission-peculiar hardware and software will be delivered for the Level IV integration of the mission experiments beginning in 1981. During 1981, interfaces will continue to be maintained with the NASA discipline program offices, the Principal Investigators, and appropriate engineering groups to assure that the scientific objectives of the missions are achieved. MSFC will continue to participate in and manage the analysis of the requirements, objectives, characteristics, and constraints of several systems, subsytems, and hardware/software components of the STS, payload carrying equipment and payload components, so as to define and develop requirements for all levels of integration to insure physical, functional, and operational compatibility for all missions.

Research and Analysis

Research and technology activities at MSFC are oriented toward developing technologies required for future science missions. The principal science areas are astrophysics and solar physics. In 1981, study efforts for the Gravity Probe-B (GP-B) and an Advanced X-Ray Astrophysics Facility will be continued.

	Permanent Positions (Civil Service)
SPACE APPLICATIONS.....	317

The civil service complement requested for this line item will be involved in three major space applications assignments: (1) Atmospheric Cloud Physics Laboratory, (2) Materials Processing in Space, and (3) Supporting Research.

Atmospheric Cloud Physics Laboratory

Atmospheric Cloud Physics Laboratory (ACPL), under MSFC's management direction, will be flown first as a partial payload of Spacelab to provide the scientific community a unique multipurpose laboratory facility for conducting experimental atmospheric cloud physics research in a low-gravity environment. During 1981 development testing of the flight unit will be accomplished, payload specialist training will be conducted and the first flight Principal Investigators (PI's) will conduct experiment testing to check out procedures, timelines and experiment-to-laboratory compatibility. Subsequently, hardware update or refurbishment of the flight unit will be accomplished for utilization as a qualification unit and qualification testing will be completed in preparation for delivery to the Kennedy Space Center. Systems engineering and integration will enter a critical phase to assure proper design, engineering, and scientific relationships among the areas of Spacelab-to-ACPL, man-machine constraints, and overall performance capability.

Materials Processing in Space

The Materials Processing in Space program emphasizes the fundamental science and technology of processing materials under conditions that allow detailed examination of the constraints imposed by gravitational forces. These studies are directed towards selected materials and processes which will best identify the limitations due to gravity as well as demonstrate the enhanced control that may be possible by the weightless environment of space. In 1981, the Materials Processing in Space program at MSFC will include four major elements: (1) crystal growth and solidification, (2) containerless processing, (3) fluid and chemical processing, and (4) commercialization studies. Expansion of the program to include a wider base of investigations using existing hardware is being planned for the latter part of the five-year period, 1980-84, based on the outcome of prior research activities. The activities include ground-based research, engineering and scientific analyses, advanced studies, and technical management of definition, design, development, and operation of material processing experiments, apparatus, and payloads.

Supporting Research

Theoretical and experimental research will be done in the area of severe storms and local weather. Efforts will be concentrated on the analysis of applications programs including weather and climate, communications, and earthquake hazards reduction.

	Permanent Positions (Civil Service)
TECHNOLOGY UTILIZATION	11

The Technology Utilization program transfers new knowledge and innovative technology resulting from NASA's Research and Development programs for application in industry, medicine, and public sector areas. MSFC civil service engineering and science personnel provide the primary source of technical skills necessary to accomplish the technology transfer to the public sectors.

	Permanent Positions (Civil Service)
AERONAUTICAL RESEARCH AND TECHNOLOGY	7

The Aeronautical Research and Technology effort is concerned with aircraft operational safety. The major activities in 1981 will be to continue studies of turbulence over the surface of an aircraft wing, to perform gust correlations, to investigate the dissipation of fog, and to continue development of a Clear Air Turbulence (CAT) detection system. Analysis of data from field tests of the CAT detection system will be accomplished in 1981. Atmospheric flow systems will be measured remotely by using infrared lasers.

SPACE RESEARCH AND TECHNOLOGY 119

The major Space Research and Technology discipline efforts at Marshall are in materials, structures, dynamics, high density circuit technology, guidance and control, data processing technology, large solar array technology, electronic systems technology, and cryophysics and propulsion. In 1981, these efforts will focus on developing technology for high performance propulsion power systems and large space systems for the future.

Also in this area is the Standards and Practices program which provides for development of equipment for multimission applications and business practices to effect cost savings and for improvements in current and future space programs. In 1981, civil service personnel will continue to manage the development of those projects selected by the Standard Equipment Review Panels.

Also included in this area is the Shuttle/Spacelab Payloads effort concerned primarily with the Induced Environmental Contamination Monitor (IECM), and Tribological Experiments. All of these areas will have continuing emphasis throughout 1981.

ENERGY TECHNOLOGY 184

MSFC activities include energy studies, development of a guidance and control system for coal extraction, development tasks and commercial and Federal buildings applications tasks in support of the national program for Solar Heating and Cooling.

Energy Studies

Energy from space encompasses definition studies in two areas: satellite power systems and nuclear waste management. Activities in 1981 will include the identification of system/subsystem requirements, development

of conceptual designs and operational scenarios, development and impact of technology requirements, concept evaluations and selections and economic cost model development.

Automated Coal Extraction

The Department of Energy has overall responsibility for developing an automated longwall guidance and control shearer mining system which will improve productivity and enhance health and safety of the miners. MSFC is working with the Department of Energy to develop a prototype automated Longwall Guidance and Control System. Activities will include program and contract management, design, fabrication, test of experimental sensors and controls, data evaluation and system analysis.

Solar Heating and Cooling

MSFC is responsible for supporting three major programs of the overall national program for Solar Heating and Cooling: (1) the "Development in Support of Demonstration program," (2) the "Commercial Demonstration program," and (3) the "Demonstration of Solar Heating and Cooling in Federal Buildings program." The purpose of the Development in Support of Demonstration program is to use present technology and technology emerging from the national research and technology program to bring solar heating and cooling systems and subsystems to the point where they will be tested and ready for use in residential and commercial applications. The Commercial Demonstration Program is organized to encourage the use of solar energy in commercial applications and to recommend and develop new ways to eliminate constraints against wide-spread acceptance. The Federal Building program is designed to stimulate growth and improve the efficiency of the solar industry by demonstrating Federal Government confidence in and support of the industry.

	Permanent Positions (Civil Service)
CENTER MANAGEMENT AND OPERATIONS SUPPORT	594

Center Management and Operations Support is defined as that support or service being provided to all Marshall Space Flight Center organizations which cannot be directly identified to a benefiting program or project. The civil service personnel involved are:

Director and Staff - The Center Director, Deputy Director and immediate staff, e.g., Comptroller, Legal, Patent Counsel, Equal Opportunity, Public Affairs, and Safety.

Management Support - Includes a wide range of activity categorized as management support for programs and functional organizations for the entire Center. Specific functions include resource and budget analysis, program control, contracting and procurement, personnel management, property management, resource control and management information systems and analysis.

Operations Support - This is a broad spectrum of activity that is required to maintain and operate facilities, buildings, and equipment; and to provide the normal housekeeping services and logistics support for the personnel who manage and conduct the affairs of the Center. Specific activities are:

Maintenance and operation of all buildings and facilities
Data processing and computer support
Reliability and quality assurance
Center-wide security and protection
Fire protection
Custodial services
Logistics support including transportation, supplies
Medical care of employees
Photographic and graphic support
Energy management

RESOURCE REQUIREMENTS BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
I. PERSONNEL AND RELATED COSTS	119,453	119,961	128,051	127,967
Summary of Fund Requirements				
A. Compensation and Benefits				
1. Compensation				
a. Permanent positions	105,715	105,945	113,009	112,755
b. Other than full time permanent positions	1,113	1,388	1,364	1,407
c. Reimbursable detailees	83	69	36	33
d. Overtime and other compensation	1,071	870	1,093	1,136
Subtotal, Compensation	107,982	108,272	115,502	115,331

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
2. Benefits	10,893	11,121	11,849	11,900
Subtotal, Compensation and Benefits	118,875	119,393	127,351	127,231
B. Supporting Costs				
1. Transfer of personnel	184	246	246	246
2. Personnel training	394	322	454	490
Subtotal, Supporting Costs	578	568	700	736
Total, Personnel and Related Costs	119,453	119,961	128,051	127,967

Explanation of Fund Requirements

A. Compensation and Benefits	118,875	119,393	127,351	127,231
1. Compensation	107,982	108,272	115,502	115,331
a. Permanent positions	105,715	105,945	113,009	112,755

The funds shown above will support 3,561 permanent positions in 1981. The increase from the 1980 budget estimate to the 1980 current estimate is due primarily to the October 1979 pay increase. The decrease in 1981 from 1980 is due to one less workday and a reduction in workyears offset by a decrease in reimbursable activity.

Basis of Cost for Permanent Positions

In 1981 the cost of permanent positions will be $112,755,000, a decrease of $254,000 over 1980. This decrease is calculated as follows:

Cost of permanent positions in 1980	113,009
Cost increase in 1981	+2,392

Within grade and career advances:		
Full year effect of 1980 actions	+679	
Partial year effect of 1981 actions	+673	
Full year effect of 1980 pay increases	+143	
Decrease in reimbursable activity	+897	
Cost decrease in 1981		-2,646
Turnover savings and abolished positions:		
Full year effect of 1980 actions	-1,744	
Partial year effect of 1981 actions	-515	
One less paid day	-387	
Cost of permanent positions in 1981		112,755

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
b. Other than full-time permanent positions				
1. Cost	1,113	1,388	1,364	1,407
2. Workyears	108	150	160	165

The increase in workyears in the 1980 current estimate and the 1981 estimate reflect the new White House Research Apprenticeships program. The decrease in cost from the 1980 budget estimate to the 1980 current estimate is due to a change in skill mix. The increase of the 1981 estimate is due to the increase in the White House Research Apprenticeships program.

The 1981 estimate includes 165 workyears which will be used to support the following programs:

Distribution of Other Than Full-Time Permanent Workyears

Program	Workyears
Cooperative training	64
Summer employment	24
Opportunity programs	56
Other temporary employment	21
Total	165

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
c. Reimbursable detailees	83	69	36	33

Reimbursable detailees have been assigned to NASA from DOD to support the Center in the field of solid rocket motors and in the use of the Neutral Buoyancy Simulator. The simulator is used in the development of operational procedures and the evaluation of design concepts to assure flight hardware will function in space (effort supports development, design, instrumentation, and engineering techniques for Spacelab Transfer Tunnel, STS Power Module, Shuttle Payload Bay and Solar Array Systems). This effort provides mutual benefits to NASA and DOD by providing NASA with special talents and by keeping DOD personnel current on manned space flight technology. The decreased cost in 1980 from the budget estimate to current estimate is due to the release of four Navy divers supporting the Neutral Buoyancy Simulator activity. Only a minimum level of support will be required in 1981 as continuing requirements will be supported by trained NASA divers.

d. Overtime and other compensation	1,071	870	1,093	1,136

The 1980 current estimate has increased from the 1980 budget estimate due to the effect of the October 1979 pay increase, increased overtime due to reduced civil service manpower levels, and a continuation of the Spacelab resident office personnel in support of the European Space Agency.

2. Benefits	10,893	11,121	11,849	11,900
The distribution of these costs by major categories is as follows:				
Civil Service Retirement Fund	7,397	7,361	7,903	7,876
Employee life insurance	334	476	497	493
Employee health insurance	2,093	2,158	2,246	2,243
Workman's compensation	1,032	1,075	1,059	1,191
FICA	36	51	51	51
Severance pay	1	---	93	46
Total	10,893	11,121	11,849	11,900

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The increases in 1980 are primarily due to the October 1979 pay increase. The 1981 increases are due to reduced reimbursable activity offset by one less paid day. Workman's compensation costs are based on the Department of Labor billings for 1980 and 1981.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
B. Supporting Costs	578	568	700	736
1. Transfer of personnel	184	246	246	246

The estimated costs provide for certain relocation costs, such as the expenses of selling and buying a home and the movement of household goods.

2. Personnel training	394	322	454	490

The purpose of the MSFC training program is to continue the development of skills and knowledge of civil service employees in order to more efficiently support MSFC's roles and missions. The benefits to be derived by NASA, from the training and educational programs conducted at MSFC, include: enhancement of scientific and engineering leadership in the scientific community; maintenance of a high degree of professional competency within the administrative and clerical work force; development of needed skills and knowledge required in MSFC mission activities; and extending MSFC work force capability and increasing productivity. The increase in the 1980 current estimate over the 1980 budget estimate reflects the operating level necessary to support on-going programs and the training requirements for the implementation of the Civil Service Reform Act. The 1981 estimate assumes a training program at approximately the 1980 level.

II. TRAVEL	2,558	2,684	2,604	2,982
Summary of Fund Requirements				
A. Program Travel	2,390	2,463	2,407	2,768
B. Scientific and Technical Development Travel	40	28	32	35
C. Management and Operations Travel	128	193	165	179
Total, Travel	2,558	2,684	2,604	2,982

Explanation of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
A. Program Travel	2,390	2,463	2,407	2,768

Program travel is directly related to the accomplishment of the Center's mission and is approximately 93 percent of the total MSFC travel. Travel requirements are for on-going programs such as the Space Shuttle Main Engine, External Tank and Solid Rocket Booster, STS Operations, Spacelab, Inertial Upper Stage, Space Telescope, Space Science and Applications Payloads and basic and supporting research and technology. Travel for Spacelab, Spacelab Payloads, and Space Telescope will require both domestic and European travel. The decrease from the 1980 budget estimate to the 1980 current estimate reflects a reduction in travel to implement Section 112 of Public Law 96-86. The increase in 1981 is required to support program milestones.

B. Scientific and Technical Development Travel	40	28	32	35

Scientific and technical development travel permits employees to participate in meetings and technical seminars with representatives of the aerospace community. This participation allows them to benefit from exposure to technological advances outside MSFC, as well as to present both accomplishments and problems to their associates. Many of the meetings are working panels convened to solve problems for the benefit of the Government.

C. Management and Operations Travel	128	193	165	179

Management and operations travel is required for the direction and coordination of general management matters. It includes travel by managers in such areas as personnel, financial management, and procurement activities and travel of the Center's top management to NASA Headquarters, other NASA Centers, and local transportation. The decrease from 1980 budget estimate to the 1980 current estimate reflects a reduction in travel to implement Section 112 of Public Law 96-86. The 1981 estimate reflects essentially the same level of travel activity as in 1980.

III. FACILITIES SERVICES	11,443	12,395	11,825	12,881

The Marshall Space Flight Center (MSFC) occupies 1,841 acres under Department of the Army permit in a complex of science and engineering laboratories and special development and test facilities.

The complex encompasses 3,654,923 gross square feet of building space including 18 major buildings. Also included are 17 major technical facilities. This physical plant houses an average daily on-Center population of approximately 4,500 personnel. Many of the test facilities are utilized on more than one shift or during off-peak hours.

Summary of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
A. Maintenance and Related Services				
1. Facilities	2,480	2,190	2,271	2,827
2. Equipment	320	182	368	394
Subtotal	2,800	2,372	2,639	3,221
B. Custodial Services	2,702	3,077	2,418	3,119
C. Utilities Services	5,941	6,946	6,768	6,541
Total, Facilities Services	11,443	12,395	11,825	12,881

Explanation of Fund Requirements

A. Maintenance and Related Services	2,800	2,372	2,639	3,221
1. Facilities	2,480	2,190	2,271	2,827

This activity involves a total of 237 facilities (buildings, structures, and trailers) with 3.7 million square feet of floor area. Also involved are 1,841 acres of land area, one million square yards of surfaced area, and several special structures and systems. The funding for 1981 reflects requirements for repair and alteration projects, such as relocating shop areas to reduce heating requirements, installing a two and one-half ton Rankin Solar System to reduce energy requirements, and interior painting which were deferred from 1980.

a. Maintenance of buildings and grounds 2,421

The estimate includes 41 workyears of support contractor effort for maintenance and reimbursements to the Army (Redstone Arsenal) for facility maintenance and related services for such items as electrical distribution lines, arterial roads, grounds related to MSFC, and use of Army facilities.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		

b. Supplies and materials..... 406

This estimate provides for the acquisition of building materials, electrical materials, electronic materials, general maintenance materials, general operating materials, general service materials, metals, guages, pipes, valves, and fittings.

2. Equipment 320 182 368 394

This activity includes 13 workyears of support contractor effort and involves maintenance and repair of over 3,900 items of equipment at MSFC. The 1980 budget estimate was optimistic and planned for a reduction in support contractor effort. Based on 1979 experience and aging inventory of equipment requiring increased maintenance, the 1980 current estimate reflects the 1979 level plus three additional workyears necessary to support minimum essential requirements. The 1981 increase assumes the same level of support activity.

B. Custodial Services 2,702 3,077 2,418 3,119

Custodial services includes janitorial services, security services, fire protection, trash removal, sanitary landfill operations, pest control activities, and related supplies and materials. The decrease in 1980 current estimate from the 1980 budget estimate reflects some rephasing of support contract funding plans as well as a lower level of support contractor efforts and associated materials. The 1981 estimate reflects full funding of essentially the same level of services as in 1980.

1. Janitorial services 1,559

This activity provides service to about three million square feet of facility space and trash removal from approximately 125 separate locations. Work is performed principally through a support contractor with a level of effort of 106 workyears.

2. Security and fire protection..... 1,532

Services are provided by a support contractor with a level of effort of 38 workyears and through the Army (Redstone Arsenal). Included are 24-hour security coverage of MSFC property, law enforcement, motor vehicle control and registration, as well as fire protection.

3. Minor requirements 28

Services are related to landfill operations and "as needed" pest control.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
C. Utilities Services	5,941	6,946	6,768	6,541

The Army (Redstone Arsenal) provides electricity, steam, water, and sewage disposal services to MSFC on a reimbursable basis, and the estimates, therefore, are included in this activity. Also provides for propane and burner fuel for generating steam for environmental heating and cooling. The decrease in the 1980 current estimate and 1981 provides for increased utility rates offset by reduced consumption. The cost of purchased commodities is shown in the following table:

1. Electricity (109,000 mW/Hrs.)	4,125
2. Propane (12,000 gals.)	5
3. Fuel oil (544,000 gals.)	260
4. Steam (219,400 K/lbs.)	1,525
5. Water and sewage	605

IV. TECHNICAL SERVICES	6,541'	5,588	6,287	6,687
Summary of Fund Requirements				
A. Automatic Data Processing				
1. Equipment	884	812	852	912
2. Operations	3,371	2,706	3,143	3,275
Subtotal	4,255	3,518	3,995	4,187
B. Scientific and Technical Information				
1. Library	722	720	770	822
2. Education and Information	121	142	142	155
Subtotal	843	862	912	977

		1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
			(Thousands of Dollars)		
C.	Shop Support and Services	1,443	1,208	1,380	1,523
	Total, Technical Services	6,541	5,588	6,287	6,687

Explanation of Fund Requirements

A.	Automatic Data Processing	4,255	3,518	3,995	4,187

Provides centralized systems analysis, programming, operations, and related computational services to meet the management and administrative computing requirements. Also includes maintenance of ADP equipment and related supplies and materials. Included are 133 workyears of support contractor effort.

1.	Equipment	884	812	852	912

Maintenance is provided under separate contracts for central site computers and associated equipment. Equipment maintained includes two large Univac 1108 systems, CalComp Disc secondary storage system for the Univac 1108 system, and a key-to-disc which collects, controls, organizes, and edits raw data for input into the Univac 1108 system. The increase from the 1980 budget estimate to the 1980 current estimate is based on actual maintenance cost experience since the 1980 budget estimate was submitted. These contractual services are being maintained at approximately the current level of effort in 1981.

2.	Operations	3,371	2,706	3,143	3,275

This function provides for the development and utilization of computer techniques and systems programming of all digital computers and associated equipment at MSFC. The computer systems include the two large Univac 1108 systems, seven Univac 9300 Remote Job Entry terminals, one IBM 1401, and two FR-80 Electronic plotters. Also included is associated auxiliary support equipment such as film processors, Xerox microfiche printers, Xerox forms copiers, and punch card accounting machines (PCAM). Also included are the operation of two large magnetic tape libraries containing a combined total of 60,000 reels; receipt, control, and distribution of program and data processing products; and testing and cleaning of magnetic tapes.

Also included in the operation costs are program design and development, and development of data base management, configuration management, and accounting software systems. Support is also provided for developing engineering drawings and parts management systems. The increased cost from the 1980 budget estimate to the 1980 current estimate is due to renegotiated labor rates.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
B. Scientific and Technical Information	843	862	912	977

This activity provides for the operation of the Redstone Scientific Information Center library at MSFC and support to the Center in various scientific and technical information services.

1. Library	722	720	770	822

Scientific information and library services are provided to MSFC employees and associated contractor personnel through the Redstone Scientific Information Center (RSIC) operations. The RSIC contains a central collection of 234,000 books and journals, 3,000 periodicals, 1,000,000 documents on microfilm and 400,000 technical papers. Operation of the RSIC by the Army is under direction of a joint MSFC/Army Redstone Scientific Information Board with costs shared. The 1981 costs reflect the 1980 current level of effort.

2. Education and information	121	142	142	155

The funds provide for the preparation of reproducible pages for publication of technical manuscripts and related documents. The annual volume of work under this contract is an estimated 12 thousand manuscript pages. Also included is MSFC's share of the operation of the MSFC Visitor Information Center located at the Alabama Space and Rocket Center. The increase from the 1980 current estimate to the 1981 budget estimate is due to increased costs of technical publication services.

C. Shop Support and Service	1,443	1,208	1,380	1,523

Forty-one workyears of support contractor effort provide the Center with support in the areas of graphics, models and design, construction, and management of exhibits. Related supplies, materials, and equipment are also included in this activity. Graphic materials are prepared for use in such presentations as senior management meetings. The increase from the 1980 budget estimate to the 1980 current estimate is due to a higher level of program activity than planned. The increase in the 1981 estimate is due primarily to an increase in support contractor effort and increased cost of supplies and materials.

1. Instrumentation support	24

This category provides funds for gauge calibration services work procured from the Army (Redstone Arsenal). Included are microwave, radio frequency, and optical and acoustic instrumentation calibration.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		

2. Photographic services..... 460

Consists of procurement of off-site commercial still photographic and motion picture production services. Also includes operation of the film library. Still photographic services include printing and processing of color and black and white prints, slides, vugraphs, and copy camera photography. Motion picture production services include script writing, film editing, sound recording, and printing and processing of sound motion pictures. Approximately 138,000 still photo units and 240,000 feet of motion picture service are required annually.

3. Graphics..... 1,039

Forty-one workyears of support contractor effort is required for the preparation of charts, graphs, vugraphs and similar visuals for administrative and operational requirements are included in this activity. Approximately 35,000 work units are completed annually. Also includes the design, construction, and management of exhibits in connection with MSFC's Public Affairs activity.

V. MANAGEMENT AND OPERATIONS.....	9,012	8,256	8,832	9,860
Summary of Fund Requirements				
A. Administrative Communications.....	2,639	2,603	2,912	3,131
B. Printing and Reproduction.....	559	487	584	615
C. Transportation.....	2,639	2,325	2,114	2,638
D. Installation Common Services.....	3,175	2,841	3,222	3,476
Total, Management and Operations.....	9,012	8,256	8,832	9,860

Explanation of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
A. Administrative Communications	2,639	2,603	2,912	3,131

Communications support for MSFC, which includes 27 workyears of support contractor effort, consists of local telephone service, long distance telephone service, and various kinds of other nontelephone communications. Costs in local telephone service in 1979 were higher than anticipated due to large rate increases and these increases are reflected in the 1980 current estimate. The increase in 1981 is primarily for the Federal Telecommunications Service (FTS) telephone network.

1. Local telephone service..... 1,607

The MSFC Central Exchange provides instruments and lines at the Center for local telephone service. The increase in 1981 is for escalation of telephone rates and support contractor wage rate increases.

2. Long distance telephone service..... 1,072

Provides for MSFC use of the GSA operated long distance (FTS) telephone network. Costs result from a formula which is based primarily on the number of calls made two years in the past and the number of circuits used by the Center. Included are such items as long distance commercial tolls and the Autodin network for ordering supplies and materials and sending and receiving classified information. Also included are the costs of leased lines for the teleconferencing network and two workyears of support contractor effort

3. Other communication services..... 452

These funds provide for use of Weeden Mountain radio transmission facilities, support of the Emergency Warning System, and operation of MSFC's Fire Surveillance System. Also provided are payments for entry into the GSA teletype system for Government subscribers, entry into the Western Union teletype system for commercial subscribers, and overseas telegrams and cable system upkeep. Seven workyears of contractor effort are required to support these activities and the administration and management of telecommunication services.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
B. Printing and Reproduction	559	487	584	615

A portion of MSFC's printing/reproduction requirements are met by an on-site reproduction plant operated by MSFC personnel. This reproduction plant produces approximately 18,000,000 units of reproduction work each year. In addition to the on-site reproduction plant, MSFC must also purchase from the Government Printing Office (GPO), Army, and private firms about 33,000,000 units of printing each year. This purchased printing is either an overflow requirement that cannot be handled within the on-site workload, or is such a type that cannot be handled with the limited capability of the on-site equipment. Included in the cost of printing and reproduction are four support contractor workyears of effort. The increase from the 1980 budget estimate to the 1980 current estimate is due to the continued high level of program activity requiring reproduction support from GPO. Increases in 1981 allow for increases in labor and materials consistent with the 1980 level of effort.

C. Transportation	2,639	2,325	2,114	2,638

Transportation functions at MSFC include 56 workyears of support contractor effort for operation and maintenance of vehicles and aircraft, transportation related supplies and materials, purchase of transportation equipment, and transportation of things. Included in this category is the maintenance of 334 general purpose vehicles, 318 pieces of material handling equipment, 106 general and special purpose trailers and vehicles, 290 pieces of equipment such as "A" frame cranes, "H" frame cranes, cranes, tractors, generators, and welders; intermediate inspections at 6,000 miles or six months; and major inspections at 12,000 miles or twelve months. Freight charges for shipment by both surface and air transportation of materials and equipment are also included. The decrease from 1980 budget estimate to the 1980 current estimate is due to reduced requirements for transportation of things and a decrease in purchase of motor vehicles and equipment. The increase from the 1980 current estimate to the 1980 estimate is due to an increase in cost of material and equipment for maintenance and support contractors.

D. Installation Common Services	3,175	2,841	3,222	3,476

This category includes 63 workyears of support contractor effort and provides support to Center Management and staff activities, medical services, and various other installation support services. The increase from the 1980 budget estimate to the current estimate is due primarily to increased logistics support effort which is required by increased program hardware activity. The 1981 estimate is level with the 1980 effort.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		

1. Center management and staff functions..... 31

Includes Patent Counsel Services, Tort Claims, and Equal Opportunity activities.

2. Medical services..... 787

Provides occupational medicine and environmental health services totaling 18 workyears of support contractor effort for the maintenance and improvement of employee health at MSFC, with emphasis on prevention, diagnosis, treatment, and care of illnesses and injuries caused or aggravated by the work environment.

3. Installation support services..... 2,658

Maintenance and repair of office equipment, equipment rental, acquisition of supplies and materials and miscellaneous services are included in this activity

a. Maintenance and repair of equipment..... 515

Maintenance and repair of office equipment includes the maintenance and repair services for office machines and equipment (i.e., typewriters, calculators, time stamp equipment); maintenance and repair services for photographic and reproduction equipment (i.e., enlargers, cameras, exposure controls print copiers, projectors, power supplies, tape recorders, stroboflash, film viewer, motion analyzer, copiers, copy camera, processor camera, super diazo).

b. Rental of equipment..... 205

Rental of equipment such as Xerox machines at the resident office at Canoga Park, California and Visual Search Microfilm Files located at MSFC, and other reproduction equipment are included in this category.

c. Supplies, materials, and equipment..... 503

Acquisition of primarily office type supplies and equipment.

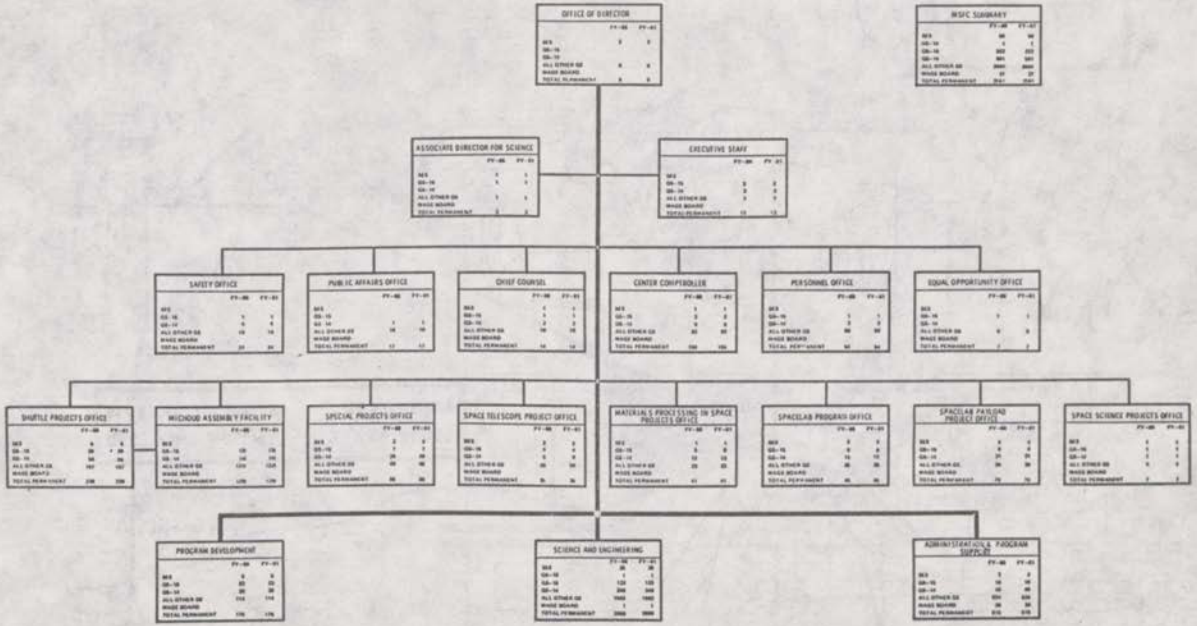
1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)		

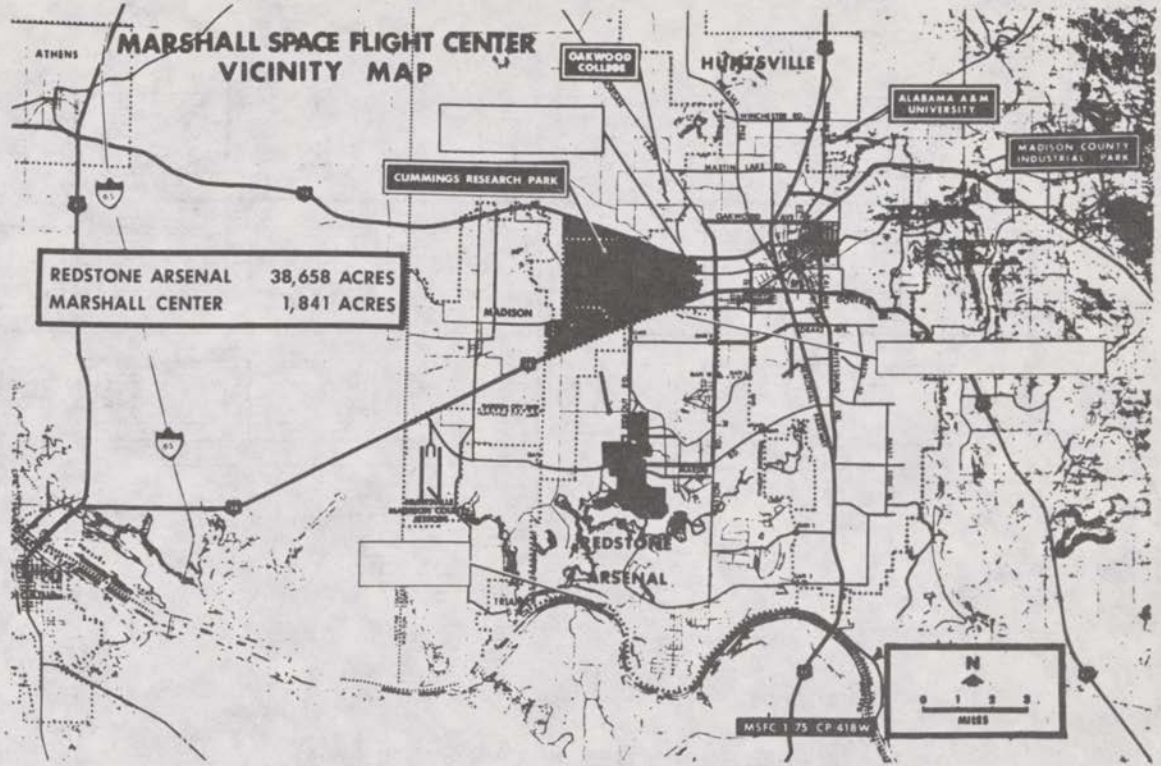
d. Miscellaneous services..... 1,435

Provides services required in support of the property management function in the areas of: (1) receiving supplies, materials, and equipment; (2) distributing supplies, materials, equipment, and program-critical hardware; (3) preparing supplies, materials, and equipment for shipment to include packing and crating and constructing required shipping containers according to government-provided specifications; and (4) warehousing of raw materials.

Also provided are such services as the disposal of toxic wastes; inspection of hazardous cargo prior to entry to Redstone Arsenal; receipt, storage, and issue services for hazardous compounds such as explosives, pyrotechnics and solid rocket motors; minor services such as laundry, furniture repair, potassium cyanide disposal, postage, Patent Counsel, tort claims, Equal Opportunity Office; miscellaneous troop service charges, for military detailees assigned to MSFC and imposed by the U.S. Army on Redstone Arsenal; and acquisition of supplies and materials.

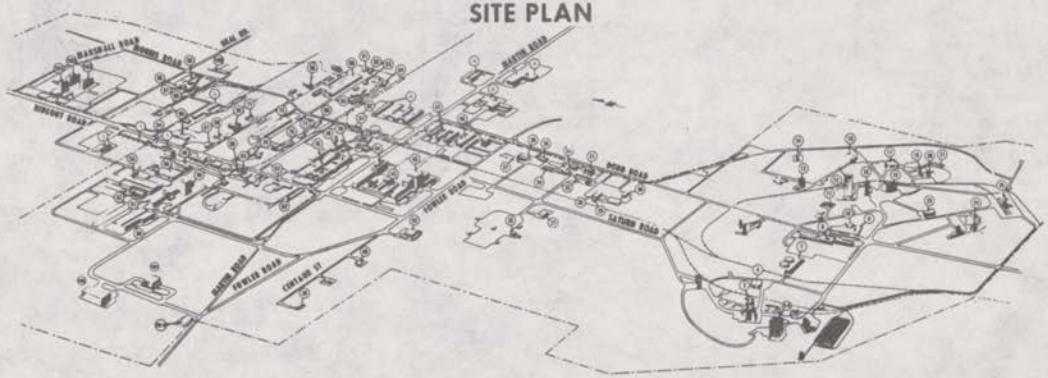
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER




MARSHALL SPACE FLIGHT CENTER
VICINITY MAP
ATHENS
OAKWOOD COLLEGE
HUNTSVILLE
ALABAMA A&M UNIVERSITY
MADISON COUNTY INDUSTRIAL PARK
CUMMINGS RESEARCH PARK
REDSTONE ARSENAL 38,658 ACRES
MARSHALL CENTER 1,841 ACRES
MADISON
REDSTONE ARSENAL
N
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MILES
MSFC 1 75 CP 418W

MARSHALL SPACE FLIGHT CENTER

SITE PLAN



HEADQUARTERS AREA

95	4208	COMMUNICATIONS FACILITY
96	4241	SHOP AND STORAGE BUILDING
97	S-4244	STORAGE BUILDING
98	S-4251	EQUIPMENT SHED
99	4250	OFFICE AND SHOP BUILDING
100	4249	OFFICE BUILDING
101	4200	OFFICE BUILDING
102	4202	OFFICE BUILDING
103	4201	OFFICE BUILDING

LAB AND SUPPORT AREA

38	4629	CRYOGENIC TESTING FACILITY
40	4623	LABORATORY BUILDING
42	4625	NON-DESTRUCTIVE EVALUATION LABORATORY
43	4622	MATERIALS LABORATORY
44	4610	OFFICE AND ENGINEERING BUILDING
45	4619	STRUCTURES AND MECHANICS LABORATORY
46	4650	SHOP AND CALIBRATION LABORATORY
47	4663	COMPUTER FACILITY
49	4640	WATER POLLUTION CONTROL FACILITY
50	4708	ENGINEERING AND DEVELOPMENT LABORATORY
51	4760	SURFACE TREATMENT FACILITY
52	S-4708	NEUTRAL BUOYANCY FACILITY
53	4718	FABRICATION AND MACHINE SHOP
53A	4715	HIGH REYNOLDS FACILITY
53B	4667	CELESTIAL & OPTICAL SENSORS FACILITY
54	4723	TRAINING FACILITY
55	4713	DEVELOPMENTAL PROCESSES LABORATORY
56	4712	OFFICE BUILDING
59	4737	SHOP AND ASSEMBLY BUILDING
62	S-4740	AIR COMPRESSOR BUILDING
63	4746	CALIBRATION LABORATORY
65	4732	BISONIC WIND TUNNEL FACILITY
66	4733	IMPULSE BASE FLOW FACILITY
67	4706	OFFICE BUILDING
68	4512	OFFICE BUILDING
70	4513	SHOP BUILDING
71	4532	ENVIRONMENTAL TEST LABORATORY
73	4601	STORAGE AND OFFICE BUILDING
74	4685	OFFICE BUILDING
75	4691	OFFICE AND LABORATORY BUILDING
76	4687	LABORATORY AND OFFICE BUILDING
77	S-4679	STORAGE SHED
78	4676	ENVIRONMENTAL TEST FACILITY
79	S-4696	AUTOMATION CHECKOUT BUILDING
80	4690	ELECTRICAL SYSTEMS LABORATORY BUILDING
81	4675	HAZARDOUS OPERATIONS LABORATORY
82	4693	SHOP AND STORAGE BUILDING
83	4683	VEHICLE MAINTENANCE SHOP
86	4753	PHOTO LAB
90	4681	SPACE SCIENCES LABORATORY
91	S-4698	STORAGE BUILDING
92	S-4699	STORAGE BUILDING
93	4682	TRANSPORTATION SUPPORT BUILDING
94	4694	CENTER ACTIVITIES BUILDING
104	4752	MULTIPURPOSE HIGH BAY FACILITY
105	4755	HIGH BAY ASSEMBLY FACILITY

TEST AREA

WEST AREA

2	4670	PROPULSION & STRUCTURAL TEST FACILITY
4	4674	BLOCKHOUSE
7	4667	PUMP HOUSE
8	4666	OFFICE BUILDING
8A	4699	STRUCTURAL TEST FACILITY

EAST AREA

9	4566	DOCUMENTATION REPOSITORY
10	4567	PUMP AND BOILER HOUSE
11	S-4549	DEIONIZED WATER PLANT
12	4550	STRUCTURAL TEST FACILITY
13	4522	PROPULSION SYSTEMS COMPONENT TEST STAND
14	4530	PROPULSION SYSTEMS COMPONENT TEST STAND
15	4561	SHOP AND LABORATORY BUILDING
16	4557	STRUCTURAL TEST FACILITY
17	4583	TEST AND DATA RECORDING FACILITY
18	4548	PROPULSION SYSTEMS COMPONENT TEST FACILITY
19	S-4539	TEST STAND SUPPORT BUILDING
20	4540	MODEL PROPULSION SYSTEMS TEST STAND (ACOUSTICS)
21	4541	TEST STAND CONTROL BUILDING
22	4570	BLOCKHOUSE AND CABLE TUNNELS
24	4534	PROPULSION SYSTEMS TEST STAND
25	4572	PROPULSION AND STRUCTURAL TEST FACILITY

TEST SUPPORT AREA

26	4646	OFFICE BUILDING
27	4648	HIGH PRESSURE TEST FACILITY
28	S-4659	HP GN2 FACILITY
29	S-4660	BOILER PLANT
30	S-4640	COMPRESSOR BUILDING
31	S-4655	MULTI PURPOSE HIGH BAY FACILITY
32	S-4656	HYDRAULIC EQUIPMENT DEVELOPMENT FACILITY
33	S-4653	COMPONENTS SERVICE BUILDING
34	4678	OFFICE AND STORAGE BUILDING
35	S-4654	OFFICE BUILDING
36	S-4651	SHOP BUILDING
37	4649	MULTI PURPOSE HIGH BAY FACILITY

MICHOUD ASSEMBLY FACILITY

SITE PLAN



MANUFACTURING AND ASSEMBLY

1	303	HANGAR
2	103	MANUFACTURING
3	111	LABORATORY
4	104	BATTERY CHARGING & STORAGE
5	207	BOILER HOUSE
6	202	COOLING TOWER
7	220	COMPONENT SUPPLY
8	203	MAINTENANCE SUPPLY
9	221	HAZARDOUS MATERIAL STORAGE

TEST FACILITIES

10	420	TEST & CHECKOUT FACILITY
11	404	HIGH PRESSURE TEST FACILITY
12	110	VERTICAL ASSEMBLY & HYDROSTATIC TEST
13	130	SYSTEMS ENGINEERING
14	451	PNEUMATIC TEST FACILITY

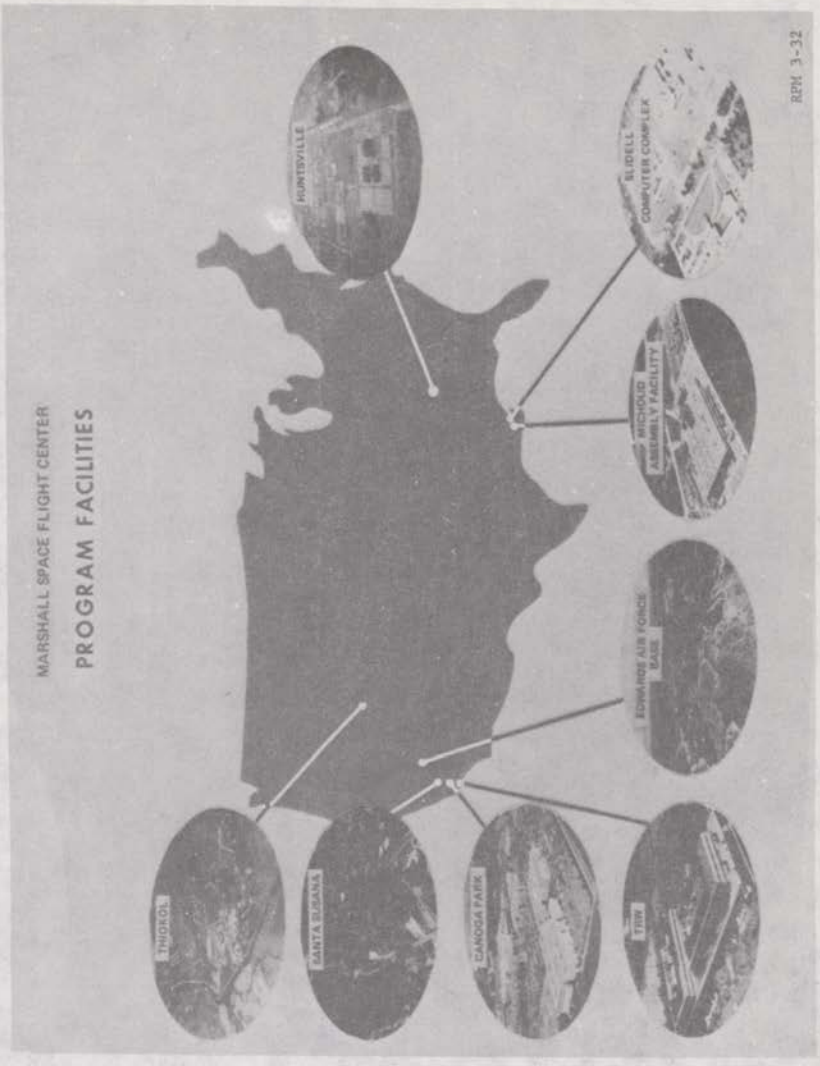
ENGINEERING & ADMINISTRATION

15	350	OFFICE AND ENGINEERING BUILDING
16	351	CAFETERIA
17	320	CONTRACTOR SERVICES BUILDING
18	101	ADMINISTRATION
19	102	ENGINEERING
20	301	MAINTENANCE SHOP

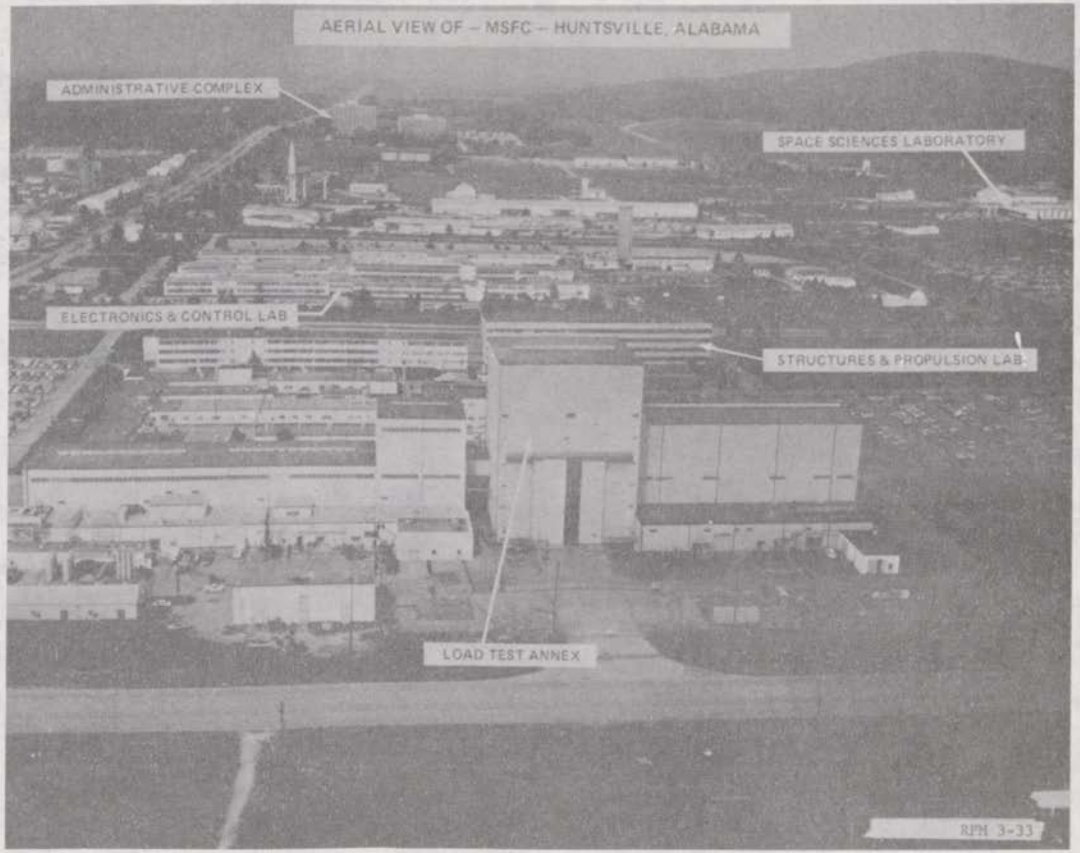
TRANSPORTATION, UTILITIES & MISC

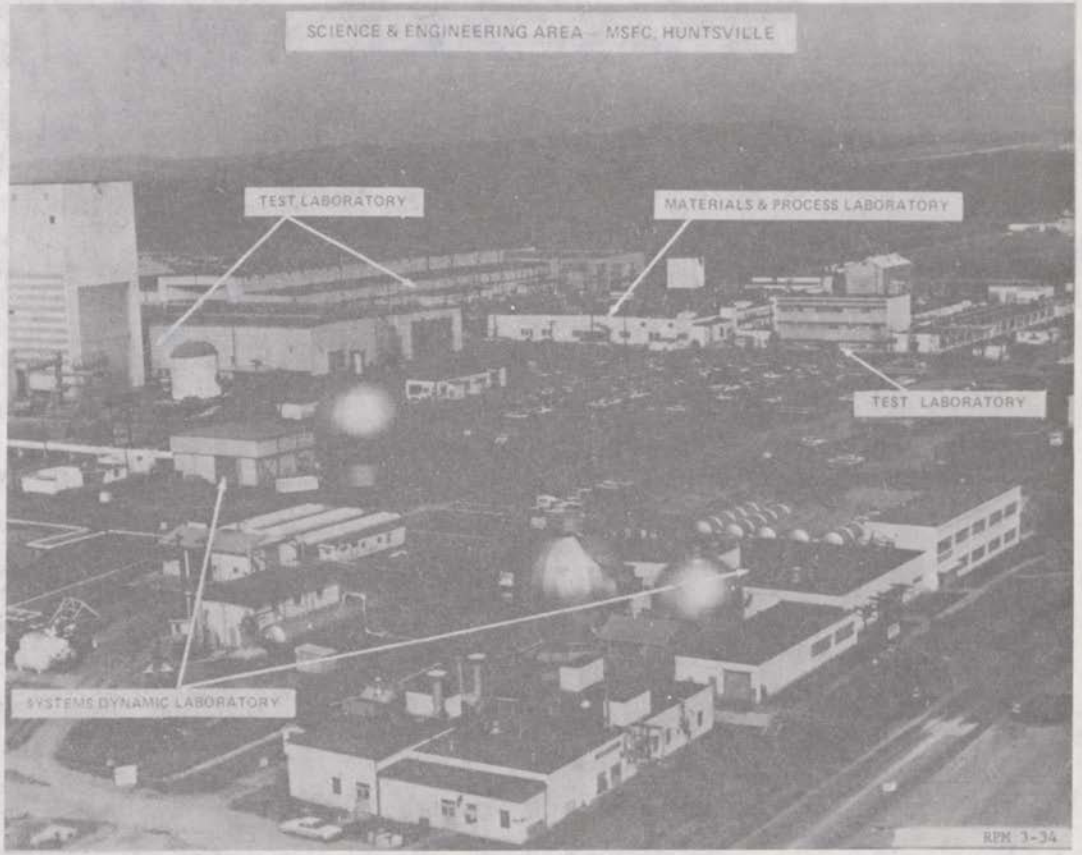
21	480	BARGE DOCK
22		GUARD HOUSE
23	450	MAIN PUMP STATION
24	201	PUMP STATION NO 1
25	304	PUMP STATION NO 3
26	143	PUMP STATION NO 4
27	308	WEST MASTER SUBSTATION
28	121	MAIN SUBSTATION
29	170	CHEMICAL WASTE LAGOON
30	119	PAINT SHOP
31	403	SALVAGE YARD
32	105	TRANSPORTATION
33	302	ELEVATED WATER TOWER

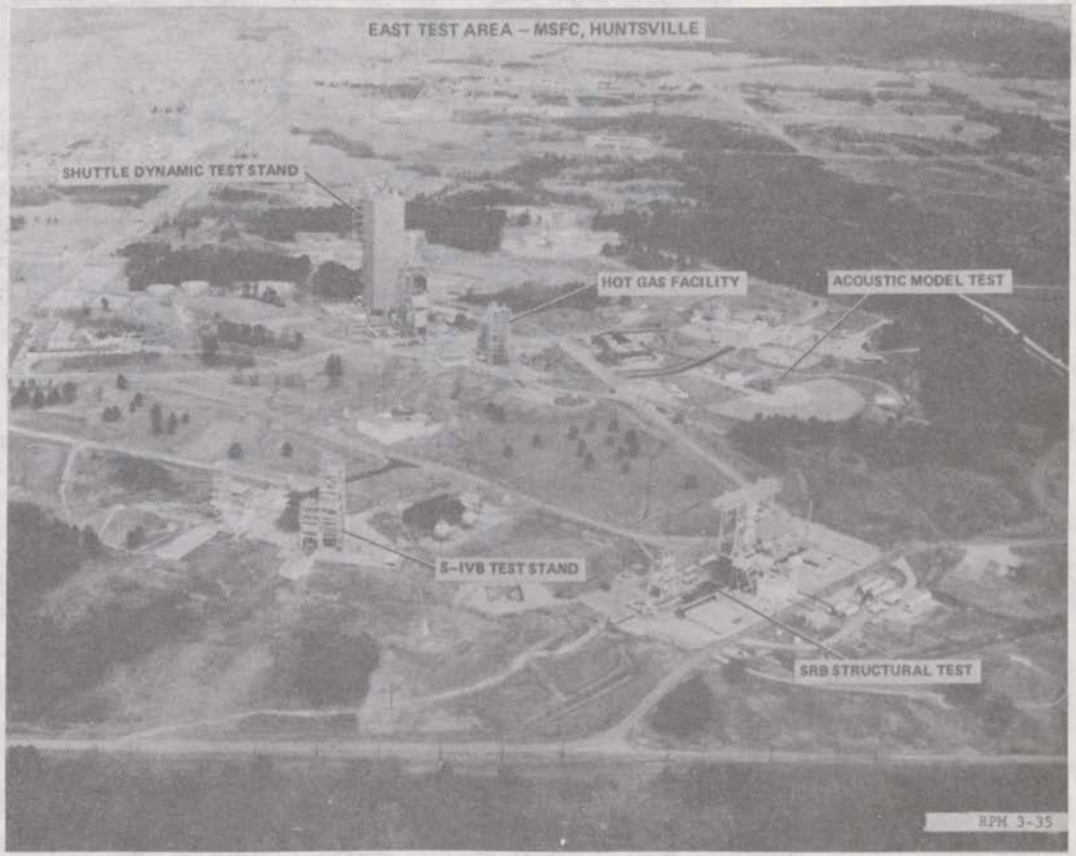
RPM 3-31


MARSHALL SPACE FLIGHT CENTER
PROGRAM FACILITIES
HUNTSVILLE
SLIDELL COMPUTER COMPLEX
MICHOUD ASSEMBLY FACILITY
EDWARDS AIR FORCE BASE
TTBF
CANOGA PARK
SANTA SUSANA
SONIC
RPM 3-32

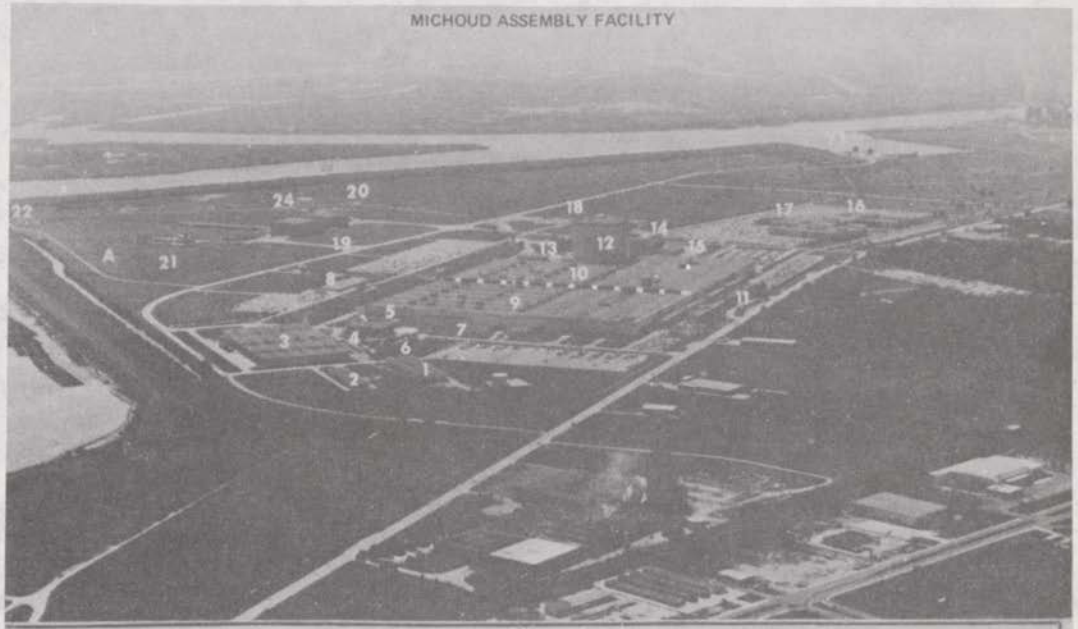
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AERIAL VIEW OF – MSFC – HUNTSVILLE, ALABAMA
ADMINISTRATIVE COMPLEX
SPACE SCIENCES LABORATORY
ELECTRONICS & CONTROL LAB
STRUCTURES & PROPULSION LAB
LOAD TEST ANNEX
RPM 3-33


SCIENCE & ENGINEERING AREA – MSFC, HUNTSVILLE
TEST LABORATORY
MATERIALS & PROCESS LABORATORY
TEST LABORATORY
SYSTEMS DYNAMIC LABORATORY
RPM 3-34


EAST TEST AREA – MSFC, HUNTSVILLE
SHUTTLE DYNAMIC TEST STAND
HOT GAS FACILITY
ACOUSTIC MODEL TEST
S-IVB TEST STAND
SRB STRUCTURAL TEST
RPM 3-35

MICHOUD ASSEMBLY FACILITY



1. MAINTENANCE SUPPLY
2. HAZARDOUS MATLS STORAGE
3. COMPONENT SUPPLY
4. BOILER PLANT & FUEL TANKS
5. BATTERY CHARGING
6. COOLING TOWER
7. LABORATORY
8. CHEMICAL WASTE RESERVOIR
9. FAB AREA
10. FAB AREA
11. ENGINEERING BUILDINGS
12. VERT ASSY & HYDROSTATIC TEST
13. SYSTEMS ENGINEERING BLDG.
14. HANGAR
15. MAINTENANCE
16. ENGINEERING & OFFICE BLDG.
17. CAFETERIA
18. CONTRACTOR SERVICES BLDG.
19. TEST & CHECK OUT
20. SALVAGE YARD
21. HIGH PRESSURE TEST FACILITY
22. MAIN PUMPING STATION
23. BARGE DOCK
24. PNEUMATIC TEST FACILITY

RPM 3-36

RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 1981 ESTIMATES

NATIONAL SPACE TECHNOLOGY LABORATORIES

DESCRIPTION

The National Space Technology Laboratories is located in southwest Mississippi, approximately 50 miles northeast of New Orleans, Louisiana. Total land area is 138,807 acres of which 13,480 acres make up the actual installation owned by NASA. The remaining 125,327 acres are held as a buffer zone. In the buffer zone, 7,162 acres are owned by NASA, and 118,165 acres are under restrictive easements. The installation has deep water access via the Pearl River and the Intracoastal Waterway. Capital investment for the National Space Technology Laboratories as of September 30, 1979 was $310,280,000.

CENTER ROLES AND MISSIONS

The National Space Technology Laboratories (NSTL), formerly the Mississippi Test Facility (MTF), was constructed and operated during the 1960's for acceptance testing of the booster stages of the Saturn V rocket system. NSTL is NASA's prime static test facility for large liquid propellant rocket engines and propulsion systems. The redesignation by NASA of MTF to the new NSTL in June 1974 recognized the emerging role of the installation in space and environmental technology efforts.

NSTL is presently engaged in development and acceptance testing of the Space Shuttle Main Engines and development testing of the Shuttle's Main Propulsion Test Article. NSTL also conducts applied research, develops techniques and demonstrates and transfers to the user community applications of NASA-developed technology in the fields of remote sensing, satellite communication, environmental sciences, and other selected applications programs. NSTL manages the installation and, through interagency agreements, provides service support and full utilization of all facilities by NASA and including collocated elements of other executive agencies engaged in compatible research, development, and operational activities. These include the Department of Interior, the Department of Commerce, the Environmental Protection Agency, the Department of Transportation, the Department of Defense, the State of Mississippi, and the State of Louisiana. The principal roles are:

Space Shuttle - NSTL provides, maintains and manages the facilities and the related capabilities required for the development and acceptance testing of the Space Shuttle Main Engines and the development testing of the Shuttle's Main Propulsion Test Article which consists of a cluster of three main engines, an external tank and an orbiter aft-fuselage structure.

Space Applications - Conducts applied research, develops techniques, demonstrates and transfers to the user community applications of NASA-developed technology in the fields of remote sensing, satellite communication and environmental sciences.

SUMMARY OF RESOURCES REQUIREMENTS

FUNDING PLAN BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
I. Personnel and Related Costs	3,040	3,151	3,374	3,444
II. Travel	131	99	137	147
III. Facilities Services	1,125	1,173	1,173	1,286
IV. Technical Services	49	41	41	43
V. Management and Operations	143	225	174	188
Total, fund requirements	4,488	4,689	4,899	5,108

Distribution of Permanent Positions by Programs

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	Budget Estimate
Direct Positions				
Space Transportation Systems	5	5	5	5
Space shuttle	5	5	5	5

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Space and Terrestrial Applications	39	39	39	39
Space applications	37	39	39	39
Technology utilization	2	---	---	---
Subtotal, direct positions	44	44	44	44
Center Management and Operations Support Positions	60	59	59	59
Total, permanent positions	104	103	103	103

PROGRAM DESCRIPTION

	Permanent Positions (Civil Service)
SPACE SHUTTLE	5

In 1981 the National Space Technology Laboratories will continue to provide, maintain, and manage the facilities and the related capabilities required for development and acceptance testing of the Space Shuttle Main Engines and the development testing of the Shuttle's Main Propulsion Test Article, which consists of a cluster of three main engines, an external tank and an orbiter aft-fuselage structure.

SPACE APPLICATIONS 39

In 1981 the National Space Technology Laboratories' Earth Resources Laboratory's program will continue:

a. To conduct research investigations in the application of remotely sensed data, stressing interests and needs of potential user agencies. This research activity uses existing aircraft and satellite programs as a basic source of remotely sensed data in conjunction with surface data to develop techniques and procedures for practical applications, and to devise cost-effective methods of transferring those techniques to the user agencies.

b. To conduct applications demonstration projects in cooperation with Federal, state, regional and local government agencies and private industry to promote the effective transfer of applications technology as well as to reduce systems costs, increase adaption to the users systems, and improve compatibility with other information sources and products routinely used by the user organization.

c. To systematically transfer, primarily to state and local governments in the 17 state region in the mid-west, south and southeast, the ability to effectively use Landsat data for their resource management and planning decisions through the Southern Regional Remote Sensing Applications Center.

d. To conduct research, develop applications and transfer technology to the user community in non-remote sensing applications primarily in such areas as data collection systems, environmental system development, and closed ecosystems development.

	Permanent Positions (Civil Service)
CENTER MANAGEMENT AND OPERATIONS SUPPORT	59

Center Management and Operations Support is defined as that support or services being provided to all National Space Technology Laboratories organizations which cannot be directly identified to a benefiting program or project. The civil service personnel involved are:

Manager and Staff - The Center Manager, Deputy Manager, and immediate staff, e.g. Legal, Patent Counsel, Equal Opportunity, and Public Affairs.

Management Support - Includes a wide range of activity categorized as management support for programs and functional organizations for the entire Center. Specific functions include resource and budget management, program control, contracting and procurement, personnel management, property management, financial management, resource control and management information systems and analysis.

Operations Support - This is a broad spectrum of activity that is required to maintain and operate facilities, buildings and equipment; and to provide the normal housekeeping services and logistics support for the personnel who manage and conduct the affairs of the Center. Specific activities are:

Maintenance and operation of all buildings and facilities
Data processing and computer support
Reliability and quality assurance
Centerwide security and protection
Fire protection
Custodial services
Logistics support including transportation, supplies, etc.
Medical care of employees
Photographic and graphic support
Safety

RESOURCES REQUIREMENTS BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
I. PERSONNEL AND RELATED COSTS	3,040	3,151	3,374	3,444
Summary of Fund Requirements				
A. Compensation and Benefits				
1. Compensation				
a. Permanent Positions	2,668	2,768	2,942	2,971
b. Other than full time permanent positions	78	79	118	145
c. Overtime and other compensation	8	13	13	15
Subtotal, Compensation	2,754	2,860	3,073	3,131
2. Benefits	270	273	279	288
Subtotal, Compensation and Benefits	3,024	3,133	3,352	3,419
B. Supporting Costs				
1. Transfer of Personnel	8	10	10	10
2. Personnel Training	8	8	12	15
Subtotal, Supporting Costs	16	18	22	25
Total, Personnel and Related Costs	3,040	3,151	3,374	3,444

Explanation of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
A. Compensation and Benefits	3,024	3,133	3,352	3,419
1. Compensation	2,754	2,860	3,073	3,131
a. Permanent positions	2,668	2,768	2,942	2,971

The funds shown will support 103 permanent positions in 1981. The current estimate for 1980 reflects an increase over the 1980 budget estimate due to the October 1979 pay increase.

Basis of Cost for Permanent Positions

In 1981 the cost of permanent positions will be $2,971,000, an increase of $29,000 over 1980. The increase results from the following:

Cost of permanent positions in 1980		2,942
Cost increases in 1981		+66
Within grade and career advances:		
Full year effect of 1980 actions	+37	
Partial year effect of 1981 actions	+24	
Full year efeect of 1980 pay increases	+5	
Cost decreases in 1981		-37
Turnover savings and abolished positions:		
Full year effect of 1980 actions	-17	
Partial year effect of 1981 actions	-11	
One less paid day in 1981	-9	
Cost of permanent positions in 1981		2,971

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
b. Other than full-time permanent positions				
1. Cost	78	79	118	145
2. Workyears	9	9	13	15

The 1981 distribution of workyears is as follows:

Distribution of Other than Full-Time Permanent Workyears

Program	Workyears
Cooperative training	4
Opportunity programs	5
Other temporary employment	6
Total	15

The increase from the 1980 budget estimate to the 1980 current estimate is a result of the assignment of the three part-time permanent positions, and the new White House Research Apprenticeships program. The 1981 estimate includes the scheduled build-up of the Research Apprenticeships program.

c. Overtime and other compensation	8	13	13	15

The overtime levels shown are necessary to meet management and administrative requirements in such areas as procurement and financial management.

2. Benefits	270	273	279	288

The following table reflects the personnel benefits by major category:

Civil Service Retirement Fund	201	201	206	212
Employee life insurance	12	13	14	15
Employee health insurance	56	58	58	60
FICA	1	1	1	1
Total	270	273	279	288

The increase from the 1980 budget estimate to the 1980 current estimate is a result of the October 1979 pay increase. The increase in 1981 is due to the full year effect of the October 1979 pay increase.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
B. Supporting Costs	16	18	22	25
1. Transfer of personnel	8	10	10	10

The amount estimated for 1981 is based on the planned personnel turnover.

2. Personnel training	8	8	12	15

The personnel training costs are primarily for "Upward Mobility" training for women and minorities, and Equal Employment Opportunity (EEO) "Counsel Training." The increase of the 1980 current estimate over the 1980 budget estimate and the increase in 1981 is due to the greater demand for upward mobility training and Civil Service Reform Act implementation training.

II. TRAVEL	131	99	137	147
Summary of Fund Requirements				
A. Program Travel	61	58	63	67
B. Scientific and Technical Development Travel	2	15	3	4
C. Management and Operations Travel	68	26	71	76
Total, Travel	131	99	137	147

Explanation of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
A. Program Travel	61	58	63	67

Program travel requirements are directly related to the accomplishment of the Center's mission, and will mainly be in support of the Space and Terrestrial Applications Office. The increase from the 1980 budget estimate to the 1980 current estimate is to support increased activities in the Earth Resources Laboratory program.

B. Scientific and Technical Development Travel	2	15	3	4

Scientific and technical development travel will permit employees to participate in meetings and technical seminars with other representatives of the aerospace community. This participation allows them to benefit from exposure to technological advances outside NSTL as well as to present both accomplishments and problems to their associates. Many of the meetings are working panels convened to solve certain problems for the benefit of the Government. The decrease from the 1980 budget estimate to the 1980 current estimate reflects a reassessment of requirements for meeting and seminar travel associated with the Earth Resources Laboratory program.

C. Management and Operations Travel	68	26	71	76

Management and operations travel is used for the direction and coordination of general management matters. It includes travel in such areas as personnel, financial management, and procurement activities; travel of the Center's top management to NASA Headquarters, and other NASA Centers; and local transportation. The 1979 actual, 1980 current estimate and 1981 levels have been adjusted to include the rental costs of GSA vehicles for the Earth Resources Laboratory, which were included under the Transportation function in the 1980 budget. Also, the 1981 estimate reflects increased travel related to the Earth Resources Laboratory program.

III. FACILITIES SERVICES	1,125	1,173	1,173	1,286

The National Space Technology Laboratories (NSTL) covers 138,807 acres of grounds and a complex of facilities which are comprised of laboratories, office, and rocket engine test facilities.

The complex encompasses some 1,178,177 gross square feet of building space including seven major buildings. Also included are five major technical facilities. This physical plant supports an average daily on-Center population of 3,000 to 3,300 personnel. Many of the test facilities are utilized on schedules involving more than one shift and/or frequently during off-peak hours.

Summary of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
A. Maintenance and Related Services				
Facilities	111	100	100	100
B. Custodial Services	262	246	246	246
C. Utilities Services	752	827	827	940
Total, Facilities Services	1,125	1,173	1,173	1,286

Explanation of Fund Requirements

A. Maintenance and Related Services	111	100	100	100
Facilities	111	100	100	100

This activity, requiring 1 workyear of effort, provides for the modifications and alterations of facilities for normal recurring movements of personnel and equipment of the Earth Resources Laboratory.

B. Custodial Services	262	246	246	246

Provides security guard services, janitorial services and fire protection to the Earth Resources Laboratory personnel by the National Space Technology Laboratories institutional support services contractor.

C. Utility Services	752	827	827	940

Provides for the purchase of the two utility commodities; electricity from the Mississippi Power Company; and natural gas from the United Gas Pipe Line Company. Natural gas is the primary heating fuel used at NSTL.

The increase from the 1980 current estimate to the 1981 budget estimate is due to an increase in rates. The estimated requirements for these utilities are as follows:

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
1. Electricity (12,560 mW/Hrs)				510
2. Natural gas (156,300 K cu. ft.)				430
IV. TECHNICAL SERVICES	49	41	41	43
Summary of Fund Requirements				
A. Automatic Data Processing				
Operations	43	35	35	37
B. Scientific and Technical Information				
Library	6	6	6	6
Total, Technical Services	49	41	41	43
Explanation of Fund Requirements				
A. Automatic Data Processing	43	35	35	37

Provides for the supplies, materials and software programs in support of the Earth Resources Laboratory.

B. Scientific and Technical Information	6	6	6	6

Provides for the books, periodicals and other technical reports required by the Earth Resources Laboratory.

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	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
V. MANAGEMENT AND OPERATIONS	143	225	174	188
Summary of Fund Requirements				
A. Administrative Communications	22	25	25	25
B. Printing and Reproduction	30	47	47	48
C. Transportation	14	56	14	18
D. Installation Common Services	77	97	88	97
Total, Management and Operations	143	225	174	188
Explanation of Fund Requirements				
A. Administrative Communications	22	25	25	25

Provides for the local telephone service for the Earth Resources Laboratory.

B. Administrative Printing	30	47	47	48

Provides for printing and reproduction services in support of the Earth Resources Laboratory personnel.

C. Transportation	14	56	14	18

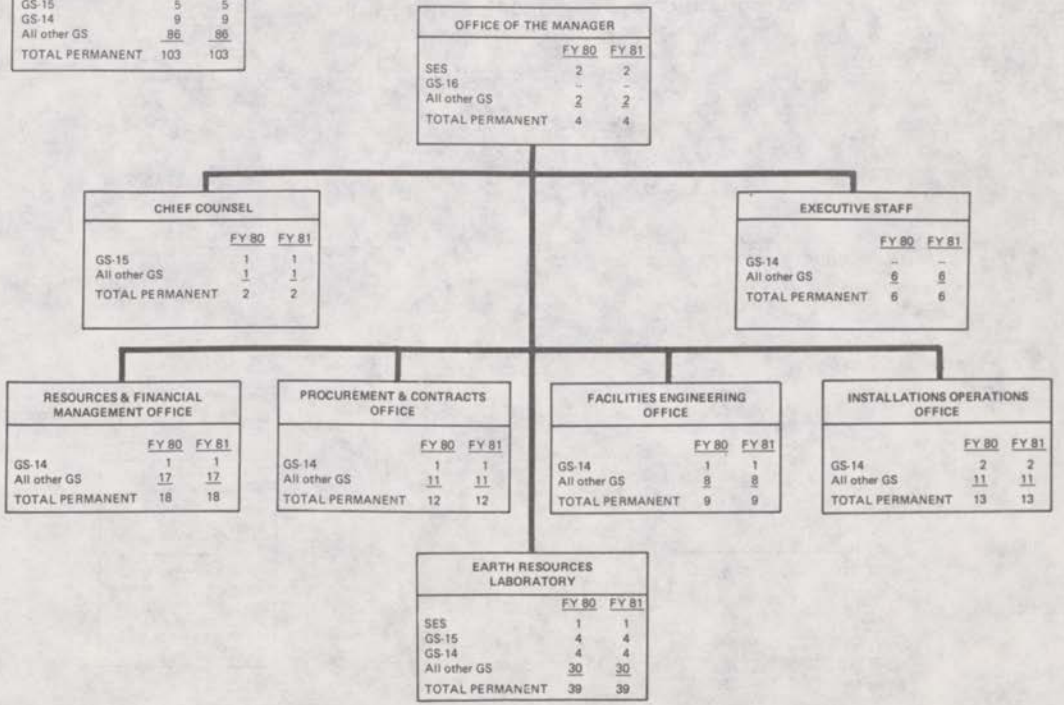
The estimate includes freight costs, government bills of ladings, air freights, other general shipments and related transportation costs. The 1979, 1980 current estimate and 1981 levels have been adjusted to reflect the transfer of rental costs for GSA vehicles to Management and Operations Travel. The 1981 estimate reflects an increase in related transportation costs.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
D. Installation Common Services.....	77	97	88	97

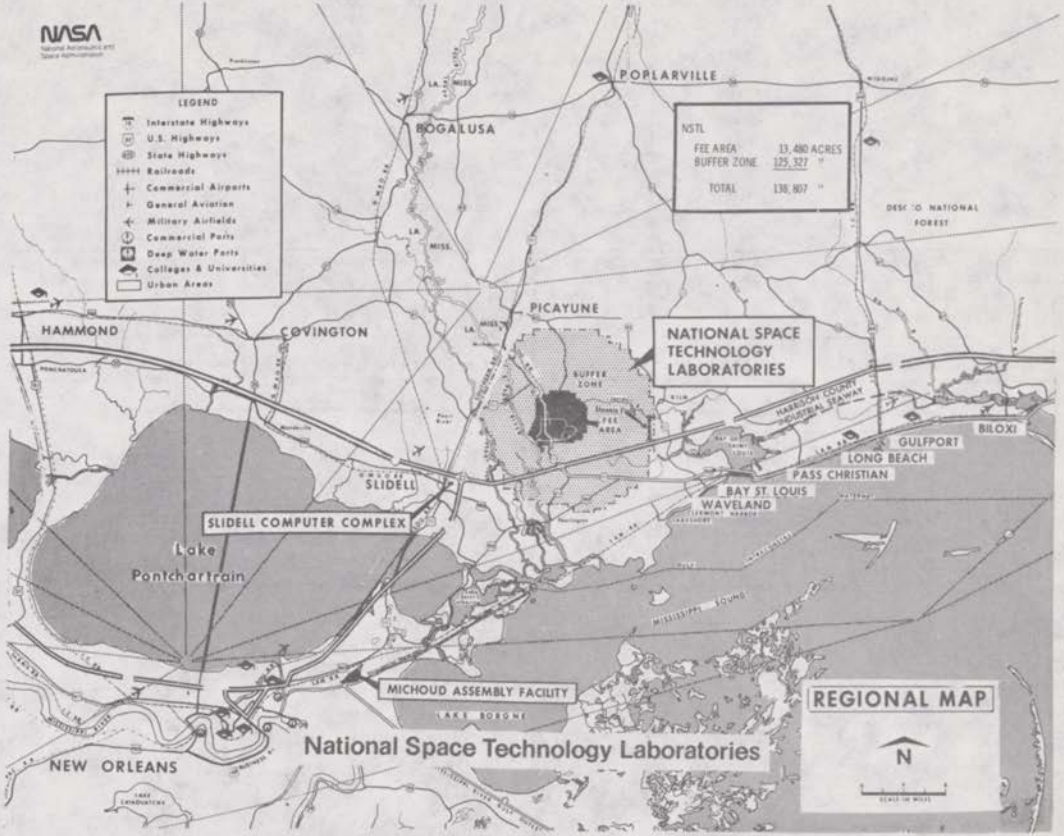
Provides supplies, materials and equipment for the Earth Resources Laboratory. The decrease from the 1980 budget estimate to the 1980 current estimate reflects a reassessment of requirements. The increase in the 1981 budget estimate is due to increased requirements for supplies and materials for use by the Earth Resources Laboratory.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
NATIONAL SPACE TECHNOLOGY LABORATORIES
DECEMBER 4, 1979

NSTL SUMMARY STAFFING	FY 80	FY 81
SES	3	3
GS-16	–	–
GS-15	5	5
GS-14	9	9
All other GS	86	86
TOTAL PERMANENT	103	103

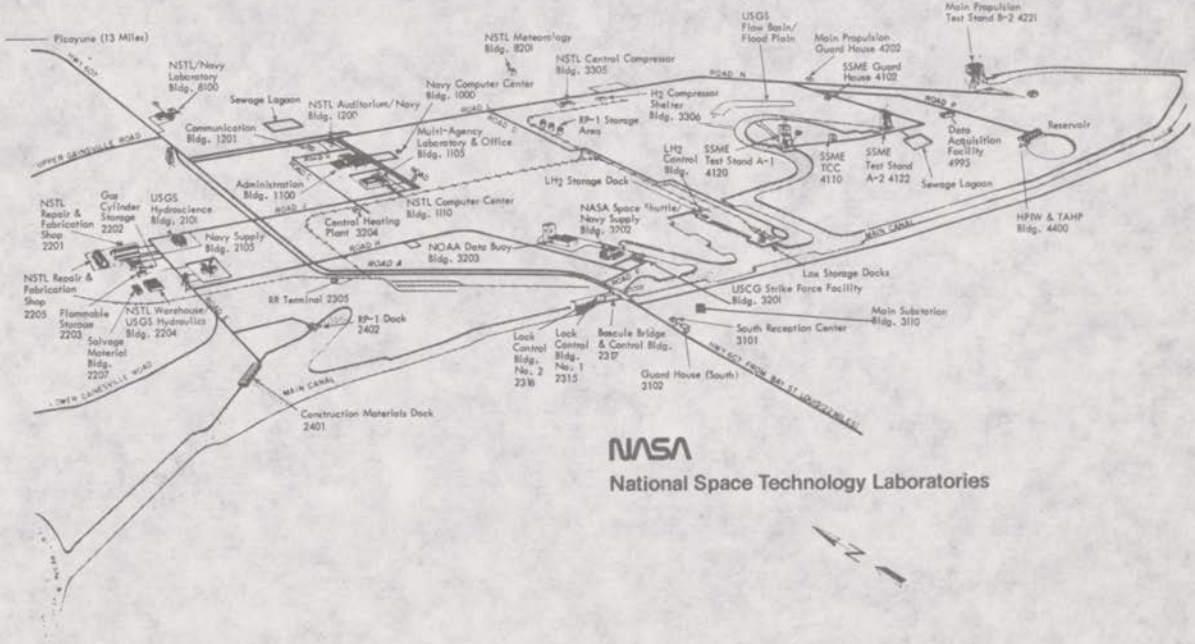


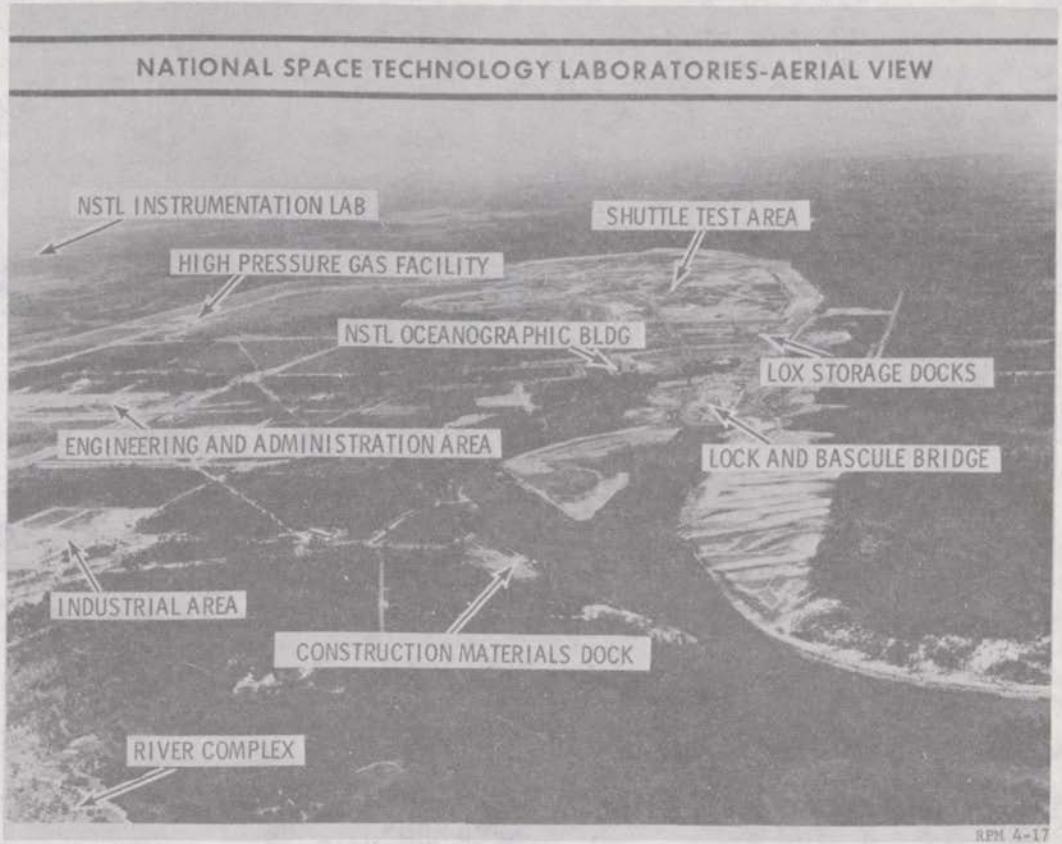
RPM 4-14


NASA
LEGEND
Interstate Highways
U.S. Highways
State Highways
Railroads
Commercial Airports
General Aviation
Military Airfields
Commercial Ports
Deep Water Ports
Colleges & Universities
Urban Areas
NSTL
FEE AREA 13,480 ACRES
BUFFER ZONE 125,327 "
TOTAL 138,807 "
POPLARVILLE
BOGALUSA
PICAYUNE
HAMMOND
COVINGTON
NATIONAL SPACE TECHNOLOGY LABORATORIES
BUFFER ZONE
FEE AREA
HARRISON COUNTY INDUSTRIAL SEAWAY
BILOXI
GULFPORT
LONG BEACH
PASS CHRISTIAN
BAY ST. LOUIS
WAVELAND
SLIDELL
SLIDELL COMPUTER COMPLEX
Lake Pontchartrain
MICHOUD ASSEMBLY FACILITY
NEW ORLEANS
National Space Technology Laboratories
REGIONAL MAP
N

RPM 4-15

NSTL LOCATION PLAN




NATIONAL SPACE TECHNOLOGY LABORATORIES-AERIAL VIEW
NSTL INSTRUMENTATION LAB
SHUTTLE TEST AREA
HIGH PRESSURE GAS FACILITY
NSTL OCEANOGRAPHIC BLDG
LOX STORAGE DOCKS
ENGINEERING AND ADMINISTRATION AREA
LOCK AND BASCULE BRIDGE
INDUSTRIAL AREA
CONSTRUCTION MATERIALS DOCK
RIVER COMPLEX
RPM 4-17

RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 1981 ESTIMATES

GODDARD SPACE FLIGHT CENTER

DESCRIPTION

The Goddard Space Flight Center, located 15 miles northeast of Washington, DC, at Greenbelt, Maryland is situated on a 554-acre main site. Three additional nearby plots of 640 acres comprise the remote site area and contain the Goddard Antenna Test Range, the Goddard Optical Facility, the Propulsion Research Facility, the Magnetic Fields Component Test Facility, the Attitude Control Test Facility, and the Network Training and Test Facility. The total capital investment for the Goddard Space Flight Center, including tracking stations and contractor-held facilities at various locations as of September 30, 1979, was $692,166,000.

The majority of the Goddard Center's personnel are located at Greenbelt, Maryland; other personnel are located at the Goddard Institute for Space Studies in New York City, and throughout the world, managing the operation of satellite tracking and communications network stations.

CENTER ROLES AND MISSIONS

The Goddard Space Flight Center, established in 1959 as the first major United States installation devoted to the investigation and exploration of space, conducts a wide-ranging program in space science and applications. The Goddard Center has developed many diverse capabilities: the management of complex projects; the development of wholly integrated spacecraft, ranging from systems engineering to development, integration, and testing; the development and operation of satellite tracking networks, data acquisition and analysis; and scientific research to include both theoretical studies and the development of many significant scientific experiments flown on satellites. The principal and supporting roles are:

PRINCIPAL

Earth Orbital Spacecraft Development and Flight Operations - including spacecraft propulsion and supporting technology such as low cost structural evaluation and reliability demonstration, advanced guidance systems and space power systems. Major emphasis is on automated, standard spacecraft systems, free flyers, experiment development and integration, and the planning and conducting of associated flight operations.

Tracking and Data Acquisition Systems and Support Operations - planning, developing and implementing the tracking network, data processing and analysis, communications, and mission control systems and facilities. Planning and conducting support of Earth orbital spacecraft. Includes flight control, tracking, data acquisition, communications, and information processing and analysis. Network planning and implementation support for Shuttle, including Orbital Flight Tests. (Tracking and data acquisition responsibilities include orbital phase acquisition of all mission types such as manned, and deep space).

Spacelab Payloads - developing, analytically integrating and processing data for Spacelab payloads in astrophysics, solar terrestrial physics, astronomy, and assigned applications roles.

Space Physics and Astronomy Payloads and Science - developing the technical discipline base, including astronomical sensors; developing and implementing flight experiments, including space physics and experimentation for planetary missions.

Applications Research and Development - developing the technical discipline base, developing spaceborne sensors, developing ground data processing systems and data analysis systems, and implementing applications experiments for Environmental Observations and Resources Observations.

Upper Atmospheric Research - developing and applying analytical techniques, evaluating advanced instrumentation concepts for atmospheric constituent analysis, and developing concepts for future flight missions.

Information Systems Technology - developing and maintaining a technology base.

Sounding Rocket Development, Procurement and Operations - developing and procuring sounding rockets and carrying out all phases of operations from mission/flight planning to landing and recovery. Includes supporting systems (i.e., guidance, telemetry and attitude control), payload carrier development and development acquisition.) (Most GSFC sounding rocket activities involve the higher performance, more complex vehicle support systems. Most activities involving lower performance vehicle systems are assigned to Wallops Flight Center).

Launch Vehicle Procurement - focusing on Delta procurement for Space Science and Space Applications-oriented missions, reimbursable missions for other Government agencies, domestic commercial users, and international users.

SUPPORTING

Planetary Science - developing and applying techniques for the analysis of planetary atmospheres.

Environmental Observations - contributing to the technical discipline base, developing spaceborne sensors and implementing experiments.

SUMMARY OF RESOURCES REQUIREMENTS

FUNDING PLAN BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
I. Personnel and Related Costs	107,900	110,150	115,011	115,638
II. Travel	2,384	2,672	2,542	2,712
III. Facilities Services	9,574	10,288	10,547	11,816
IV. Technical Services	2,599	2,325	2,449	3,076
V. Management and Operations	5,453	5,762	5,256	6,093
Total, fund requirements	127,910	131,197	135,805	139,335

Distribution of Permanent Positions by Program

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Direct Positions				
Space Transportation Systems	120	112	112	72
Space shuttle	40	33	32	3
Space flight operations	20	17	21	21
Expendable launch vehicles	60	62	59	48
Space Science	1,080	981	1,006	967
Physics and astronomy	994	908	917	881
Planetary exploration	86	73	89	86

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Space and Terrestrial Applications	857	924	922	984
Space applications	846	915	908	971
Technology utilization	11	9	14	13
Aeronautics and Space Technology	88	66	99	128
Space research and technology	88	66	99	128
Space Tracking and Data Systems	606	602	570	538
Tracking and data acquisition	606	602	570	538
Subtotal, direct positions	2,751	2,685	2,709	2,689
Center Management and Operations Support Positions	731	755	731	751
Total, permanent positions	3,482	3,440	3,440	3,440

PROGRAM DESCRIPTION

	Permanent Positions (Civil Service)
SPACE SHUTTLE	3

The objective of the Space Shuttle activities at Goddard Space Flight Center (GSFC) is to plan and implement the equipment systems, communications data, voice circuits, and operational procedures required for support during the Orbital Flight Test phase, and the subsequent operational phase of the Shuttle program.

SPACE FLIGHT OPERATIONS	21

The objective of the Goddard activities in this area is to provide the technical support and data to effectively integrate Goddard free-flyer payloads into the Space Transportation System. During 1981, Goddard will perform a variety of studies, utilizing Goddard's scientific and technical base, to better develop the Shuttle Payload requirements and interface for the Goddard free-flyer payloads.

	Permanent Positions (Civil Service)
EXPENDABLE LAUNCH VEHICLES	48

The GSFC is the management center for the Delta launch vehicle. The Delta vehicle is NASA's only medium class standard launch vehicle and has the capability of accurately putting a wide variety of spacecraft into a broad spectrum of orbits, ranging from equatorial to polar inclinations. The Delta is used for NASA missions, for a wide range of reimbursable missions for other Government agencies, domestic commercial users, and international users. The Delta program is managed to provide for production of the launch vehicles required for approved missions, to provide the necessary operations support, to maintain production capability for projected missions and to provide for solid propellant upper stages and apogee booster motors. The Delta project provides engineering, quality, and configuration control services to maintain operational capability with high reliability.

PHYSICS AND ASTRONOMY	881

Physics and Astronomy is comprised of research in two major areas: Astrophysics and Solar Terrestrial Research.

Goddard Astrophysics activities have the objectives of: accomplishing laboratory and flight scientific research to increase human knowledge of the Earth's space environment, the stars, and other objects; and providing advanced technical development of experiments and spacecraft components for future astrophysics missions.

To this end, Goddard has organized its activities to accomplish scientific progress in all of the following discipline areas of astrophysics: gamma ray astronomy, X-ray astronomy, ultraviolet and optical astronomy, infrared and radio astronomy, and particle astrophysics.

During 1981, Goddard's investigators will actively be involved in development of instruments for the Space Telescope and Gamma Ray Observatory, and data analysis of data for several major Physics and Astronomy missions; the High Energy Astronomy Observatory, the Dynamics Explorer, and the Solar Maximum Mission.

The spacecraft development will be completed and assembly started for a 1981 launch of the Dynamics Explorer. Additionally, instruments will continue to be fabricated and delivered for testing and evaluation. Government furnished equipment (GFE), standard tape recorders, and the standard ground support equipment for the spacecraft will be delivered to the spacecraft contractor and will include the NASA near-Earth Transponder and the NASA Standard Tracking and Data Relay Satellite System (TDRSS) Transponder.

In 1981, the International Ultraviolet Explorer (IUE) spacecraft, with its unique satellite control and data management systems, will continue to afford guest observers the opportunity to point the satellite in real time from the ground, quickly make observations, and receive data in visual formats. Additionally, it is expected that the International Sun-Earth Explorer (ISEE) series will provide unusual opportunities to study the dynamic interactions of solar wind and the Earth's magnetosphere from various points in space.

In 1981, other Explorer efforts will continue. It is anticipated that we will move into development of the following Explorer missions: Active Magnetospheric Particle Tracer Experiment and Cosmic Background Explorer.

Goddard will provide the management and support of NASA Domestic and International Sounding Rocket programs. The project involvement extends from the conception through launch and data analysis in support of research within Galactic Astronomy, High Energy Astrophysics, Solar Physics, Plasma Physics, Aeronomy, Meteorology, Planetary Astronomy, and the space applications of materials processing science. During 1981, we plan to introduce sounding rocket technology to the Shuttle via the mode of Experiments of Opportunity (EOP). This is a cost-effective approach which allows the experimenter to obtain scientific data from an instrument designed to fly on a sounding rocket or the Shuttle. The highlight of the year is anticipated to be the 1981 African Solar Eclipse Rocket, to be launched from the San Marco launch platform off the coast of Kenya. In 1981, we anticipate the accomplishment of the development and the implementation of a logistic and technical consultation services for the Shuttle's self-contained payload containers.

	Permanent Positions (Civil Service)
PLANETARY EXPLORATION	86

The Goddard science activity within the Planetary Exploration program is designed to emphasize the physics of interplanetary space and planetary environments. To this end, Goddard will, in 1981, maintain as strong and viable a research group as is required to carry out this role.

During 1981, Goddard investigators will be actively involved in the development of two instruments, the Neutral Mass Spectrometer and the Photopolarimeter Radiometer for Project Galileo. These instruments will measure chemical composition and the physical properties of clouds in the atmosphere of Jupiter. Goddard will also be involved in the data analysis activity of various instruments on Voyager and Pioneer Venus.

SPACE APPLICATIONS	971

The Goddard Space and Terrestrial Applications program for 1981 spans this Center's broad roles and missions mandate. Included for 1981 are activities in the discipline areas of Resource Observations and Environmental Observations.

Goddard engaged in three major types of activities in these areas: A. Research and Technology; B. Flight Projects; and C. Application Demonstrations. These activities may be characterized as follows:

A. The Space Research and Technology effort in general is directed toward solving major problems in the above mentioned major applications disciplines. It stresses continuity of applied research, from the assessment of these problems, to conceptual instrument design and testing, mission and payload studies, concepts of flight missions, and their final analyses and evaluation after launch. It includes the design and construction of mathematical models to study:

1. The global circulation of this planet's atmosphere for better weather and climate predictions;

2. The dynamics of the earth to provide improved understanding of geodynamics and earthquake processes, and gravity fields;

3. The processes of the oceans such as surface winds, waves, temperature, currents, and circulation to support our weather and climate effort as well as our ocean research program;

4. The earth's renewable and nonrenewable resources for better monitoring, assessment, and management; and

5. The environment of the earth's atmosphere and hydrosphere.

Other examples of efforts of more specific nature include: new instrument development for measuring temperature and pressure profiles in the atmosphere which are essential input parameters for our weather and climate models, user active and passive microwave systems for measuring sea surface temperatures, winds as well as soil moisture essential for water resources modeling and agriculture yield predictions, new instruments for ocean color measurements important for ocean studies and pollution determination, new high precision laser electronic ranging systems to support our Earth and ocean dynamics efforts, new low cost data collection platforms, and low cost global positioning system terminals for civilian application.

B. Application's Flight Project responsibilities at Goddard for 1980 and 1981 include:

1. Operational weather satellite missions for the National Oceanic and Atmospheric Administration (NOAA).

   a. NOAA-B--scheduled for launch during the 2nd quarter of 1980;

   b. NOAA-C--satellite integration is expected to be completed in the 1st quarter of 1980 in preparation for 2nd quarter 1981 launch;

c. NOAA-D--satellite integration is expected to be completed in the 3rd quarter of 1980;

d. NOAA-E Bus--modifications for incorporation of Search and Rescue components will be completed and delivery of the Bus will occur in the 3rd quarter 1980; and

e. Geostationary Operational Environmental Satellite (GOES-E)--to be launched in the 2nd quarter of 1981.

2. Landsat and Nimbus satellites extended operations--will continue to provide remotely sensed resources observations and environmental observations to a worldwide applications research science community.

3. Landsat-D-fabrication, assembly and test of the Thematic Mapper and Multispectral Scanner System instruments, observatory modules, systems and subsystems will continue, and delivery of all observatory components and subassemblies of the mission system contractor for integration and test of the first space segment will be completed by the end of 1980. Launch is scheduled for late 1981.

4. Earth Radiation Budget Experiment-monitoring of the design and fabrication of the instrument package and spacecraft are the main areas of emphasis in 1981.

5. Spinning Solid Upper Stages (SSUS-A)--presently planned to be launched on an early Shuttle flight to launch Intelsat-V.

C. Applications demonstration activities involve the formulation, analysis, and distribution of applications data received from satellites for which Goddard has management responsibility. Such demonstrations concern the use of data from Nimbus-7 spacecraft for the solution of problems concerning pollution, ocean resources and dynamics, and weather and climate. The Heat Capacity Mapping Mission (HCMM) will evaluate the utility of thermal measurements from satellites for determining such parameters as soil moisture and rock types inferred from surface temperatures and thermal inertia. Other examples will be the data from Landsat-3 spacecraft. This information will be of use to investigators in the agricultural, forestry, geology, land use, cartography, hydrology, ecology, and oceanography disciples. A major activity is the transfer of Landsat data applications technology to state and local government organizations, and private industry. Goddard, with the Eastern Regional Sensing Applications Center, has responsibility for remote sensing technology in 17 states.

860

	Permanent Positions (Civil Service)
TECHNOLOGY UTILIZATION	13

At Goddard, Technology Utilization activities are directed toward the application of space technology to public and private sector needs. Foremost among the technology applications projects in 1981 are the following:

1. New technology identification, evaluation, and publication,

2. Dissemination methods and techniques, and

3. Public sector technology applications projects.

SPACE RESEARCH AND TECHNOLOGY	128

The objectives of Goddard in Space Research and Technology program activities are to provide results appropriate to space mission capability enhancement. Past efforts have produced many worthwhile advances in space system capability, reliability, and effectiveness. During 1981, areas of increasing attention include cryogenics for space flight, information systems, sensors, and laser ranging.

TRACKING AND DATA ACQUISITION	538

The Tracking and Data Acquisition program at Goddard is broken into two main areas: operation of the Spaceflight Tracking and Data Network (STDN); and mission control, data processing, and computation support for flight projects.

The STDN is operated in direct support of NASA's Earth orbiting scientific and applications satellites and Shuttle/Spacelab programs. In addition, the Network provides services to satellites that are operated by other United States Government Agencies, such as the Department of Defense and the National Oceanic and Atmospheric Administration, by foreign governments, and by commercial companies. Appropriate segments of the Network deliver critical coverage for the launch of spacecraft that are on deep space missions by providing support during portions of the early flight path not visible to NASA's Deep Space Network (DSN).

NASA Communications Network (NASCOM) provides all operational communications required by NASA. Facilities of this Network link the stations of the STDN and will make it possible for the Tracking and Data Relay Satellite System (TDRSS) to operate as a part of the overall tracking and data acquisition complex for which NASA has responsibility.

The TDRSS will provide the satellite relay of Earth orbiting spacecraft data to a single ground station located at White Sands, New Mexico. The system will employ both S- and Ku-band frequencies and will greatly increase coverage capabilities available to Earth orbiting spacecraft. The network will provide the operational interface between the project users and the TDRSS. With the demonstration of a successful TDRSS, a number of STDN ground stations will be closed. However, some of the current stations will be maintained to provide for Shuttle launch and high altitude orbit support that cannot be provided by the TDRSS.

During 1981, the STDN is projecting support for approximately 43 missions including: Space Transportation System flights, High Energy Astronomy Observatories, Fleet Satellite Communications-4, International Sun-Earth Explorers, International Ultraviolet Explorer, Magsat, Solar Maximum Mission, and Stratospheric Aerosol and Gas Experiment.

Mission and Data Operations provide support to flight missions in the categories of mission control, operational computing, and sensor data processing. This includes mission and systems analysis, systems design and implementation, and the operation and maintenance of multimission and dedicated technical facilities to support both Goddard and non-Goddard missions.

During 1981, emphasis will continue to be placed on defining concepts for spacecraft and data autonomy in order to modify designs of flight and ground systems to improve the response, capacity, and effectiveness of the end-to-end data system, as well as the development of system concepts and techniques to provide data to multiple users from multiple data sources.

In the area of mission contol, work will continue on the first Payload Operations Control Center Network (POCCNET) cluster to allow the reuse of standard components and designs in order to share expensive resources among a large number of missions.

For operational computing two major efforts will be continued. The first will be to put in place a new metric data handling system in order to provide an improved central point of metric data reception from the STDN; and, the second is to size the computational requirements for the Shuttle era and provide a new computing capability for flight dynamics, including attitude computations, and command management.

Emphasis will be placed on end-to-end data concepts; and, in addition, a major effort will be required to develop and implement a new capability to process and distribute Spacelab payload data.

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	Permanent Positions (Civil Service)
CENTER MANAGEMENT AND OPERATIONS SUPPORT.....	751

Center Management and Operations Support is defined as that support or services being provided to all Goddard organizations which cannot be directly identified to a benefiting program or project. The civil service personnel involved are:

Director and Staff

The Center Director, Deputy Director and immediate staff, Staff Organizations, e.g., Legal, Patent Counsel, Equal Opportunity, Planning and Analysis, Public Affairs, and Safety.

Management Support

Includes a wide range of activities generally categorized as activities of a general and administrative nature which are required to operate and maintain the installation. Specific functions include resources and budget management, program control, contracting and procurement, personnel management, property management, financial management, and resource control and management information systems and analysis.

Operations Support

This is a broad spectrum of activity that is required to maintain and operate facilities, buildings, and equipment; and to provide the normal housekeeping services and logistics support for the personnel who manage and conduct the affairs of the Center. Specific activities are: maintenance and operation of all buildings and facilities, data processing and computer support, reliability and quality assurance, Centerwide security and protection, fire protection, custodial services, logistics support including transportation, supplies, medical care of employees, and photographic and graphic support.

RESOURCE REQUIREMENTS BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
I. PERSONNEL AND RELATED COSTS	107,900	110,150	115,011	115,638
Summary of Fund Requirements				
A. Compensation and Benefits				
1. Compensation				
a. Permanent positions	96,912	98,441	102,800	102,837
b. Other than full time permanent positions	772	776	935	965
c. Overtime and other compensation	801	866	897	897
Subtotal, Compensation	98,485	100,083	104,632	104,699
2. Benefits	8,712	9,165	9,394	9,361
Subtotal, Compensation and Benefits	107,197	109,248	114,026	114,060
B. Supporting Costs				
1. Transfer of personnel	146	208	163	163
2. Personnel training	557	694	822	1,415
Subtotal, Supporting Costs	703	902	985	1,578
Total, Personnel and Related Costs	107,900	110,150	115,011	115,638

Explanation of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
A. Compensation and Benefits	107,197	109,248	114,026	114,060
1. Compensation	98,485	100,083	104,632	104,699
a. Permanent positions	96,912	98,441	102,800	102,837

The estimate for 1981 will support 3,440 permanent positions. The increase from the 1980 budget estimate to the 1980 current estimate is due to the October 1979 pay increase.

Basis of Cost for Permanent Positions

The estimate for permanent compensation (starting from prior year cost) is based upon the position structure at the start of the year, as modified by the addition of new positions and an abolishment of existing positions, within grade advances, career development, and the October 1979 pay increase. After these modifications, the year-end position structure is established and the cost effect for the year is calculated based on the estimated period that these modifications are in effect. The cost of permanent positions in 1981 will be $102,837,000, an increase of $37,000 over 1980. The increase from 1980 results from the following:

Cost of permanent positions in 1980		102,800
Cost increases in 1981		+3,012
Within grade and career advances:		
Full year effect of 1980 actions	+1,124	
Partial year effect of 1981 actions	+1,289	
Full year effect of 1980 pay increases	+55	
Change in reimbursable	+544	
Cost decreases in 1981		-2,975
Turnover savings and abolished positions:		
Full year effect of 1980 actions	-1,463	
Partial year effect of 1981 actions	-1,158	
One less paid day in 1981	-354	
Cost of permanent positions in 1981		102,837

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
b. Other than full time permanent positions				
1. Cost	772	776	935	965
2. Workyears	81	79	91	95

The 1981 plan includes 95 workyears which will support the following programs:

Distribution of Other than Full Time Permanent Workyears

Program	Workyears
Cooperative training	33
Summer employment	5
Opportunity programs	21
Other temporary employment	36
Total	95

The workyear increases from the 1980 budget estimate to the 1980 current estimate reflect a build-up in the clerical work study program, the continuation of the part-time employment program and the institution of the White House Research Apprenticeships program. The 1981 budget estimate reflects the full year effect of the October 1979 pay increase.

c. Overtime and other compensation	801	866	897	897

Overtime at Goddard is required to meet peak operational requirements where additional workhours are essential, generally culminating in the launch of a manned or automated spacecreat. Some of the areas involved are fabrication, experimentation, testing, launching and tracking of the spacecraft. The increase from the 1980 budget estimate to the 1980 current estimate reflects the October 1979 pay increase.

2. Benefits	8,712	9,165	9,394	9,361

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			

The following table indicates the cost of personnel benefits by the major categories:

Civil Service Retirement Fund	6,779	6,990	7,298	7,274
Employees life insurance	229	388	245	245
Employees health insurance	1,436	1,657	1,640	1,691
Workman's compensation	134	92	186	126
FICA	20	25	25	25
Severence pay	15	---	---	---
Other benefits	99	13	---	---
Total	8,712	9,165	9,394	9,361

The increase from the 1980 budget estimate to the 1980 current estimate reflects the October 1979 pay increase. Workmen's compensation costs are based on the Department of Labor billings for 1980 and 1981.

B. Supporting Costs	703	902	985	1,578
1. Transfer of personnel	146	208	163	163

The category includes the reimbursement to employees for movements of household goods to the employee's new duty station, and other relocation expenses.

2. Personnel training	557	694	822	1,415

The personnel training costs are based on continuation of current training programs and the need to reorient skills of employees into areas compatible with the direction of the current space program and Goddard's role in the program. The increases in the 1980 current estimate and 1981 are necessary to fund training associated with the Civil Service Reform Act and the Tracking and Data reorganization.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
II. TRAVEL	2,384	2,672	2,542	2,712
Summary of Fund Requirements				
A. Program Travel	2,025	2,285	2,168	2,304
B. Scientific and Technical Development Travel	219	247	239	266
C. Management and Operations Travel	140	140	135	142
Total, Travel	2,384	2,672	2,542	2,712
Explanation of Fund Requirements				
A. Program Travel	2,025	2,285	2,168	2,304

Program travel is essential to the accomplishment of the Center's mission, particularly with regard to the Physics and Astronomy, Space and Terrestrial Applications, Tracking and Data Acquisition, and Space Transportation Systems programs. In these areas, efforts will be devoted to performing applications research, developing complex satellites and launch systems, managing data processing systems, and creating scientific instruments for further research. The decrease from the 1980 budget estimate to the 1980 current estimate reflects a reduction in travel to implement Section 112 of Public Law 96-86. The increase in the 1981 estimate over the 1980 current estimate is due to increased requirements associated with such programs as Space Telescope and the Cosmic Background Explorer.

B. Scientific and Technical Development Travel	219	247	239	266

Scientific and technical development travel permits employees to participate in meeting and technical seminars with other representatives of the aerospace community. This participation allows them to benefit from exposure to technological advances outside GSFC, as well as to present both accomplishments and problems to their associates. Many of the meetings are working panels convened to solve certain problems for the benefit of the Government. Space Science programs are the primary users of travel in this area. The decrease from the 1980 budget estimate to the 1980 current estimate reflects a reduction in travel to implement Section 112 of Public Law 96-86. The 1981 estimate provides for the same level of travel activity as in 1980.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
C. Management and Operations Travel	140	140	135	142

Management and operations travel is used for the direction and coordination of general management matters. It includes travel in such areas as personnel, financial management, and procurement activities, travel of the Center's top management to other NASA Centers, and local transportation. The decrease from the 1980 budget estimate to the 1980 current estimate reflects a reduction in travel to implement Section 112 of Public Law 96-86. The 1981 estimate provides for the same level of travel activity as in 1980.

III. FACILITIES SERVICES	9,574	10,288	10,547	11,816

Goddard Space Flight Center (GSFC) is located on a 554-acre main site and on a 640-acre remote site area with a complex of laboratory and office-type buildings as well as test facilities. This complex encompasses 2,266,899 gross square feet of building space including 17 major buildings. Also included are seven major technical facilities. This physical plant supports an average daily on-Center population of 5,800 to 6,100 personnel. Many of the test facilities are utilized on schedules involving more than one shift and during off-peak hours.

Summary of Fund Requirements

A. Rental of Real Property	677	647	677	966
B. Maintenance and Related Services				
1. Facilities	1,966	1,504	1,470	1,427
2. Equipment	65	16	15	15
Subtotal	2,031	1,520	1,485	1,442
C. Custodial Services	1,713	1,972	1,722	2,121
D. Utilities Services	5,153	6,149	6,663	7,287
Total, Facilities Services	9,574	10,288	10,547	11,816

Explanation of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
A. Rental of Real Property	677	647	677	966

This provides space for personnel at certain tracking stations and the Goddard Institute for Space Studies (GISS) in New York City, as well as storage and warehouse space for equipment, supplies and materials. The area requirements in 1981 are the same as those rented in 1980. The increase from the 1980 budget estimate to the 1980 current estimate is due to an anticipated reduction of rental space which did not materialize. The increase in 1981 is due to GSA's reevaluation of rental rates.

B. Maintenance and Related Services	2,031	1,520	1,485	1,442
1. Facilities	1,966	1,504	1,470	1,427

The 1979 actuals included maintenance items deferred from 1978, lamp replacement in offices to achieve energy savings, rehabilitation of air-conditioning system to achieve energy reduction, and other miscellaneous items.

This activity provides in 1981 for the continuation of the same level of effort as in 1980. The major services included are:

a. Maintenance and operation 438

These funds provide general buildings maintenance including painting, inspection, and mechanical and electrical maintenance.

b. Ground maintenance 160

Provides for mowing, cultivation, mulching, fertilizing and care of trees and shrubs.

c. Supplies and facilities equipment 385

Included in this category are chemicals, building materials, electrical and electronics materials, general maintenance and operating materials, metals, pipes, valve, and fittings.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
d. Routine facilities work				444

Included in this activity is support for rehabilitation and modification of facilities, office alteration and safety upgrading.

2. Equipment	65	16	15	15

Provides for maintenance of and equipment for the onsite radio communications network.

C. Custodial Services	1,713	1,972	1,722	2,121

This activity involves a total of 114 support contractor workyears of effort at GSFC. The decrease in the the 1980 current estimate from the 1980 budget estimate reflects some rephasing of funding plans as well as a reduction of three support contractor workyears of effort. The 1981 estimate reflects full year funding of essentially the same level of services as in 1980.

1. Janitorial services (74 workyears of effort)	1,285

This activity is applicable to about 2.2 million square feet of area, and includes washing and relamping of light fixtures, office cleaning, minor laundry services, and trash removal.

2. Security guard services (40 workyears of effort)	836

This activity includes badging of all onsite personnel and visitors, vehicle identification, and protection of all Government facilities and equipment including the GISS in New York City.

D. Utilities Service	5,153	6,149	6,663	7,287

The estimate provides for operation and maintenance of the utility plant and distribution systems as well as the purchase of utility services, and supplies, materials and equipment required for the maintenance of these systems. Electricity is purchased from the Potomac Electric and Power Company, natural gas from Washington Gas Light Company and fuel oil from a local supplier. Water and sewage is provided by the Washington Suburban Sanitary Commission. The increases from the 1980 budget estimate to the 1980 current estimate and from the 1980 current estimate to the 1981 estimate are due to utility rate and negotiated support service contract wage increases. The purchased utilities are as follows:

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
1. Electricity (92,780 MW/hrs)				4,753
2. Natural Gas (173,700 K cu. ft.)				685
3. Fuel Oil (700,000 gals)				363
4. Water and Sewage				345
IV. TECHNICAL SERVICES	2,599	2,325	2,449	3,076
Summary of Fund Requirements				
A. Automatic Data Processing				
1. Equipment	493	280	36	628
2. Operations	1,106	1,070	1,257	1,308
Subtotal	1,599	1,350	1,293	1,936
B. Scientific and Technical Information				
1. Library	606	576	718	719
2. Education and Information	181	217	206	206
Subtotal	787	793	924	925
C. Shop Support and Services	213	182	232	215
Total, Technical Services	2,599	2,325	2,449	3,076
Explanation of Fund Requirements				
A. Automatic Data Processing	1,599	1,350	1,293	1,936

This funding provides accounting and management information to satisfy requirements of NASA and GSFC management. Included is support of GSFC business data functions.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
1. Equipment	493	280	36	628

The 1979 costs included miscellaneous purchases of equipment such as disc drivers for use with the newly purchased IBM 360/50 computer. The maintenance costs of all GSFC-owned administrative ADP equipment and the lease costs of all leased administrative ADP hardware are included in this estimate. Leased equipment includes Xerox 1200 printer, various terminals, and other peripheral equipment. Maintenance services are provided for the IBM 360/50 (main business computer), memory disc drives, terminals, and associated equipment. The decrease from the 1980 budget estimate to the 1980 current estimate is due to purchases made in 1979 that were originally planned for 1980. The 1981 estimate includes an administrative computer.

2. Operations	1,106	1,070	1,257	1,308

The systems supported include Institutional Management, Finance and Accounting, Procurement and Personnel Management. The increase in 1980 from the budget estimate to the current estimate, and the increase from 1980 current estimate to 1981 is due to support contractor wage increases. Computer programming, keypunching operators, and other support personnel provide for 36 workyears of effort. Supplies, materials and software programs are included as operational costs for provision of administrative ADP information.

B. Scientific and Technical Information	787	793	924	925

These funds provide for the operation of a technical library at GSFC, a public affairs educational and informational program, and support to the Center in the provision of various scientific and technical information services.

1. Library	606	576	718	719

Cataloging, reference, acquisition, translating services, and distribution of books and publications in the operation of the GSFC library are funded in this estimate. This includes over 65,000 books, 45,000 journals, plus almost one million microfiche copies of aerospace documents. The increase from the 1980 budget estimate to the 1980 current estimate reflects increased costs for periodicals.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
2. Education and Information	181	217	206	206

This estimate includes funds for exhibit management and refurbishment, spacemobile operation, demonstration models, workshops and symposia, and educational and information materials.

C. Shop Support and Services	213	182	232	215

Support is provided in the areas of safety, photo services, graphics, and publications. Fire protection system maintenance and related supplies and equipment; film and print processing, photographic supplies and repair of photographic equipment; art work services and related supply and equipment costs; and materials and equipment maintenance for compilation of documents comprise this category. The increase from the 1980 budget estimate to the 1980 current estimate reflects increased requirements for photo and graphic services.

V. MANAGEMENT AND OPERATIONS	5,453	5,762	5,256	6,093
Summary of Fund Requirements				
A. Administrative Communications	2,251	2,299	2,284	2,284
B. Printing and Reproduction	335	316	309	256
C. Transportation	1,268	1,845	1,237	1,978
D. Installation Common Services	1,599	1,302	1,426	1,575
Total, Management and Operations	5,453	5,762	5,256	6,093

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
A. Administrative Communications	2,251	2,299	2,284	2,284

Provides for local telephone service, long distance telephone service, and other non-telephone communications.

1. Local telephone services 1,378

Covers 3,990 PBX internal lines and 5,800 telephone instruments at Goddard; there are 10 tielines for Baltimore-area communications. Two hundred and fifty centrex lines are used for computer data operations.

2. Long distance telephone service 831

a. Federal Telecommunications System use will approximate 869,000 calls in 1981.
b. Tolls or commercial long distance costs are included.

3. Other communication services 75

a. Teletype costs including the GSA Automatic Records System (ARS).
b. Also included is a United Press International Wire Service for the Public Affairs Office.

B. Printing and Reproduction	335	316	309	256

This estimate provides the funding for an onsite printing plant operated by Goddard personnel. This printing plant produces approximately 17,000,000 units of printing each year. In addition to this onsite printing plant, Goddard must also purchase from private firms under Government Printing Office contract about 30,000,000 units of printing each year. This purchased printing is a combination of an overflow requirement that cannot be handled because of the onsite workload and items that cannot be handled with the onsite equipment. Types of printing accomplished by offsite private firms are multiple-copy forms, multicolor work, and forms for computer use. The 1981 estimate reflects a constrained level of activity.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
C. Transportation	1,268	1,845	1,237	1,978

This estimate includes 50 workyears of support contractor effort for the operation of Center transportation and storage areas, and other miscellaneous services. Also included are supplies and equipment for vehicle maintenance, gasoline, contracted services for vehicle maintenance, and special vehicle rental. The decrease from 1980 budget estimate to the 1980 current estimate reflects some rephasing of support contract funding plans. The 1981 increase is due to an anticipated increase in support contractor wage rates.

1. Contractor support provides the following services:

a. Operation of Transportation Center--32 workyears for drivers, dispatchers, supervisory personnel; provide pickup and delivery of purchased items and stock items, mail delivery, shuttle transportation, issuance of motor pool vehicles.
b. Packing and crating--one workyear for preparing shipments.
c. Rigging--three workyears for rigging equipment for relocation on the Center for shipment elsewhere.
d. Tape storage--six workyears to operate central magnetic tape depository.
e. Storage and warehousing--seven workyears to operate receiving areas for supplies, stock issuance, and warehousing and storage function.
f. Moving and hauling--one workyear for moving equipment and furniture on emergency basis.

D. Installation Common Services	1,599	1,302	1,426	1,575

This activity supports Center management and staff activities, provides medical services, and covers various installation support services. The increase in 1980 from the budget estimate to the current estimate is due to increases in postage and office furniture and for emergency preparedness which was not included in the 1980 budget estimate. The increase in 1981 is due to wage rate increases.

1. Center management and staff 284

Includes patent searches and applications; stenographic services, handbook revisions, Equal Opportunity programs; and general administrative supplies, materials, equipment, and equipment maintenance (microfilm, copiers, special typewriters) for staff offices.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		

2. Medical Services 695

Provides support in Occupational Medicine and Environmental Health. Eighteen support contractor workyears are required for onsite support.

a. Occupational medicine 496

This activity consists of operation of the Goddard onsite Health Unit and medical services for the Goddard Institute for Space Studies (GISS) employees in New York. Twelve workyears provide emergency care onsite, annual physical exams for Goddard employees, fitness programs, immunizations and counseling. Annual physical exams are provided for approximately 3,440 employees at the Center. The necessary supplies, materials, and equipment for operation of the Health Unit are included.

b. Environmental health 199

Environmental health consists of industrial hygiene and an environmental health lab at a total of six workyears for detection and correction of health hazards. Necessary supplies, materials and equipment are included.

3. Installation support services 596

This estimate includes all administrative support items not specifically identified elsewhere. Among these are the purchase of office furniture and operating supplies issued from stock; maintenance of all Center labor-saving devices; materials for mailroom and warehouse operation; and postage costs.

a. Office supplies 195

General office supplies, furniture, and operating supplies for warehouse and mailroom, such as pallets and gas cylinders are included in this estimate.

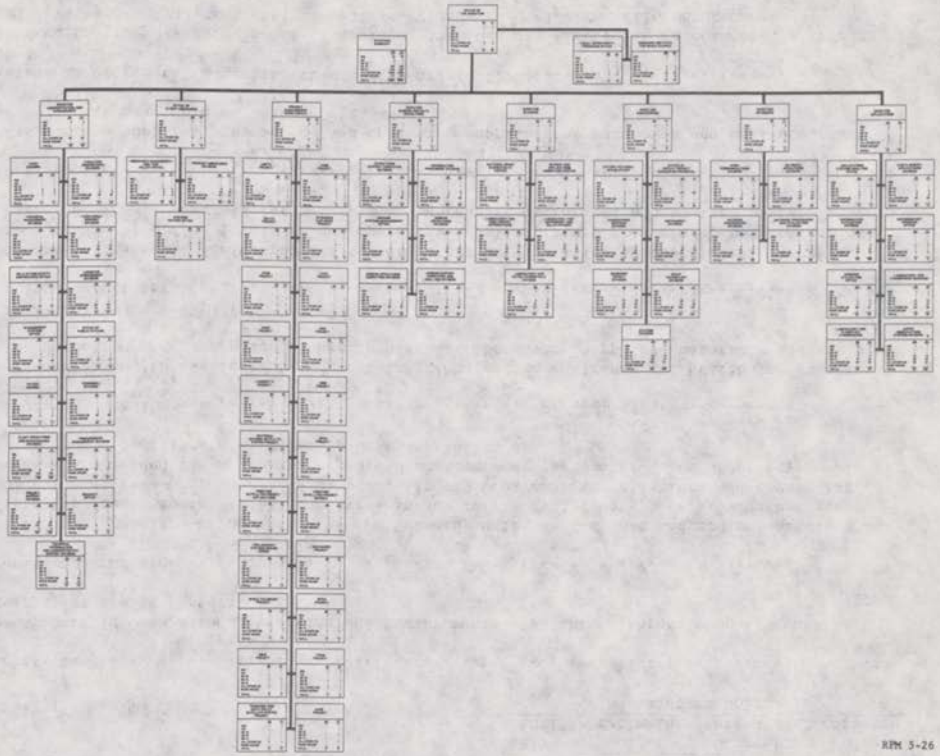
b. Maintenance of general administrative equipment..... 109

This funding provides maintenance of copiers, time stamps, electronic calculators, electric typewriters, calculators, and adding machines; as well as cylinder and electric file maintenance.

c. Postage 292

GODDARD SPACE FLIGHT CENTER
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
ORGANIZATION AND STAFFING SUMMARY

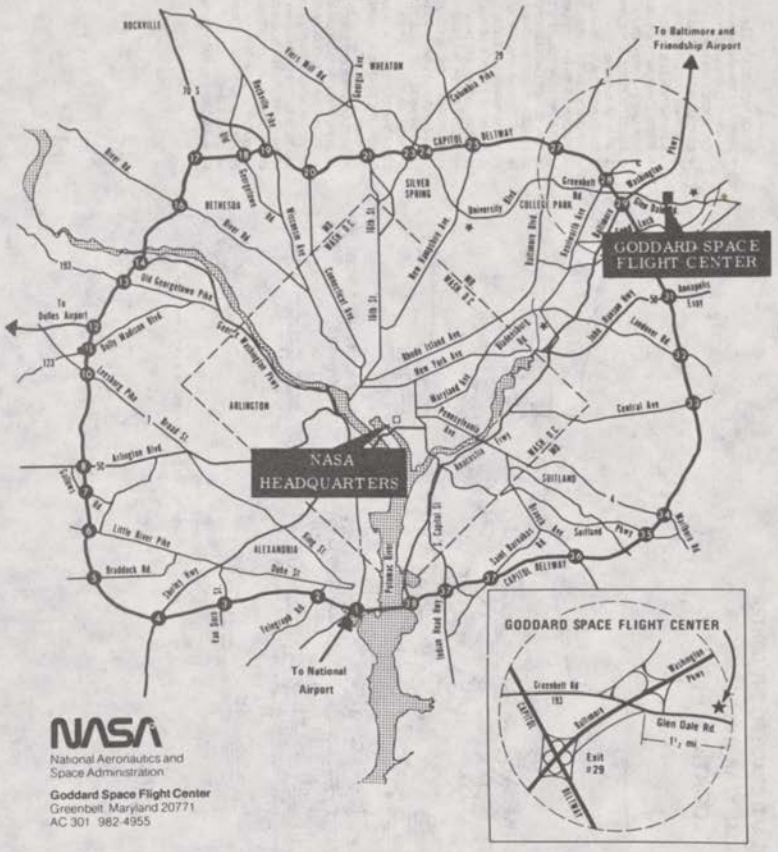
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RPM 5-26

GODDARD SPACE FLIGHT CENTER
FISCAL YEAR 1981 ESTIMATES
AREA MAP

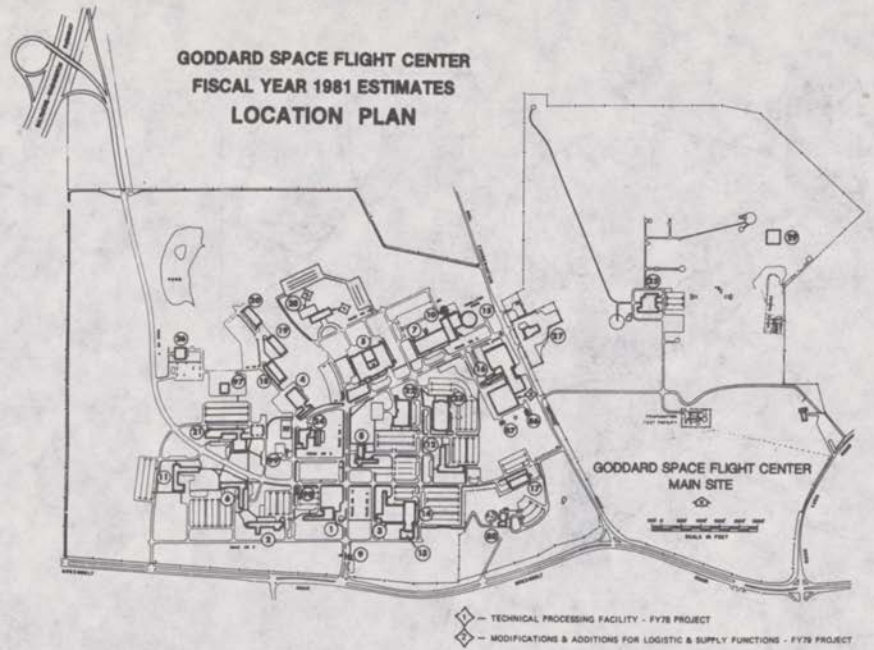
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NASA
National Aeronautics and Space Administration
Goddard Space Flight Center
Greenbelt, Maryland 20771
AC 301 982-4955

57-166 0 - 80 - 56

GODDARD SPACE FLIGHT CENTER
FISCAL YEAR 1981 ESTIMATES
LOCATION PLAN



1 SPACE PROJECTS BUILDING
2 RESEARCH PROJECTS LABORATORY
3 CENTRAL FLIGHT CONTROL & RANGE OPERATIONS BUILDING
4 GENERAL PURPOSE FACILITY BUILDING
5 INSTRUMENT CONSTRUCTION & INSTALLATION LABORATORY
6 SPACE SCIENCES LABORATORY
7 PAYLOAD TESTING FACILITY
8 SATELLITE SYSTEMS BUILDING
9 MAIN GATE HOUSE
10 ENVIRONMENTAL TESTING LABORATORY
11 APPLIED SCIENCES LABORATORY
12 TRACKING & TELEMETRY LABORATORY
13 NETWORK CONTROL CENTER FACILITY
14 SPACECRAFT OPERATIONS FACILITY
15 LAUNCH PHASE SIMULATOR
16 DEVELOPMENT OPERATIONS BUILDING
17 MULTI-PURPOSE BUILDING
18 BUSINESS OPERATIONS BUILDING
19 MULTI-PURPOSE BUILDING
20 GEOCHEMISTRY BUILDING
21 METEOROLOGICAL SYSTEMS DEVELOPMENT LABORATORY
22 MECHANICAL TEST FACILITY & QUALITY ASSURANCE LABORATORY
23 DATA INTERPRETATION LABORATORY
24 CENTRAL HEATING & REFRIGERATION PLANT
25 NETWORK TRAINING & TEST FACILITY
26 NASA SPACE SCIENCE DATA CENTER
27 MOBILE EQUIPMENT SUPPORT FACILITY
28 TECHNICAL PROCESSING FACILITY
29 FREQUENCY STANDARD AND TEST FACILITY
86 DAY CARE CENTER BUILDING
87 GAS CYLINDER STORAGE BUILDING
88 VISITOR INFORMATION FACILITY
97 PLANT MAINTENANCE SUPPORT FACILITY
98 GEWA STORE
99 NASA CAREER DEVELOPMENT CENTER

880

RPM 5-28


GODDARD SPACE FLIGHT CENTER
GREENBELT, MARYLAND

RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 1981 ESTIMATES

WALLOPS FLIGHT CENTER

DESCRIPTION

Wallops Flight Center (WFC) includes three separate areas on the Atlantic Coast of Virginia's Eastern Shore: the main base, the Wallops Island launching site, and the Wallops mainland site. The administrative offices range control center, support shops, and main telemetry buildings are located on the main base. Wallops Island is about seven miles southeast of the main base and is connected to the mainland by a causeway and bridge. The island is about five miles long and one-half mile wide at its widest point. Located on the island are rocket storage buildings, blockhouses, assembly shops and launch sites. The Wallops mainland is a one-half mile strip west of the island which houses the radar and optical tracking sites.

Wallops Flight Center, totalling 6,166 acres, consists of 1,833 acres on the main base, 3,095 acres on Wallops Island, 108 acres on the mainland tracking site, and 1,140 acres of marsh land. The total capital investment, including fixed assets in progress and contractor-held facilities at various locations as of September 30, 1979, was $141,887,000.

CENTER ROLES AND MISSIONS

Wallops Flight Center prepares, assembles, launches and tracks space vehicles and acquires scientific information from them. Wallops also has developed, maintains, and operates a research airport in support of NASA's aeronautical research programs which include projects associated with airport-aircraft interface, air traffic control, avionics systems technology, final approach and landing systems, airport configuration, high speed turn-off techniques, airport environmental studies, noise reduction technology, and general aviation research focused on aircraft spin characteristics, cross-wind landings, pilot performance, and procedures and aides at uncontrolled airports and airspace. Its facilities are utilized by the scientists and engineers from the laboratories and research centers of NASA, other governmental agencies, colleges and universities, and the worldwide scientific community. Center personnel assist these scientific research teams with their projects and develop, as necessary, special types of instrumentation and equipment to complete the mission. The principal and supporting roles are:

PRINCIPAL

Sounding Rocket Development, Procurement and Operations - developing and procuring sounding rockets and carrying out all phases of operations, from mission and flight planning to landing and recovery. Payload carrier development, telemetry, experiment management support to other institutions, launch operations, and tracking and data acquisition are included.

Balloon Program - managing, monitoring, scheduling, and analyzing balloon activities conducted for NASA, the Office of Naval Research and the National Science Foundation.

SUPPORTING

Sounding Rocket Payload Carrier Development and Experiment Management Support - providing support in the applications disciplines of weather and climate.

Aeronautical Flight Test Support - providing flight test support for Langley Research Center's aeronautical flight test programs, including tracking and data acquisition.

SUMMARY OF RESOURCES REQUIREMENTS

FUNDING PLAN BY FUNCTION

		1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
			(Thousands of Dollars)		
I.	Personnel and Related Costs	10,476	10,749	11,361	11,440
II.	Travel	276	406	325	347
III.	Facilities Services	3,317	3,398	3,586	3,771
IV.	Technical Services	575	524	537	963
V.	Management and Operations	1,162	1,253	1,276	2,456
	Total, fund requirements	15,806	16,330	17,085	18,977

Distribution of Permanent Positions by Program

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Direct Positions				
Space Transportations Systems	6	-	4	4
Space flight operations	2	-	2	2
Expendable launch vehicles	4	-	2	2
Space Science	73	67	72	72
Physics and astronomy	73	67	72	72
Space and Terrestrial Applications	51	56	55	55
Space applications	47	55	54	54
Technology utilization	4	1	1	1
Aeronautics and Space Technology	34	34	34	34
Aeronautical research and technology	34	34	34	34
Space Tracking and Data Systems	105	108	105	105
Tracking and data acquisition	105	108	105	105
Subtotal, direct positions	269	265	270	270
Center Management and Operations Support Positions	129	130	125	125
Total, permanent positions	398	395	395	395

PROGRAM DESCRIPTION

	Permanent Positions (Civil Service)
SPACE FLIGHT OPERATIONS	2

In 1981, the civil service personnel will provide mission and range safety support for Space Shuttle launches. Wallops Flight Center (WFC) tracking activities will also support Space Shuttle missions during the orbital phase.

EXPENDABLE LAUNCH VEHICLES	2

In 1981, Wallops civil service personnel will receive, inspect and store the Scout expendable launch vehicle and maintain the launch facility for future Scout missions.

PHYSICS AND ASTRONOMY	72

Sounding Rocket Program

The objective of this program is to support space research, using low cost sounding rockets, in the fields of Solar Physics, Galactic Astronomy, Fields and Particles, and Ionospheric Physics. Wallops Flight Center provides flight systems support, launch range support, and support to experiments utilizing sounding rockets.

In 1981, the Wallops Launch Range will provide launch activities and ground instrumentation/support of the launches at WFC and at the Poker Flats Research Range near Fairbanks, Alaska, plus expedition type support to other areas. The WFC launch range is equipped with launchers capable of handling sounding rockets of all sizes. The Poker Flats Research Range, jointly supported by WFC and the Defense Nuclear Agency, has limited capability, although its facilities can be supplemented by the mobile equipment from WFC.

Balloon Program

The objective of this program is to support space research, using low cost balloon platforms, in the fields of Solar Physics, Galactic Astronomy, Stratospheric Composition and Aeronomy.

In 1981, WFC will provide ground instrumentation support, technical, and flight hardware support to experimenters in the balloon program.

The majority of the flights are conducted from the National Scientific Balloon Facility site at Palestine, Texas, or the United States Air Force site at Holloman, New Mexico; however, some flights are supported from remote sites in the northern United States, Canada, Alaska, Australia, New Zealand, Argentina and Brazil.

	Permanent Positions (Civil Service)
SPACE APPLICATIONS	54

Environmental Observations

In 1981, the WFC civil service personnel will continue to conduct the Meteorological Rocket Network project. The objectives of this project are:

1. To investigate the processes which characterize the physical state of the strato-mesosphere region of the atmosphere and to determine interactions within this layer of the atmosphere and with the troposphere.

2. To provide data for climatology of the upper atmosphere.

3. To provide in-situ measurement data which are used to calibrate satellite remote sensors.

Through the Meteorological Rocket Networks project, WFC manages NASA's participation in the Cooperative Meteorological Rocket Network (CMRN), the Experimental Inter-American Meteorological Rocket Network (EXAMETNET) and the Eastern-Western Hemisphere Meteorological Rocket Network.

In Ocean Processes, where the primary emphasis is being placed, investigations in the broad areas of sea state measurement, surface currents, ocean topographical mapping, and their supporting ground truth, are in progress.

In 1981, the WFC civil service personnel will be involved in investigating the feasibility of determining ocean surface currents from satellites and aircraft measurement of the local surface wave structure; investigating the "sea state bias effect" in satellite altimetry to develop methods of correcting the error; determining the mean sea surface of geoid; evaluating and determining the inadequacies of existing predictive and descriptive synoptic ocean circulation models and investigating the impact of utilizing synoptic altimeter data as input to the models; and developing techniques of using altimeter pulse wave from data for the determination of sea state.

Balloon Program

The objective of this program is to support the Space and Terrestrial Applications program using low cost balloon platforms in the field of stratospheric composition, meteorology and aeronomy.

	Permanent Positions (Civil Service)
TECHNOLOGY UTILIZATION	1

In 1981, the Technology Utilization program at WFC involves (1) expediting application of new technology, (2) encouraging the use of NASA Technology in other sectors, and (3) understanding more fully the technology transfer process and its impact.

AERONAUTICAL RESEARCH AND TECHNOLOGY	34

In 1981, the WFC airport will be involved in conducting research tests of various aircraft in the terminal area operating environment. Flight studies will be made of new approach and landing procedures utilizing the latest in guidance equipment and techniques, pilot information displays, terminal area navigation, and tests of other systems leading to automatic landing of aircraft. One runway has been modified to study the effect of runway grooving as a means of controlling aircraft hydroplaning on wet or slush-covered runways. Studies of automotive hydroplaning have also been conducted using this runway. The data acquired from the aircraft and automotive tests will ultimately assist in the development of safer, more flexible transportation systems.

TRACKING AND DATA ACQUISITION	105

Tracking and data acquisition activities provide both fixed and mobile equipment for tracking, data acquisition, and communications. These activities will encompass the acquisition of new systems, modifications and updating of existing systems and the operation, maintenance, and repair of these instrumentation systems. Included are highly precise instrumentation radars, analog and digital telemetry systems, precise range timing systems, range intercommunication systems, radio communication systems, tracking laser systems, digital data transmission systems, command and control systems, and digital data processing systems. These instrumentation systems are used in support of both aeronautical and rocket launched flight projects. These flight projects are conducted at WFC or at off-range locations in various parts of the world, depending upon the scientific experiment requirements. The sounding rocket programs supported at Wallops will cover all of the atmospheric and space disciplines in which research is undertaken, utilizing a family of launch vehicles varying in size and power from the small meteorological rockets to the 72-foot Scout with orbital capability. In 1981, more than 400 sounding rockets are to be launched from Wallops Island and remote sites around the world, carrying experiments in the fields of Aeronomy, Energetic Particles, Ionospheric Physics, Meteorology, and Solar Physics.

Of particular interest is the current effort to measure the effect of aerosols on the protective layer of ozone in the upper atmosphere which filters out harmful solar radiation.

	Permanent Positions (Civil Service)
CENTER MANAGEMENT AND OPERATIONS SUPPORT	125

Center Management and Operations Support is defined as the support or services being provided to all Wallops Flight Center organizations which cannot be directly identified to a benefitting R&D program or project. The civil service personnel involved are:

Director and Staff

The Center Director, Deputy Director and the immediate staff, e.g., Legal, Patent Counsel, Equal Opportunity, Planning and Analysis, Public Affairs and Safety.

Management Support

This category includes a wide range of activity categorized as management support for programs and functional organizations for the entire Center. Specific functions include resource and budget management, program control, contracting and procurement, personnel management, property management, financial management, resource control and management information systems and analysis.

Operations Support

This is a broad spectrum of activity that is required to maintain and operate facilities, buildings and equipment; and to provide the normal housekeeping services and logistics support for the personnel who manage and conduct the affairs of the Center. Specific activities are:

Maintenance and operation of all buildings and facilities
Data processing and computer support
Reliability and quality assurance
Center-wide security and protection
Fire protection
Custodial services
Logistics support including transportation and supplies
Medical care of employees
Photographic and graphic support

RESOURCE REQUIREMENTS BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
I. PERSONNEL AND RELATED COSTS	10,476	10,749	11,361	11,440
Summary of Fund Requirements				
A. Compensation and Benefits				
1. Compensation				
a. Permanent positions	9,006	9,299	9,878	9,936
b. Other than full time permanent positions	224	251	241	241
c. Overtime and other compensation	279	177	210	210
Subtotal, Compensation	9,509	9,727	10,329	10,387
2. Benefits	919	977	977	998
Subtotal, Compensation and Benefits	10,428	10,704	11,306	11,385
B. Supporting Costs				
1. Transfer of personnel	6	10	10	10
2. Personnel training	42	35	45	45
Subtotal, Supporting Costs	48	45	55	55
Total, Personnel and Related Costs	10,476	10,749	11,361	11,440

Explanation of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
A. Compensation and Benefits	10,428	10,704	11,306	11,385
1. Compensation	9,509	9,727	10,329	10,387
a. Permanent positions	9,006	9,299	9,878	9,936

The funds will support 395 permanent positions in 1981. The cost increase from the 1980 budget estimate to the 1980 current estimate is due primarily to the October 1979 pay increase.

Basis of Cost for Permanent Positions

In 1981, the cost of permanent positions will be $9,936,000 an increase of $58,000 from 1980. The increase results from the following:

Cost of permanent positions in 1980		9,878
Cost increases in 1981		+284
Within grade and career advances:		
Full year effect of 1980 actions	+120	
Partial year effect of 1981 actions	+117	
Full year effect of 1980 pay increases	+47	
Cost decreases in 1981		-226
Turnover savings and abolished positions:		
Full year effect of 1980 actions	-91	
Partial year effect of 1981 actions	-96	
One less paid day in 1981	-39	
Cost of permanent positions in 1981		9,936

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
b. Other than full time permanent positions				
1. Cost	224	251	241	241
2. Workyears	31	29	31	31

The 1981 plan includes 31 workyears which is the same as the 1980 current estimate and will support the following programs:

Distribution of Other than Full Time Permanent Workyears

Program	Workyears
Cooperative training	18
Summer employment	2
Opportunity programs	8
Other temporary employment	3
Total	31

The decrease from the 1980 budget estimate to the 1980 current estimate is due to a reevaluation based on 1979 actual experience.

c. Overtime and Other Compensation	279	177	210	210

Overtime funds are required at WFC primarily to meet operational requirements of the sounding rocket program of the Physics and Astronomy and Space Applications programs. Many factors beyond the Center's control, such as launch schedules, weather holds, and range clearance problems necessitate work beyond normal hours to operate the launch facilities, provide instrumentation support, and conduct tracking and data acquisition activities required to assure mission success. The increase from the 1980 budget estimate to the 1980 current estimate is due primarily to the October 1979 pay increase.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
2. Benefits	919	977	977	998
Following are the amounts of contribution by category:				
Civil Service Retirement Fund	646	669	691	693
Employee life insurance	30	44	32	32
Employee health insurance	227	247	239	239
Workmen's compensation	10	13	11	30
FICA	5	3	3	3
Other benefits	1	1	1	1
Total	919	977	977	998

Workmen's compensation estimates reflect the Department of Labor billings for 1980 and 1981.

B. Supporting Costs	48	45	55	55
1. Transfer of Personnel	6	10	10	10

The transfer of personnel costs in 1980 and 1981 will cover the expenses for one permanent change of station move planned each year.

2. Personnel Training	42	35	45	45

The estimates for personnel training provide for costs of the WFC engineering technician apprentice program. Current estimates for 1980 and 1981 are increased slightly over the 1980 budget estimate to reflect current experience and to provide for Civil Service Reform Act implementation training.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
II. TRAVEL	276	406	325	347
Summary of Fund Requirements				
A. Program Travel	220	210	232	248
B. Scientific and Technical Development Travel	25	51	53	57
C. Management and Operations Travel	31	145	40	42
Total, Travel	276	406	325	347
Explanation of Fund Requirements				
A. Program Travel	220	210	232	248

Program travel is directly related to the accomplishment of the Center's mission and reflects the continuing effort in the procurement and launch activities, the sounding rocket development program, the balloon program, and the aeronautical flight test program. The increase from the 1980 budget to the 1980 current estimate is due to increased travel requirements in support of off-site launch activity.

B. Scientific and Technical Development Travel	25	51	53	57

Scientific and technical development travel permits employees to participate in meetings and technical seminars with other representatives of the aerospace community. This participation allows them to benefit from exposure to technological advances outside WFC, as well as to present both accomplishments and problems to their associates. Many of the meetings are working panels convened to solve certain problems for the benefit of the Government.

C. Management and Operations Travel	31	145	40	42

Management and operations travel is used for the direction and coordination of general management matters. It includes travel in such areas as personnel, financial management, and procurement activities; travel of the Center's top management to NASA Headquarters, and other NASA Centers; and local transportation. The decrease from the 1980 budget estimate to the 1980 current estimate reflects the transfer of the support contract for intra-center transportation services to the Management and Operations function.

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	(Thousands of Dollars)			
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Summary of Fund Requirements				
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	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
III. FACILITIES SERVICES	3,317	3,398	3,586	3,771

Wallops Flight Center involves 6,166 acres and a complex of facilities which mainly consist of research, airport, and launch operations facilities. This complex encompasses 1,057,344 gross square feet of building space including three major buildings. Also included are three major technical facilities. This physical plant supports an average daily on-Center population of 900 to 1,100 personnel housed on site. Many of the test facilities are utilized on schedules involving more than one shift and/or frequently during off-peak hours.

Summary of Fund Requirements

A. Maintenance and Related Services				
1. Facilities	999	1,072	985	1,031
2. Equipment	110	52	113	121
Subtotal	1,109	1,124	1,098	1,152
B. Custodial Services	701	718	754	801
C. Utilities Services	1,507	1,556	1,734	1,818
Total, Facilities Services	3,317	3,398	3,586	3,771

Explanation of Fund Requirements

A. Maintenance and Related Services	1,109	1,124	1,098	1,152
1. Facilities	999	1,072	985	1,031

This activity, requiring 40 workyears of effort, provides for the maintenance, repair and alteration of over 300 buildings and one million square feet of building space on 6,166 acres of land. The corrosive environment at WFC, caused by its proximity to the ocean, requires frequent maintenance and repair of exterior surfaces, roofing, utility distribution systems, mechanical doors, hardware and building equipment.

The decrease from the 1980 budget estimate to the 1980 current estimate is due to decreased requirements for supplies and materials. The increase from 1980 current estimate to the 1981 budget estimate is for negotiated support contract wage increases. Major types of support in this area are:

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
a. Ground Maintenance				351
Twenty-one workyears provide for maintenance of lawns, trees and shrubs, and for snow removal.				
b. Maintenance and operations				334
Nineteen workyears provide for the maintenance and operation of over 300 buildings.				
c. Supplies				346
Provides for the replacement of supplies necessary to the operation of the WFC facility.				
2. Equipment	110	52	113	121

Seven workyears provide for the maintenance of facility related equipment at the Center. The increase in the 1980 current estimate and the 1981 budget estimate over the 1980 budget estimate are a result of the transfer of the heating and air conditioning contract into this function from the Facilities function.

B. Custodial Services	701	718	754	801

Provides for 50 workyears of support service contractor effort for janitorial services, firefighting and ambulance service, and plant security. Also provides for refuse removal, pest control and other miscellaneous services. The increases in the 1980 current estimate and in 1981 estimate over the 1980 budget estimate are for negotiated support contractor wage increases.

1. Janitorial Services 286

Twenty workyears provide for the cleaning of buildings.

2. Fire fighting and plant security 435

Thirty workyears provide for firefighting, ambulance, and security guard service.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
3. Miscellaneous				80

Provides for refuse removal, pest control, laundry and other miscellaneous services.

C. Utilities	1,507	1,556	1,734	1,818

The only purchased utilities at Wallops Flight Center are electricity and fuel oil to operate the heating plant. This funding also provides for 15 support contractor workyears to operate and maintain the heating plant and water and sewage facilities. Since the 1980 budget estimate, utility consumption figures have been revised. The increase in 1980 from the budget estimate to the current estimate is due to increased utility rates. The increase in 1981 is due to utility rate and negotiated support service contract wage increases. The purchased utilities are as follows:

1. Electricity (16,200 MWH)	778
2. Fuel Oil (1,244 K Gal.)	629

IV. TECHNICAL SERVICES	575	524	537	963

Summary of Fund Requirements

A. Automatic Data Processing				
1. Equipment	12	14	14	416
2. Operations	205	118	147	162
Subtotal	217	132	161	578
B. Scientific and Technical Information				
1. Library	99	104	112	120
2. Education and Information	15	175	100	100
Subtotal	114	279	212	220

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
C. Shop Support and Services	244	113	164	165
Total, Technical Services	575	524	537	963

Explanation of Fund Requirements

A. Automatic Data Processing	217	132	161	578

Provides for administrative data processing including equipment maintenance, programming, and operation. Six workyears of support contractor effort are budgeted for this activity. The increase from the 1980 budget estimate to the 1980 current estimate provides for higher equipment maintenance cost and negotiated support contractor wage increases. The increase in 1981 is to provide for the replacement of the Honeywell 625 Real-Time Data Processing System.

1. Equipment 416

Provides for annual maintenance of remote terminals and peripheral equipment used for administrative data processing, and in 1981, for the replacement of the Honeywell 625 Real-Time Data Processing System.

2. Operations 162

Six workyears provide programming and operation of equipment used for processing of necessary business data such as payroll and other fiscal records, procurement, and personnel and supply data.

B. Scientific and Technical Information	114	279	212	220

Includes the purchases of books, supplies and materials for, and the operation of the WFC Technical Library. It also provides for public information services, and for the exhibits, and operation of a Visitor Information Center. The increases in 1980 and 1981 over the 1979 level reflect the completion of the Visitor Information Center (VIC) in 1980 and subsequent operational costs. The decrease of the 1980 current estimate from the 1980 budget estimate reflects completion of the VIC later in 1980 than previously anticipated resulting in reduced operations requirements for the fiscal year.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
1. Library				120

Three workyears are used to operate the Library. The procurement of books, subscriptions, supplies and materials are also covered.

2. Education and Information 100

One workyear of support contractor effort is used to provide tour guide services for visitors. Provision is also made for the cost of exhibits and the operation of the soon to be completed Visitor Information Center (VIC) at WFC and for miscellaneous other public information services.

C. Shop Support and Services	244	113	164	165

Four workyears of support contractor effort will be used to provide engineering and fabrication support for facility planning and alteration. The increase from the 1980 budget estimate to the 1980 current estimate reflects a one manyear increase in the engineering services and machine shop support requirements.

V. MANAGEMENT AND OPERATIONS	1,162	1,253	1,276	2,456
Summary of Fund Requirements				
A. Administrative Communications	115	136	136	146
B. Printing and Reproduction	70	86	75	80
C. Transportation	225	80	208	1,208
D. Installation Common Services	752	951	857	1,022
Total, Management and Operations	1,162	1,253	1,276	2,456

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		

Explanation of Fund Requirements

A. Administrative Communications..... 115 136 136 146

Provides for the operation of the WFC main switchboard and teletype facility, for the cost of leased lines and long distance tolls, and for maintenance services. The increase from 1980 to 1981 is to cover the cost of negotiated support contract wage increases.

1. Long Distance Telephone Service..... 6

Covers the cost of leased lines and long distance tolls.

2. Other Communication Services..... 140

Five workyears are required to operate the WFC main switchboard and teletype facility. Provision is also made for maintenance and repair services.

B. Printing and Reproduction..... 70 86 75 80

Provides for five workyears of support service contractor effort to operate the printing and reproduction facility at WFC. The decrease from the 1980 budget estimate to the 1980 current estimate is due to a slight decrease in requirements for supplies and materials. The increase from the 1980 current estimate to the 1981 budget estimate is to cover the cost of negotiated support contract wage increases.

C. Transportation..... 225 80 208 1,208

Includes the cost of commercial off-base services and repairs to the government-owned motor vehicle fleet; the maintenance and repair of the WFC Queen Air aircraft; and freight and related transportation costs. The increase from the 1980 budget estimate to the 1980 current estimate reflects the transfer of the intra-Center transportation contract from the Management and Operations Travel category as well as increased costs for maintenance and repair of motor vehicles and aircraft. The 1981 estimate includes the cost of replacing the 17-year-old Queen Air aircraft with a more modern fuel efficient, turbine powered, and reliable aircraft. This replacement is in keeping with the requirement to upgrade the Queen Air aircraft within NASA, as other agencies have, with newer aircraft that will provide long-term dependability. The replacement aircraft will also increase reliability, safety, maintainability, and performance in satisfying WFC's continuing needs.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		

1. Transportation of Things..... 5

Covers the cost of freight charges, and costs related to local moves, i.e., drayage and parcel post.

2. Maintenance and Repair of Vehicles..... 128

Provides for commerical services and repairs to the Government-owned motor vehicle fleet.

3. Maintenance and repair of aircraft..... 1,075

Provides for approximately one workyear of contractor effort and for parts and supplies required to maintain the WFC Queen Air aircraft. Also provides for the replacement of the 17-year-old Queen Air aircraft in 1981.

D. Installation Common Services.....	752	951	857	1,022

Provides for medical services, rental of copying machines, supplies, materials and equipment used for administrative purposes, supply management, materials handling, and postage. The decrease from the 1980 budget estimate to the 1980 current estimate is due to decreased requirements for supplies and materials, machine rentals and postage. The increase from 1980 to 1981 is for negotiated support contract wage increases.

1. Medical Services..... 34

Provides for the part-time services of medical doctors in support of the WFC Occupational Health program.

2. Machine Rental..... 155

Covers the rental and maintenance of copying equipment.

3. Supplies and Equipment..... 365

Provides for supplies, materials and equipment necessary for the administrative functions at WFC.

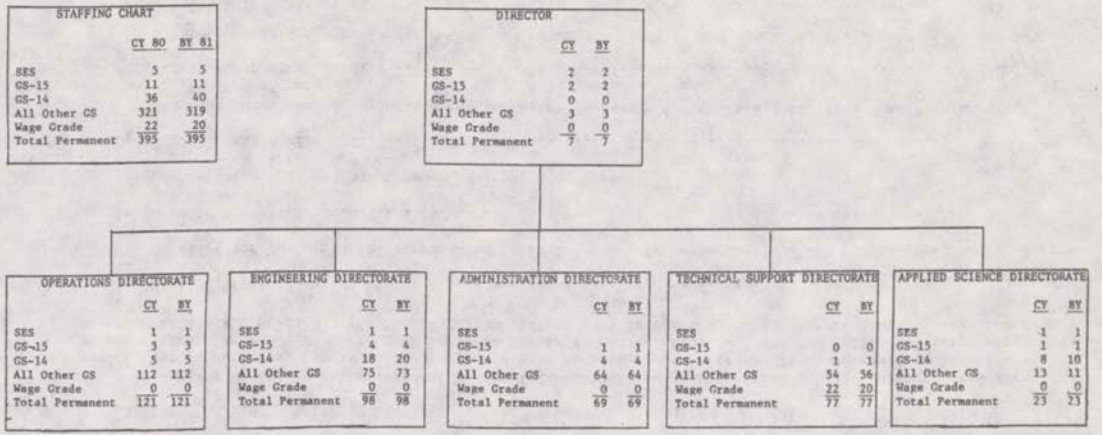
4. Supply Management..... 443

Nineteen workyears provide for moving and materials handling and operating the supply system at WFC.

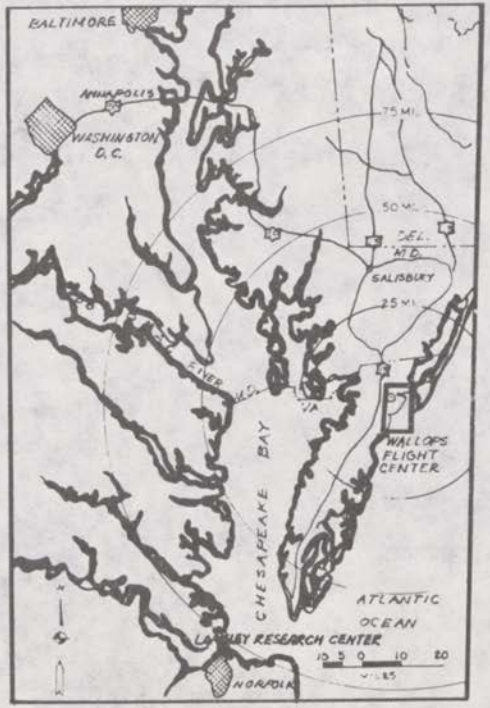
5. Postage..... 25

Covers the cost of the Center's postal bill.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
ORGANIZATION AND STAFFING CHART
WALLOPS FLIGHT CENTER

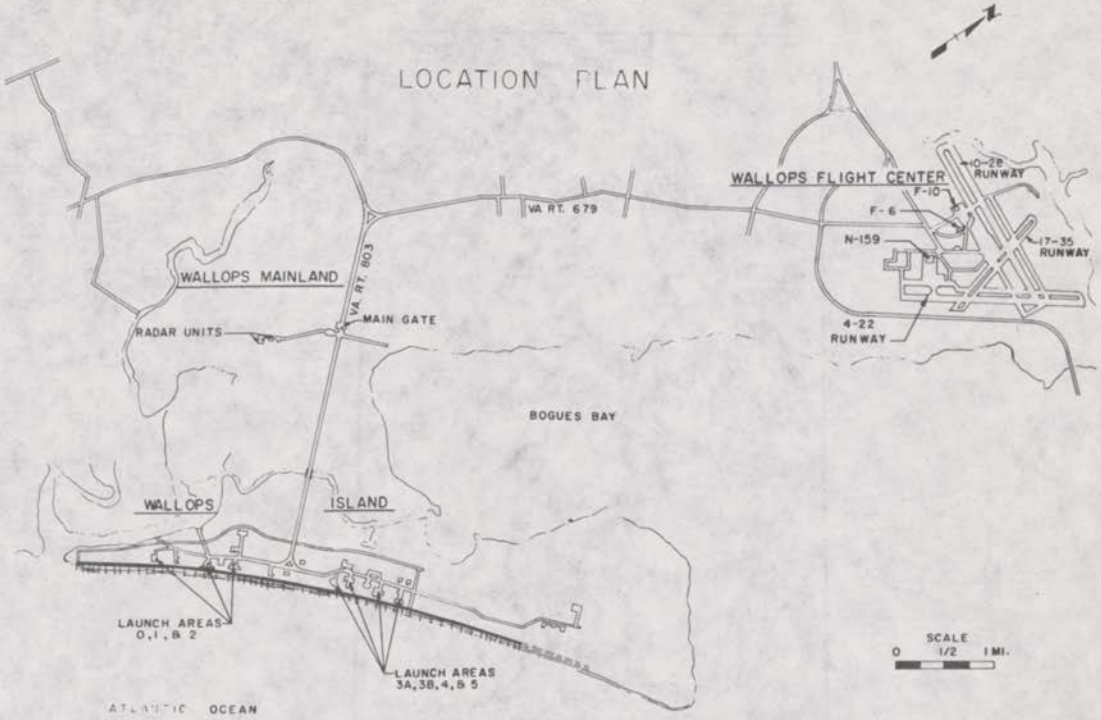


—WALLOPS—
FLIGHT CENTER LOCATION



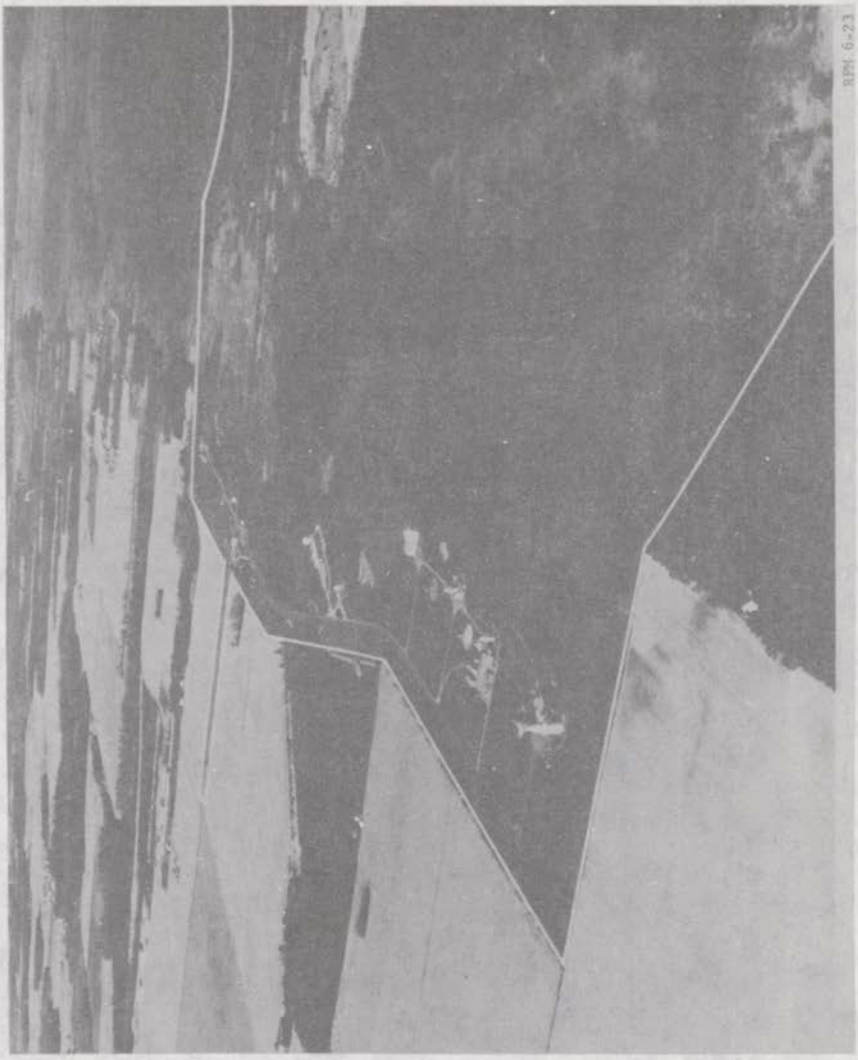
WALLOPS FLIGHT CENTER

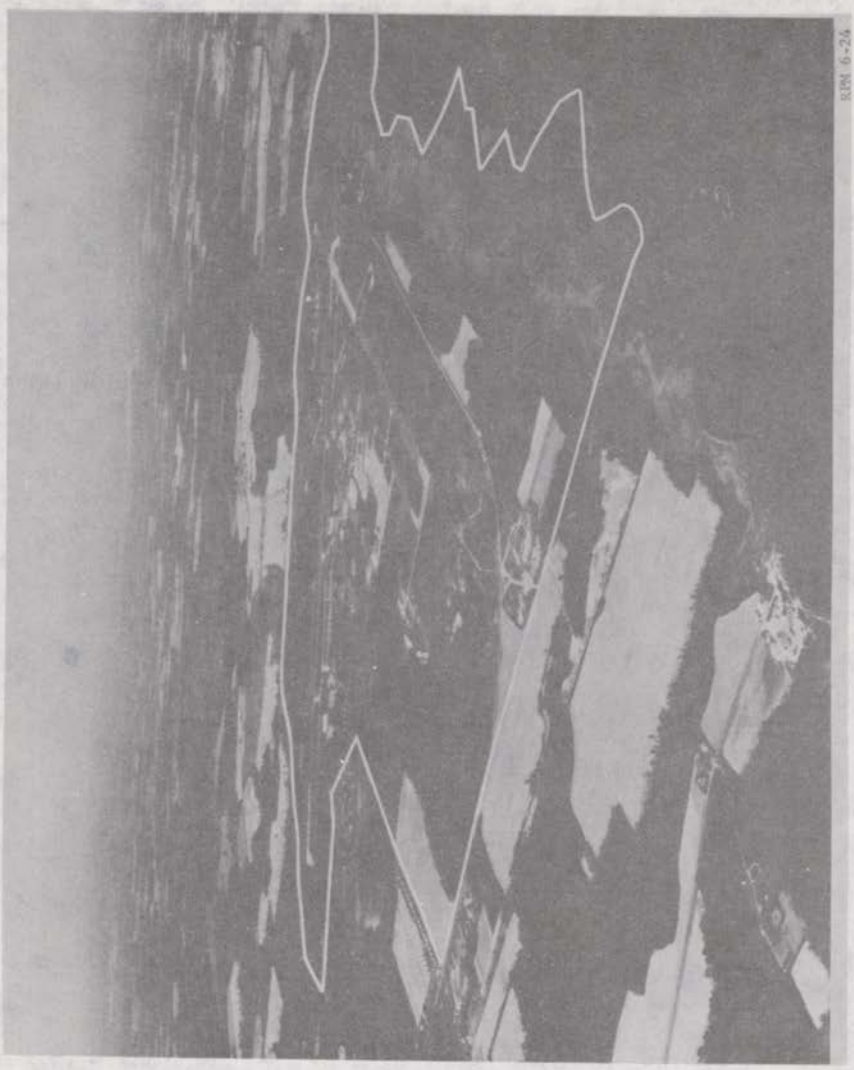
LOCATION PLAN

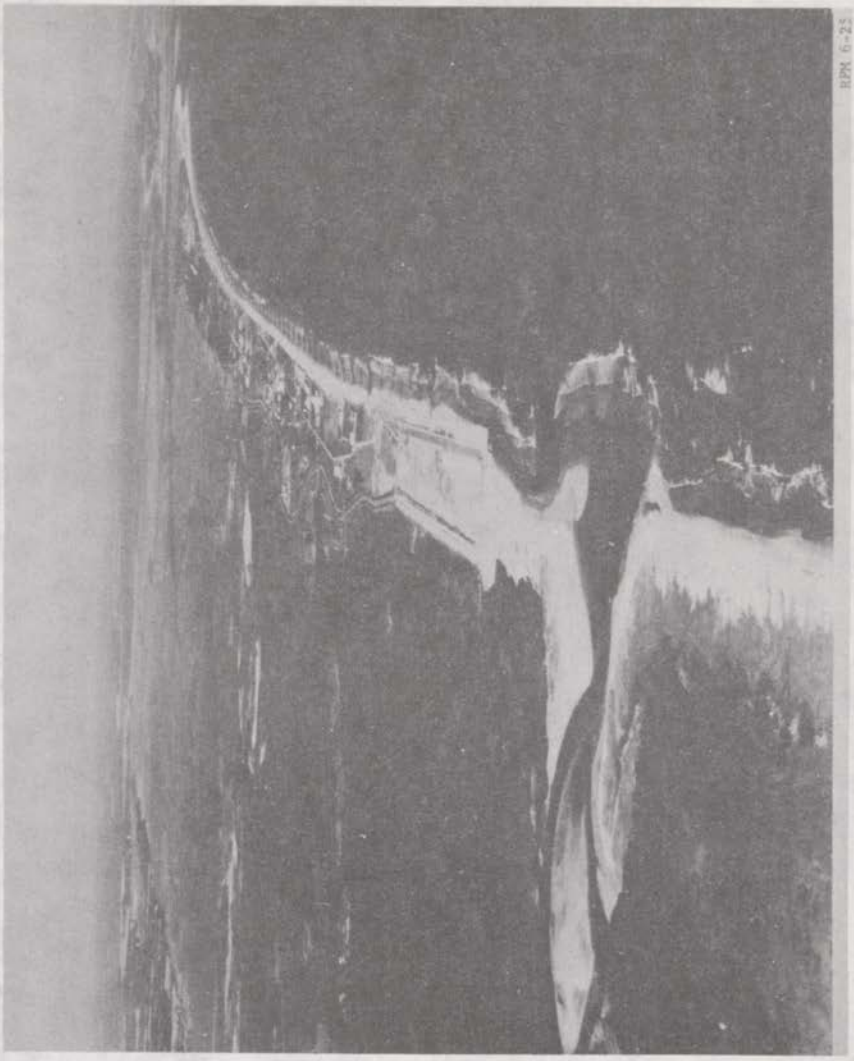


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RPM 6-22


RPI 6-23


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RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 1981 ESTIMATES

AMES RESEARCH CENTER

DESCRIPTION

The Ames Research Center (ARC) is located on 421 acres at the southern end of San Francisco Bay on land contiguous to the U.S. Naval Air Station, Moffett Field, California. Certain facilities, such as the utilities and airfield runways, are used jointly by NASA and the Department of the Navy. Also housed at the ARC is the U.S. Army Research and Technology Laboratory. Personnel from this laboratory work closely with Ames personnel on research of mutual interest. The capital investment at the ARC, including fixed assets in progress and contractor-held facilities at various locations, as of September 30, 1979, was $447,809,000.

CENTER ROLES AND MISSIONS

The programs at the Ames Research Center involve research and development in the fields of aeronautics, space science, life science, and space technology, as well as applications to national needs of the new science and technology growing out of the aerospace program. Specifically, the Center's major program responsibilities are concentrated in: short-haul aircraft technology, rotorcraft technology, flight simulation, computational fluid dynamics, planetary probes, airborne sciences and applications, and aeronautical and space life sciences. In addition to these major program responsibilities, the Center provides support for military programs, and various civil aviation projects. The principal and supporting roles are:

PRINCIPAL

Fundamental Aerodynamics - advancing the general state of the art, both theoretical and experimental.

Short-Haul Aircraft Technology - developing a technology base for facilitating incorporation of short-haul aircraft into overall air transportation systems.

Rotorcraft Technology - developing a technology base for improving efficiency and flexibility for both civil and military use.

Computational Fluid Dynamics - furthering the state of the art through the definition of new systems, both hardware and software, and application to aeronautical and other related areas.

Flight Simulation - improving the state of the art to permit more effective use of simulators in aircraft design and validation-of-flight simulation.

Military Support - providing the technical support to military aviation in areas consistent with other ARC aeronautics roles and unique ARC capabilities.

Airborne Research and Applications - operating instrumented jet aircraft for the purpose of conducting airborne research and applications experiments.

Planetary Probes - developing thermal protection systems required for planetary atmosphere entry probes and managing probe development.

Planetary Mission Operations and Data Analysis - completing the currently approved Pioneer series, including associated mission operations.

Life Sciences:

Human-Vehicle Interactions - furthering the state of the art through the study of man-machine and other human factor interactions and considerations involved in aircraft operations.

Biomedical Support Systems - developing advanced technology for development of long duration life support systems and protective systems.

Biological Experiments - developing, managing and operating experiments for determining effects of space flight on (non-human) living organisms and for providing information applicable to solving space medicine problems.

SUPPORTING

Space Transportation Passenger Selection Criteria - developing and evaluating the medical criteria for non-crew passenger selection.

Astronomical Observation Techniques - focusing on airborne research and the developing of infrared techniques and supporting systems for use in Spacelab payloads.

Vertical/Short Take-Off and Landing (V/STOL) Technology - developing a technology base for military V/STOL in support of Department of Defense missions.

SUMMARY OF RESOURCES REQUIREMENTS

FUNDING PLAN BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
I. Personnel and Related Costs	51,456	53,514	56,661	57,113
II. Travel	1,285	1,313	1,353	1,446
III. Facilities Services	6,185	7,439	7,804	8,736
IV. Technical Services	844	909	866	924
V. Management and Operations	2,942	2,664	3,117	3,250
Total, fund requirements	62,712	65,839	69,801	71,469

Distribution of Permanent Positions by Program

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Direct Positions				
Space Science	321	324	308	303
Physics and astronomy	94	90	101	98
Planetary exploration	89	96	71	69
Life sciences	138	138	136	136
Space and Terrestrial Applications	117	112	116	117
Space applications	109	107	108	109
Technology utilization	8	5	8	8
Aeronautics and Space Technology	807	801	816	820
Aeronautical research and technology	642	658	651	655
Space research and technology	165	143	165	165
Subtotal, direct positions	1,245	1,237	1,240	1,240

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Center Management and Operations Support Positions	421	416	418	418
Total, permanent positions	1,666	1,653	1,658	1,658

PROGRAM DESCRIPTION

	Permanent Positions (Civil Service)
PHYSICS AND ASTRONOMY	98

Ames concentrates its physics and astronomy activities in the field of infrared astronomy, taking the agency lead in this discipline.

In 1981, the civil service personnel will provide support for the airborne astronomy program which includes a C-141 aircraft--the Kuiper Airborne Observatory (KAO)--as well as a Lear Jet aircraft. These aircraft are operated by Ames as flying astronomical observatories with the bulk of the observing accomplished by various University research teams. Ames supports these facilities with its in-house science competence and with its in-house capability to operate research aircraft.

Infrared astronomy observation from space platforms avoids obscuration caused by the Earth's atmosphere. Ames has responsibility for instruments to accomplish these observations including development of the telescope portion of the Infrared Astronomical Satellite (IRAS), definition of an advanced instrument for use on Spacelab missions, and studies of instruments that may eventually be used as free flyers in space.

PLANETARY EXPLORATION	69

These civil service personnel are required in 1981 to accomplish the ongoing programs in support of agency goals in planetary exploration. This program consists of a continuing series of project management activities, backed by the scientific expertise of principal investigators from Ames, other NASA Centers and the University community. An in-house supporting research and technology program serves both to maintain the Center's scientific and technological expertise and to provide the stimulus and definition for new planetary missions.

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In 1981 the civil service personnel will continue to provide project management and scientific support for: (1) Pioneers 6-9, a series of spacecraft exploring the physics of the interplanetary medium and providing ongoing data on the plasma in which the Earth is immersed; (2) Pioneers 10 and 11, two spacecraft that made close approaches to the planet Jupiter to study both the planet itself and the interaction of the solar wind with the planet's strong magnetic field (these spacecraft were then retargeted by being swung in the Jovian gravity field to explore other regions of the solar system--Pioneer 11 made the first close reconnaissance of Saturn in 1979, and Pioneer 10 has now crossed the orbit of Uranus on its way out of the solar system); (3) Pioneer Venus, launched in 1978, with its orbiter now in place around Venus; and (4) the Galileo project, approved in 1978, a natural outgrowth of the Pioneer Venus atmospheric probes. Ames has responsibility for the Probe portion of this mission.

Ames researchers are playing key roles in all of these missions; Ames scientists are responsible, as principal investigators, for measuring the characteristics of the solar wind in interplanetary space and near Jupiter and Saturn; for measuring the atmospheric structure on Mars, Venus and Jupiter; for measuring atmospheric radiation balance on Venus and Jupiter; for measuring cloud characteristics on Venus and Jupiter; and for studying Mars for possible life-bearing soils and compounds. Ames researchers are also responsible for synthesizing atmospheric models for these planets that can be used to explain their current state and evolution and that can be applied in comparative studies to understand features of the Earth's weather and climate.

Ames principal investigators and their coworkers maintain an active program of laboratory and theoretical studies to develop basic atmospheric modeling concepts, to obtain the necessary physical data on a molecular scale to interpret the spacecraft observations, and to develop new and improved scientific measurements and instrument concepts for use on spacecraft. This program concentrates on planetary atmospheres, and has been particularly active in combining radiative transfer concepts with aerosol physics to obtain comprehensive planetary cloud and dust models.

	Permanent Positions (Civil Service)
LIFE SCIENCES	136

In 1981, the civil service personnel will continue to be involved in research, hardware development, and program management related to meeting program milestones in the areas of understanding the effects of space flight on humans and other life forms; managing nonhuman biological experiments in space; developing advanced life support concepts and systems; and understanding the origin, evolution, and distribution of life and life-related chemicals on Earth and elsewhere in the universe. Examples of specific 1981 activities follows:

Space flight simulation studies will continue, with testing of 55- to 65-year old females, and other individuals with borderline of mild hypertension in the program, to understand and develop countermeasures for the physiological stresses of Shuttle flight. Ames investigators will be involved in the development phase of both animal and human experiments for the first dedicated life sciences Spacelab. Research will be underway to determine whether learned autonomic control (biofeedback training) to suppress the symptoms of motion or space sickness is still effective during the performance of a complex cognitive or motor task.

Launch of the first life sciences experiment to fly on the Shuttle will occur on a Shuttle orbital flight test mission. The first flight unit of the Research Animal Holding Facility, configured to hold mice and rats, will be delivered in late FY 1981 for checkout and test at Ames prior to its flight on Spacelab III. Hardware for U.S. experiments will be delivered to the Soviet Union for the Joint US/USSR Cosmos biological satellite flight in calendar year 1981.

Studies will be under way using closed chambers for investigations of controlled ecology life support systems for space flight.

Research in the origin and distribution of life and life-related molecules will be highlighted by analyses of biochemical pathways in living systems and of chemical abundances in precambrian deposits by the use of an ultrasensitive stable isotope measuring system, and studies of the interactions of known polypeptides and deoxyribonucleic acid (DNA) segments.

	Permanent Positions (Civil Service)
SPACE APPLICATIONS	109

A highly diversified group of scientifically capable people is required to support programs in Earth Observations including space, atmospheric, and stratospheric programs; to provide skilled personnel and specialized airborne platforms in support of the Agency's applications satellite programs; to provide skilled personnel to interpret and process both spaceborne and airborne remotely sensed data; to provide knowledgeable personnel to interact with and disseminate data and associated processing techniques to the user community.

The Ames stratosphere research program is an integrated activity that blends the expertise of the Center and University scientists both in the development of computer models for the upper atmosphere and in the measurement of stratospheric constituents and properties from aircraft platforms. Computer modeling of the stratosphere is being performed at Ames to understand the unperturbed stratosphere and to predict the effects on the stratosphere of various pollutants, such as aircraft emissions and fluorocarbons, and of natural events such as the solar cycle and solar storms. A similar program is under way for climate focussing on the climatic effects of aerosols in the Earth's atmosphere through models of aerosols and their radiative effects and measurements of aerosol properties from Ames aircraft.

Further, the Center's Space Applications role is fulfilled by: (1) conducting an active and continuing broad program of applied research and development to enhance the use of remote and in situ sensing technology for Earth resources applications and to transfer the ability to use this technology to a variety of Federal, State, regional, and local agencies; (2) working with these agencies to plan, initiate, and develop feasible and economical Earth resources sensing projects tailored to their specific needs; and (3) defining, developing, and evaluating potential satellite sensors, data acquisition and processing techniques, and associated communications technology. The Center controls a variety of operational aircraft, some of which serve as national and international faoilities for research in astronomy, geophysics, meteorology, and Earth resources; others acquire data for remote sensing projects and provide a mechanism for integration of spaceborne, airborne, and ground-based data acquisition and processing systems.

In addition, this diversified scientific group: (1) provides management support to the Office of Space and Terrestrial Applications for the airborne instrumentation research program at Ames and other NASA Centers; and (2) provides a mechanism for implementation of applications transfer activities through the Western Regional Remote Sensing Applications Center.

	Permanent Positions (Civil Service)
TECHNOLOGY UTILIZATION	8

The Technology Utilization program at Ames is a community undertaking involving the part-time efforts of scientists and engineers in many disciplines and in many Center organizations working under the leadership and coordination of a small full-time Technology Utilization Office staff to move knowledge developed from the NASA programs to industry for effective use in the market place.

AERONAUTICAL RESEARCH AND TECHNOLOGY	655

In 1981, the content of the Ames program in aeronautics is characterized in terms of three elements: Generic Research and Technology, Vehicle Specific Technology (Short-Haul, Rotorcraft) and aeronautical support to other agencies and to industry. These three elements form a coherent and interdependent program to meet the Vertical/Short Take-Off and Landing (V/STOL) and rotorcraft milestones of improved aerodynamic and operational performance, improved terminal area safety and efficiency, and reduced noise and vibrations.

Generic Research and Technology:

The Generic Research and Technology program at Ames has its principal focus in the areas of computational aerodynamics, experimental methods, avionics, and safety. The program is concentrated in the disciplines of aerodynamics and aeroelasticity, flight dynamics, guidance and control, and human factors. The program

provides the fundamental disciplinary advances, both theoretical and experimental, that extends the state of the art. Substantial progress is anticipated in our ability to compute the theoretical behavior of aerodynamic and propulsive flows and to measure experimental aircraft configuration parameters. In 1981, research programs in flight dynamics will define the important interrelationships between vehicle dynamics, stability and control, and handling qualities in the regime of hover, and in transition from vertical to horizontal flight for advanced V/STOL aircraft and rotorcraft. In guidance and control, the use of optimal control theory in conjunction with dynamic modeling of aircraft and ground-based guidance aids will provide new insight into the definition of air traffic control algorithms, particularly for the terminal area.

In 1981, highlights in the human factors program will include: completion of the development of a baseline generic display of air traffic information for use in an aircraft cockpit; development of helicopter display and control integration to reduce pilot workload; study of advanced flight display formats for improving information presentation to aircrews; and completion of the operation of the NASA/FAA Aviation Safety Reporting System as specified by the implementing Memorandum of Agreement.

Vehicle Specific Technology Short-Haul:

The Vehicle Specific Technology at Ames is focused on short-haul aircraft, both civil and military; Rotorcraft, V/STOL and Short-Range Conventional Take-Off and Landing (CTOL) aircraft. These aircraft have unique characteristics including: a dependence on propulsive life (in addition to aerodynamic lift); greater capability for versatile operations in the terminal area; and a greater degree of integration of man and machine. The vehicle technology emphasis at Ames relates to and depends on the basic capabilities and the aeronautical research disciplines described previously. In 1981, the research program will include small-scale and large-scale wind tunnel testing and ground based simulation, and will culminate in flight research utilizing both rotorcraft and powered-lift research aircraft. This class of aircraft is dependent on high lift technology and low cost guidance and control systems, both of which are part of the ongoing program at ARC. The program includes wind tunnel and simulation investigations to achieve a significantly improved short-haul transport aircraft concept and compatible low cost avionics.

Other Agency and Industry Support:

The Ames Research Center has traditionally received requests from other agencies and from the industry for test support of their aircraft and systems development programs. The Navy and NASA have agreed to a comprehensive technical support program for the Navy V/STOL aircraft technology development. The Army Research and Technology Laboratories of the U.S. Army Aviation Research and Development Command (AURADCOM) is located at Ames. The Aeromechanics Laboratory, the primary investigator of Army rotorcraft flight dynamics and controls, is also located at Ames, working both on independent R&D projects and with a staff integrated into the NASA organization on projects of joint interest. Extensive use is made of Ames aeronautical research facilities in these efforts. There are also a large number of joint programs with the Air Force Systems Command and the Navy Systems Command. Examples of these joint programs are: The Air

Force; Advanced Fighter Technology Integration, Advanced Flight Control Systems, Laser Velocimeter Vortex Flow Measurements, Aero-Optics Program and the A-10 Testing; The Navy; Aerodynamic Test Support of the AV-8B Harrier, V/STOL Fighter Studies and Wing Design Optimization Studies.

	Permanent Positions (Civil Service)
SPACE RESEARCH AND TECHNOLOGY	165

In 1981, the number of civil service personnel requested will provide a Space Research and Technology Program which encompasses both basic research and project support. The basic research focuses on entry technology and materials research. The project work supports Space Shuttle, Galileo, Infrared Astronomical Satellite (IRAS) and the Orbiter Experiment program (OEX).

In 1981, the entry technology research will provide the aerothermodynamic data required for the design, development, and verification of planetary entry vehicles, and for computational fluid dynamic codes to predict space vehicle flow fields and performance. Work is proceeding to apply laser physics and laser techniques to the development of flow diagnostic tools to remotely probe gas dynamic flows in order to define and verify turbulence models. Research efforts in the materials area will provide thermal protection systems concepts and materials for heat shields to protect earth and planetary entry vehicles (probes), develop computational chemistry codes to calculate basic properties of matter and expand the understanding of surface-environment interactions (corrosion). Research is also being conducted in the advanced electronics and materials area to determine atomic structure and properties of absorbed surface layers and to advance the state of the art of computing wave functions for molecules and atomic clusters.

In 1981, the Shuttle project will be supported with ground-based facilities to study a variety of aerodynamic and thermodynamic problems. The Galileo project will be supported with heat shield design and performance data, heat shield shape change effects on aerodynamics, and subsonic probe stability. In the area of orbiting astronomical instruments, work will continue to develop infrared detectors, to define systems for precision pointing and control of telescopes and to advance the technology required to cool the detectors to below 10 degrees Kelvin for support of the IRAS project. Ames Research Center is supporting two Space Shuttle Orbiter experiments. The first is an OEX experiment for Infrared Imaging of Shuttle (IRIS) to obtain measurements of surface temperatures of the lower and side surfaces of the orbiter by remote imagery from the C-141 Kuiper Airborne Observatory (KAO). The second is to conduct OEX thermal protection experiments to study advanced materials and to evaluate possible cost and weight reductions for the thermal protection system for Shuttle and Advanced Space Transportation Systems.

	Permanent Positions (Civil Service)
CENTER MANAGEMENT AND OPERATIONS SUPPORT	418

Center Management and Operations Support is defined as that support or services being provided to all Ames Research Center organizations which cannot be directly identified to a benefiting program or project. The civil service personnel involved are:

Director and Staff

The Center director, deputy director and the immediate staff, e.g., legal, patent counsel, equal opportunity, planning and analysis, public affairs, energy management and safety.

Management Support

Includes a wide range of activity categorized as management support for programs and functional organizations for the entire Center. Specific functions include resource and budget management, program control, contracting and procurement, personnel management, property management, financial management, and management information and analysis.

Operations Support

This is a broad spectrum of activity that is required to maintain and operate facilities, buildings, and equipment, and to provide the normal housekeeping services and logistics support for the personnel who manage and conduct the affairs of the Center. Specific activities are:

Maintenance and operation of all buildings and facilities
Administrative data processing and computer support
Centerwide security and protection
Fire protection
Custodial services
Logistics support including transportation, supplies, etc.
Medical care of employees

RESOURCE REQUIREMENTS BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
I. PERSONNEL AND RELATED COSTS	51,456	53,514	56,661	57,113
Summary of Fund Requirements				
A. Compensation and Benefits				
1. Compensation				
a. Permanent positions	45,320	47,175	49,588	49,883
b. Other than full time permanent positions	725	800	1,146	1,240
c. Reimbursable detailees	28	168	168	168
d. Overtime and other compensation	563	461	515	515
Subtotal, Compensation	46,636	48,604	51,417	51,806
2. Benefits	4,419	4,630	4,832	4,895
Subtotal, Compensation and Benefits	51,055	53,234	56,249	56,701
B. Supporting Costs				
1. Transfer of personnel	120	85	85	85
2. Personnel training	281	195	327	327
Subtotal, Supporting Costs	401	280	412	412
Total, Personnel and Related Costs	51,456	53,514	56,661	57,113

Explanation of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
A. Compensation and Benefits	51,055	53,234	56,249	56,701
1. Compensation	46,636	48,604	51,417	51,806
a. Permanent positions	45,320	47,175	49,588	49,883

The funds will support 1,658 permanent positions in 1980 and 1981. The increase from the 1980 budget estimate to the 1980 current estimate is due primarily to the October 1979 pay increase.

Basis of Cost for Permanent Positions

In 1981, the cost of permanent positions will be $49,883,000. The increase from 1980 results from the following:

Cost of permanent positions in 1980		49,588
Cost increases in 1981		+1,062
Within grade and career advances:		
Full year effect of 1980 actions	+440	
Partial year effect of 1981 actions	+510	
Full year effect of 1980 pay increases	+112	
Cost decreases in 1981		-767
Turnover savings and abolished positions:		
Full year effect of 1980 actions	-328	
Partial year effect of 1981 actions	-274	
One less paid day in 1981	-165	
Cost of permanent positions in 1981		49,883

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
b. Other than full time permanent positions				
1. Cost	725	800	1,146	1,240
2. Workyears	81	93	112	116

The 1981 plan includes 116 workyears which will support the following programs:

Distribution of Other than Full Time Permanent Workyears

Program	Workyears
Cooperative training	32
Summer employment	18
Opportunity programs	34
Other temporary employment	32
Total	116

The increase from the 1980 budget estimate to the 1980 current estimate is due to a buildup in two feeder programs: (1) the non-baccalaureate cooperative training program and (2) the NASA Graduate Intern program, the continuation of the part-time permanent program, and the institution of the White House Research Apprenticeships program.

The 1981 estimate reflects a continuation of the 1980 level allowing for the required promotion of the Graduate Interns at the end of their first year and a scheduled buildup in the Research Apprenticeships program.

c. Reimbursable detailees	28	168	168	168

The military personnel detailed to the Ames Research Center on a reimbursable basis are individuals experienced in aeronautics, rotorcraft technology and related fields.

The increase in 1980 is due to full-year payment of 5 detailees phased in during late 1979 and early 1980 to support the rotorcraft program. The 1981 estimate provides for continuation of the same level of effort.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
d. Overtime and other compensation	563	461	515	515

Overtime and night differential are used primarily for off-shift operation of major facilities such as the Unitary Plan Wind Tunnel System, the 40- by 80-Foot Subsonic Wind Tunnel, and the 6- by 6-Foot Supersonic Wind Tunnel. The increase from the 1980 budget estimate is due to additional support of 40- by 80-Foot Subsonic Wind Tunnel modification project, the cost of the October 1979 pay increase. Overtime will remain level in 1981.

2. Benefits	4,419	4,630	4,832	4,895
Following are the amounts of contribution by category:				
Civil Service Retirement Fund	3,188	3,291	3,539	3,560
Employee life insurance	133	190	150	159
Employee health insurance	865	915	877	880
Workman's compensation	216	216	246	276
FICA	17	18	20	20
Total	4,419	4,630	4,832	4,895

The increase from the 1980 budget estimate to the 1980 current estimate is due to pay increases. Workmen's compensation estimates reflect the Department of Labor billings for 1980 and 1981.

The increase in 1981 over 1980 is related to the increase in personnel compensation.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
B. Supporting Costs	401	280	412	412
1. Transfer of personnel	120	85	85	85

The decrease from the 1979 actual to the current estimates for 1980 and 1981 are due to completion of the personnel transfers related to the rotorcraft project.

2. Personnel training	281	195	327	327

The increase from the 1980 budget estimate to the 1980 current estimate is due to the tuition costs associated with the buildup of the NASA Graduate Intern program (initiated late in 1979) and costs associated with Civil Service Reform Act implementation training.

II. TRAVEL	1,285	1,313	1,353	1,446
Summary of Fund Requirements				
A. Program Travel	807	927	967	1,031
B. Scientific and Technical Development Travel	187	145	145	155
C. Management and Operations Travel	291	241	241	260
Total, Travel	1,285	1,313	1,353	1,446
Explanation of Fund Requirements				
A. Program Travel	807	927	967	1,031

Program travel is required for the accomplishment of the Center's mission and is the largest part of the Ames travel budget, accounting for 71 percent of travel costs for 1981. Travel for program purposes is required for the continuing efforts in space research, aircraft technology, flight simulation, fluid mechanics, airborne research and applications, and space life sciences.

The increase in the 1980 current estimate is required for support of the Infrared Astronomy Satellite, Galileo, Western Regional Applications program, increased C-141 flights and monitoring of various contractor's performance in the construction of the 80- by 120-Foot Wind Tunnel Test section. Increase in program travel in 1981 is needed for: the scheduled flight testing of the Tilt Rotor and the Quiet Short-Haul Research Aircraft (QSRA); the management, coordination and integration of 45 experiments in the Life Science Flight Experiments program scheduled for Spacelab 3 and 4 (which involves trips, to several institutions domestically, in Europe, and Australia); the Ames participation in the Russian Cosmos project and Bed Rest experiment which will require trips to Moscow and Budapest.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
B. Scientific and Technical Development Travel.....	187	145	145	155

Scientific and technical development travel permits employees to participate in meetings and technical seminars with other representatives of the aerospace community. This participation allows them to benefit from exposure to technological advances outside ARC, as well as to present both accomplishments and problems to their associates. Many of the meetings are made up of working panels convened to solve certain problems for the benefit of the Government. The level of travel in 1981 is expected to increase to provide for the presentation of additional aeronautical, life sciences and space and astronautical papers to the scientific community.

C. Management and Operations Travel.....	291	241	241	260

Management and operations travel provides for the direction and coordination of general management matters. It includes travel in such areas as personnel, financial management and procurement activities, and travel of the Center's top management to NASA Headquarters, other NASA Centers, contractor plants, and local transportation. The increase in 1981 allows only for the escalation of the General Services Administration (GSA) rental rates for passenger vehicles and the escalation of fuel costs for passenger vehicles.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
III. FACILITIES SERVICES	6,185	7,439	7,804	8,736

Ames Research Center is located on 421 acres of ground in a complex of facilities made up of laboratory and office type buildings as well as research wind tunnels.

This complex encompasses 2,101,754 gross square feet of building space including 10 major buildings. Also included are 11 major technical facilities. This physical plant supports an average daily population of 2,500 to 2,900 personnel. Many of the facilities are utilized on schedules involving more than one shift and frequently during off-peak hours.

Summary of Fund Requirements

A. Rental of Real Property	3	---	---	---
B. Maintenance and Related Services				
1. Facilities	327	129	134	135
2. Equipment	67	63	67	68
Subtotal	394	192	201	203
C. Custodial Services	1,703	1,640	1,702	1,841
D. Utilities Services	4,085	5,607	5,901	6,692
Total, Facilities Services	6,185	7,439	7,804	8,736

Explanation of Fund Requirements

A. Rental of Real Property	3	---	---	---

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
B. Maintenance and Related Services	394	192	201	203
1. Facilities	327	129	134	135
2. Equipment	67	63	67	68

Maintenance and repair includes the maintenance of grounds and emergency repairs of heating, ventilating, lighting equipment of institutional buildings and offices. The maintenance of grounds include general landscape maintenance of approximately 30 acres of improved planted areas and includes pest control of these areas; maintenance of approximately 45 acres of unimproved areas such as substations, aircraft taxiways, drainage ditch, large fields and along roadways within these areas; and vacuum sweeping approximately 42 acres of streets, parking lots, aircraft ramp, taxiway and V/STOL areas. The 1979 amount includes one-time items such as repair of break in the main water system and resurfacing damaged roads. The estimates for 1980 and 1981 reflect a return to the normal level of effort.

C. Custodial Services	1,703	1,640	1,702	1,841

This activity involves primarily 65 workyears of support contract effort to provide janitorial and security services, fire protection provided by the U.S. Navy, and other miscellaneous custodial services and supplies. The increase from the 1980 budget estimate to the 1980 current estimate is due to labor rate increases on the security contract. The 1981 increase will provide for the full year effect of previously negotiated contractor wage rates at the same level of effort projected in 1980.

1. Janitorial services (36 workyears of effort) 597

Janitorial and building cleaning services are associated with approximately 1.6 million square feet of various types of space located in 75 buildings. Services are also provided for 50 trailers being utilized to provide temporary office and shop space.

2. Fire protection services 381

Fire protection services are provided by the U.S. Naval Air Station, Moffett Field, California. The 1981 estimate is based on the most recent actual cost experience.

3. Security services (29 workyears of effort) 662

Included are security services for buildings and property including aircraft and computer facilities. Included also is the provision of "round-the-clock" staffing of the emergency duty office which monitors fire security, and safety alarms and coordinates fire, security, and safety areas in emergency situations.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	Budget Estimate
		(Thousands of Dollars)		
4. Other services				201

Pest control services, on an as needed basis, are funded in this activity. Also included are refuse collection, laundry and custodial supplies.

D. Utilities Services	4,085	5,607	5,901	6,692

The major ulility service is electricity with lesser requirements for natural gas, fuel, oil, water and sewage services.

1. Electricity (242,000 mW/Hrs.)	5,614
2. Natural gas (214,000 K cu. ft.)	856
3. Fuel oil (200,000 gals.)	102
4. Water and sewage	120

Utilities include electric power, natural gas, water and sewage services. Electricity is provided by the U.S. Bureau of Reclamation (USBR) and Pacific Gas and Electric Company (P.G. &E.); natural gas is provided by P.G. &E., water by the U.S. Naval Air Station, Moffett Field, and sewage service by the City of Mountain View.

Approximately 80 percent of electric power cost is consumed in the operation of high power demand research facilities such as the Unitary Plan Wind Tunnel System, the 40- by 80-Foot Wind Tunnel, the 3.5-Foot Hypersonic Tunnel, the 14-Foot Transonic Wind Tunnel and in the operation of simulators and smaller wind tunnels, and other research facilities. Approximately 55 percent of natural gas is used in research facilities; the other part is used for heating and ventilation of institutional buildings.

The estimated energy usage and funding levels requested for the 1980 current estimate and 1981 estimate are based on the latest requirements for wind tunnel testings scheduled for the two fiscal years. The requirements for energy are based on a total of eight shifts a day operation of the high speed wind tunnels.

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The difference between the 1980 budget estimate and the 1980 current estimate is primarily in consumption of electricity. The 1980 budget cost estimate was based on electric energy usage of 215 million kilowatt hours (M KWH). The 1980 current estimate is based on usage of 252 M KWH to support the level of wind tunnel testing and operations (eight shifts) required in 1980.

The 1981 estimated energy usage of 242 M KWH for an eight shift operation reflects the effect of energy conservation initiatives instituted during 1979 and 1980.

The energy cost estimates in 1980 and 1981 allow for already announced utility rate increases (the USBR in the Federal Register supplemented by local announcements, and P.G. &E. in its Application Nos. 58545 and 58546 with the California Public Utilities Commission).

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
IV. TECHNICAL SERVICES	844	909	866	924
Summary of Fund Requirements				
A. Automatic Data Processing				
Operations	480	478	516	555
B. Scientific and Technical Information				
Education and Information	253	257	241	259
C. Shop Support and Services	111	174	109	110
Total, Technical Services	844	909	866	924
Explanation of Fund Requirements				
A. Automatic Data Processing	480	478	516	555

This category reflects the central ADP facility operating costs which are incurred by administrative organizations. These costs are incurred through a system whereby user organizations are charged for actual usage of the ADP central facility's equipment and services.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
1. Operations (18 workyears of effort).....	480	478	516	555

This function includes ADP computer operations and programming that are charged to administrative organizations through the Center's charge-back systems. The charges include the organizations' proportionate share of support service contracts. The increase from 1980 budget estimate to 1980 current estimate is due to a net increase of four workyears of contract support services from a total of 14 in 1980 budget estimate, and an increase in the cost of computer printing paper. The increase in 1980 current estimate over 1979 actual, and 1981 estimate over 1980 current estimate, is due primarily to negotiated support contract wage increases.

B. Scientific and Technical Information.....	253	257	241	259
1. Education and Information (11 workyears of effort)...	253	257	241	259

Included in this category is a support service contract to perform public information services (e.g., tour guide), media development (e.g., public exhibits, etc.) and educational programs.

The decrease in the 1980 current estimate from 1979 actual and from 1980 budget estimate, reflects the reduction of the Public Affairs Office (PAO) activity related to the Pioneer/Saturn encounter which was accomplished in September 1979. The increase in 1981 is due primarily to negotiated support contract wage increases.

C. Shop Support and Services.....	111	174	109	110

This category includes administrative shop, photo and graphics services. Approximately 61 percent of this function cost is to support the public affairs activity. Subsequently, the decrease in 1980 current estimate from 1979 actual and 1980 budget estimate also reflects the reduction of the PAO activity related to the Pioneer/Saturn encounter. The increase in 1981 reflects a modest escalation in unit cost.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
V. MANAGEMENT AND OPERATIONS	2,942	2,664	3,117	3,250
Summary of Fund Requirements				
A. Administrative Communications	841	835	907	916
B. Printing and Reproduction	109	102	90	92
C. Transportation	165	38	177	194
D. Installation Common Services	1,827	1,689	1,943	2,048
Total, Management and Operations	2,942	2,664	3,117	3,250
Explanation of Fund Requirements				
A. Administrative Communications	841	835	907	916

Communication services are provided by the General Services Administration (GSA) for the Federal Telecommunications Service (FTS) and the Pacific Telephone and Telegraph Company for local service. Other communications consists of teletype equipment and services provided by Western Union. The increase in the 1980 current estimate is due to increases in rates. The increase in 1981 reflects increases in rates partially offset by a reduction in requirements.

1. Local telephone services 461

The major part of this covers 1,470 Centrex lines and 2,258 telephone instruments which serves about 3,400 individuals on-site at ARC, including on-site contractors and tenants from other Government agencies.

2. Long distance telephone service 434

This service is primarily (98 percent) FTS services; the balance (2 percent) is commercial long distance, message unit charges and leased line service charges.

3. Other communications services 21

Includes Western Union Telegraphic Services and leased equipment.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
B. Printing and Reproduction	109	102	90	92

The estimates for administrative printing includes the Printing and Reproduction Facility operating costs incurred by administrative organizations and includes supplies, materials, equipment acquisition and outside procurements. The reduction in the 1980 current estimate from the 1980 budget estimate is due to a reduction in requirements. The 1981 estimate is essentially level with 1980.

C. Transportation	165	38	177	194

The estimates include the motor pool operation cost including GSA truck rentals, freight costs, Government bills of ladings, air freights and other general shipments. The increase in 1980 from the budget estimate to the 1980 current estimate reflects full funding of the support contract for motor pool operations of four workyears. The increase in 1981 provides for higher GSA rental rates and negotiated support contract wage increases.

D. Installation Common Services	1,827	1,689	1,943	2,048

These services include the Center Management and Staff function, medical services operation, and the Installation Support Services activities. The increase from 1980 budget estimate to 1980 current estimate is due to the addition of two support contract service workyears in the installation support services function, and an increase in the workyear wage rate (for the same support service contract) negotiated by the Small Business Administration (SBA) in 1979 which was not accounted for in the 1980 budget estimate. The two additional workyears are based upon greater volume of stores supply warehousing and pickup and delivery activities experienced since the occupancy of the new warehouse facility in 1979. The increase in 1980 current estimate over 1979 actual, and the 1981 estimate over 1980 current estimate allows for a modest escalation of unit costs.

1. Center management and staff 346

Includes the general management of the Center as an installation and includes such activities as the Directorate offices, general and patent legal services, personnel, procurement, and financial management services. Significant cost items include the various Equal Employment Opportunity (EEO) programs, the Intergovernmental Personnel Act (IPA) programs, various management studies, and management information systems development.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
2. Medical services				292

Medical services include the staffing of the Health Unit, laboratory service fees, clinic supplies, and maintenance of clinic equipment.

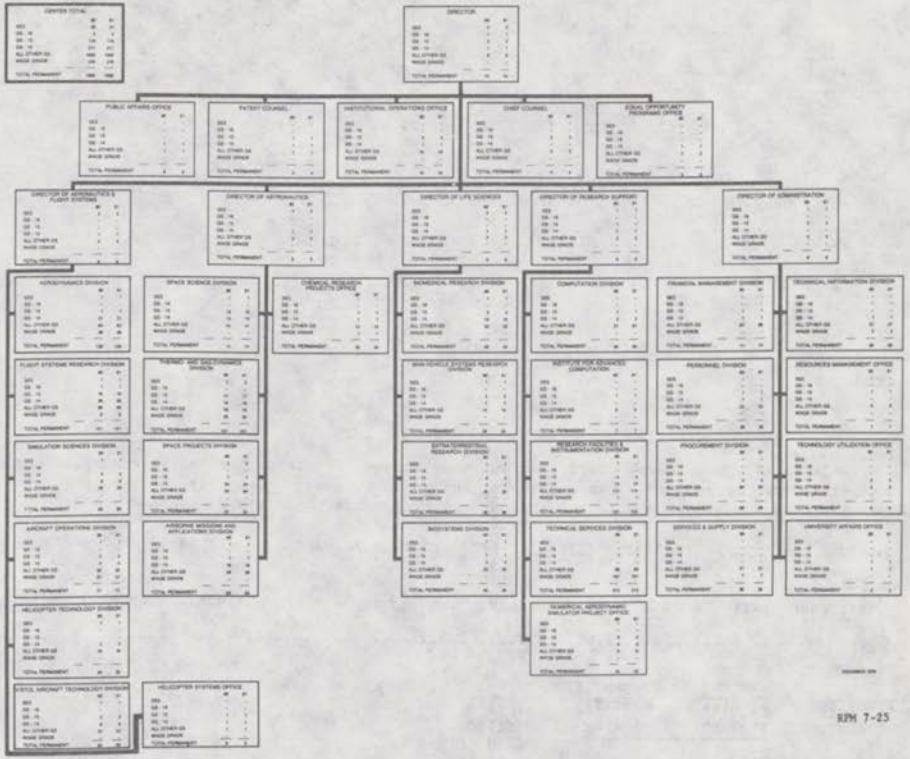
3. Installation support services (33 workyears of effort)				1,410

Installation support services consist predominantly of the support service contract for supply management, mail, and pickup and delivery services. The balance of the functional costs consist of administrative equipment acquisition, office supplies and materials, maintenance and repair and lease of office equipment, and postage.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

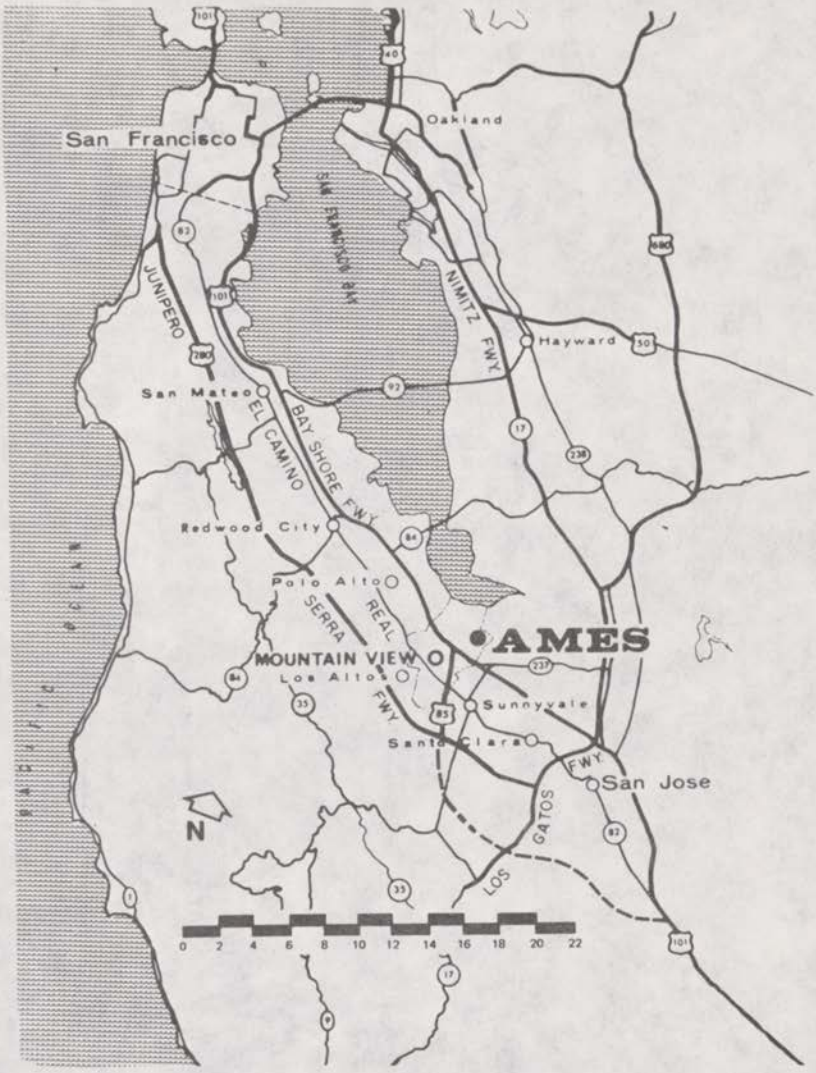
ORGANIZATION AND STAFFING CHART

AMES RESEARCH CENTER



RPM 7-25

LOCATION MAP

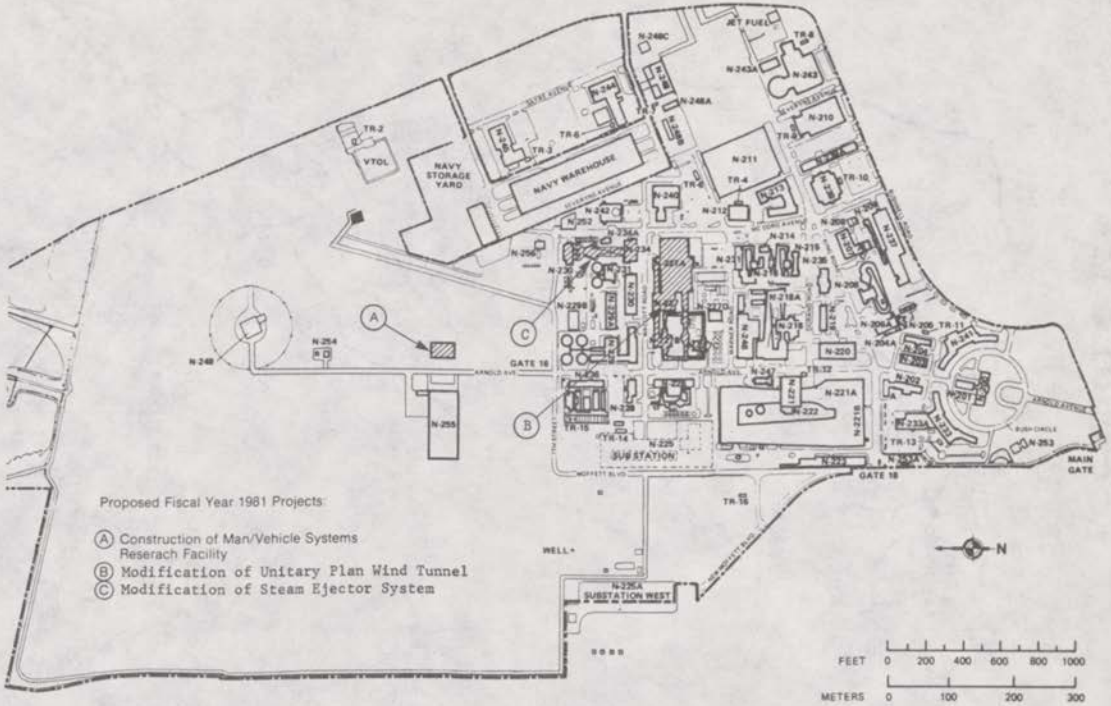


RPM 7-26

AMES RESEARCH CENTER

FISCAL YEAR 1981 ESTIMATES

LOCATION PLAN



Proposed Fiscal Year 1981 Projects:

(A) Construction of Man/Vehicle Systems Reserach Facility
(B) Modification of Unitary Plan Wind Tunnel
(C) Modification of Steam Ejector System

RPM 7-27



RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 1981 ESTIMATES

HUGH L. DRYDEN FLIGHT RESEARCH CENTER

DESCRIPTION

The Hugh L. Dryden Flight Research Center (DFRC), Edwards, California, is 65 air miles northeast of Los Angeles. The Center is located at the north end of Edwards Air Force Base on 521 acres of land under a permit from the Air Force. The Air Force Base encompasses 300,722 acres. The Center is adjacent to Rogers Dry Lake, a 55-square mile area with a complex of runways varying in length from five to eleven miles.

The physical plant consists of an office-laboratory building with adjoining shops, a flight maintenance hangar, a flight loads research facility, and an integrated support facility. Special Shuttle support facilities include the Orbiter hangar and the Orbiter mating-demating facility. Auxiliary buildings include warehouses, an auxiliary power system building, an aircraft maintenance dock, and hangar. The aerodynamic test range is operated with a site at Edwards, California. The total capital investment of the Dryden Flight Research Center, including fixed assets in progress and contractor held facilities at various locations, as of September 30, 1979, was $87,910,000.

CENTER ROLES AND MISSIONS

The primary mission of the Dryden Flight Research Center, established in 1947, is to conduct aeronautical flight research in the areas of aerodynamics, structures, control systems, propulsion systems, disciplinary integration effects, safety, operations, and human-vehicle interactions in support of both military and civil national needs. This includes planning, conducting, analyzing, and reporting of flight research for the purposes of verification of predicted characteristics and the identification of unanticipated problems in actual flight. The principal and supporting roles of the Center are:

PRINCIPAL

Aeronautical Flight Research - conducting flight research using aircraft as test facilities; conducting flight research programs of advanced aerospace vehicle concepts; and innovating concept revisions and supporting systems that ultimately lead to fully operational mission applications.

Flight Test Techniques - determining the suitability of the Remotely Piloted Research Vehicle (RPRV) test technique for flight research.

Flight Instrumentation Development - directing the cooperative efforts in development of new methods and equipment for flight measurements.

Avionic and Flight Control - conducting flight test evaluation of new and innovative concepts in flight control to validate design methods and verify system performance in the flight environment.

Low Speed Aircraft - establishing a flight data base for Vertical/Short Take-off and Landing (V/STOL) aircraft in flight dynamics and operating systems for utilization in the design and development of future civil and military aircraft.

High Speed Aircraft - conducting flight research on advanced configurations and demonstrating the potential for improved aircraft performance through the integration of aircraft systems.

Materials and Structures - conducting tests to increase the understanding of structural responses to aerodynamic heating, with particular emphasis on high temperature space or hypersonic vehicle structures.

Dryden also provides host Center functions for NASA flight activities which are managed by other Centers but which require testing at the Edwards Air Force Base complex. This function includes all institutional support and coordination as well as supervision of flight operations.

SUPPORTING

Shuttle Orbiter - providing landing and recovery capability during Orbital Flight Test (OFT) missions and contingency recovery capability for subsequent operational flights.

Aerodynamic - supporting the development of the technology data base for Laminar Flow Control concepts which could be utilized in future commercial aircraft.

Transport Aircraft - exploring as a cooperative effort, the development and validation of integrated design methods which utilize active flight controls to enhance aircraft structural efficiency.

Advanced Propulsion - supporting flight research programs to establish a technology data base for advanced turbopropeller systems to improve the energy efficiency of future aircraft.

Rotorcraft - supporting the envelope expansion and hazardous flight research testing of research rotorcraft.

SUMMARY OF RESOURCES REQUIREMENTS

FUNDING PLAN BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
I. Personnel and Related Costs	14,179	14,270	15,176	15,142
II. Travel	339	415	394	400
III. Facilities Services	2,449	2,661	3,185	3,150
IV. Technical Services	408	458	665	789
V. Management and Operations	1,693	1,987	2,282	2,200
Total, fund requirements	19,068	19,791	21,702	21,681

Distribution of Permanent Positions by Program

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Direct Positions				
Space Transportation Systems	27	19	40	30
Space shuttle	27	19	40	30
Space Science	1	1	1	2
Life sciences	1	1	1	2

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Space and Terrestrial Applications	1	1	1	1
Technology utilization	1	1	1	1
Aeronautics and Space Technology	329	319	297	306
Aeronautical research and technology	329	319	293	301
Space research and technology	---	---	4	5
Space Tracking and Data Systems	29	30	29	29
Tracking and data acquisition	29	30	29	29
Subtotal, direct positions	387	370	368	368
Center Management and Operations Support Positions	93	91	93	93
Total, permanent positions	480	461	461	461

PROGRAM DESCRIPTION

	Permanent Positions (Civil Service)
SPACE SHUTTLE	30

In 1981, Dryden Flight Research Center (DFRC) will support the Shuttle Orbital Flight Test (OFT) missions and other Shuttle activities. Current planning is for Edwards Air Force Base to be the primary landing site for the first four missions and the secondary landing site for subsequent missions. After landing, the Shuttle Orbiter will be returned to Kennedy Space Center by shuttle carrier aircraft. Dryden will provide operational and institutional support for the Space Shuttle landing activities at Edwards. In addition, Dryden will provide aircraft to test the Microwave Scanning Beam Landing System (MSBLS), provide Orbiter Convoy operations support, and maintain the Shuttle/Carrier Aircraft facility.

	Permanent Positions (Civil Service)
LIFE SCIENCES	2

In 1981, it is planned to develop and evaluate cost effective, reliable human-machine control systems for use in remote manipulation such as manual landing of Shuttle type vehicles. Flight studies of remotely piloted high performance vehicles will be performed to determine information requirements and procedures necessary for descent, approach, flare, touchdown, and rollout without direct external vision. Television sensors and displays with inside-out references will be evaluated to define optimum human-machine design characteristics.

TECHNOLOGY UTILIZATION	1

In 1981, one civil servant is required to continue studies of various means to improve the aerodynamic efficiency of ground vehicles. Various add-on devices, which potentially could be manufactured by small businesses, will be evaluated.

AERONAUTICAL RESEARCH AND TECHNOLOGY	301

The aeronautical program includes continuing work in research and technology base areas and conducting specific systems technology flight research programs involving fluid physics, propulsion, structures, avionics and controls, human factors and multidisciplinary research and Conventional Take-Off and Landing (CTOL), rotorcraft, Vertical/Short Take-Off and Landing (V/STOL), and high performance type aircraft. The majority of the programs are joint or cooperative efforts with the military, other NASA Centers or Government agencies where the unique flight research facilities and capabilities at Dryden provide an important part in the development or demonstration of technology areas of interest.

In 1981, the objective of the activities under the research and technology base program is to provide continuing research and development efforts in all technical discipline areas so that improved understanding can be applied to problems associated with aircraft in all flight regimes. Flight research in the Research and Technology (R&T) base program in 1981 includes flight demonstration of an active flutter suppression system on a highly elastic supercritical wing on a Firebee II vehicle; flight testing of a low cost AD-1 vehicle to evaluate fundamental aspects of controlling an oblique wing aircraft; and flight tests of digital fly-by-wire experiments to support development of advanced avionics technology. Effort will also continue toward the development of new or improved flight test techniques and flight test instrumentation to increase NASA's capability to conduct flight research.

The Systems Technology program in 1981 will include joint ARC/DFRC flight tests to complete the envelope expansion for the Tilt Rotor Research Aircraft; participation in the joint NASA/USAF AFTI/F-111 program for research and development of a Mission Adaptive Wing to obtain in-flight smooth contour changes to the wing aerodynamic shape to achieve improved aerodynamic efficiency; using a digital flight control system for conventional and nonconventional control without degrading overall performance; continued joint NASA/Navy F-14/Stores High Alpha flying qualities program to define safe operating envelope and means for avoiding departure/spins; continued flight evaluation of the advanced technologies incorporated in the Highly Maneuverable Aircraft Technology (HiMAT) aircraft; Aircraft Energy Efficiency (ACEE) programs including flight evaluation of an active control system that will provide gust alleviation, maneuver load control and flutter suppression for the Aeroelastic Research Wing Vehicle (ARW-2) as part of a joint Langley/Dryden program; and, acoustic flight tests of advanced high tip-speed propellers, developed by Lewis, in support of the advanced turboprop program.

	Permanent Positions (Civil Service)
SPACE RESEARCH AND TECHNOLOGY	5

This work is directed primarily toward developing and conducting selected Space Shuttle experiments and performing disciplinary research in the high temperature space structures technology area.

The Shuttle experiments includes the development of a Shuttle Entry Air Data System (SEADS); acquisition of Shuttle lift and drag data at hypersonic speeds; studies to evaluate adequacy and provide a basis for improving Shuttle handling qualities criteria; and application of modified maximum likelihood parameter estimation methods for determination of digital flight control system, stability and control, performance, and structural and atmospheric turbulence characteristics in the Shuttle reentry environment.

High temperature space structures disciplinary research will involve analysis and laboratory tests of medium size specimens to evaluate predictive techniques for thermal structures. Also airloads data will be obtained from calibrated strain gages on the Orbiter and compared with wind tunnel and theoretical predictions to evaluate flight measurement technique and analytical methods.

TRACKING AND DATA ACQUISITION	29

In 1981, DFRC will maintain and operate the NASA Aerodynamic Test Range (ATR), which provides direct operational support for a wide variety of aerodynamic and aerospace programs. During mission support operations, the various functional elements such as radar, tracking and data processing, communications, video telemetry acquisition, and telemetry data processing all function in a coordinated manner to provide real time control and monitoring capabilities.

	Permanent Positions (Civil Service)
CENTER MANAGEMENT AND OPERATIONS SUPPORT.....	93

Center Management and Operations Support is defined as that support or services being provided to all Dryden Flight Research Center organizations which cannot be directly identified to a benefitting program or project. The civil service personnel involved are:

Director and Staff - The Center Director, Deputy Director, and immediate staff, and staff organizations, e.g., Legal, Patent Counsel, Equal Opportunity, Safety and Public Affairs.

Management Support - Includes a wide range of activity categorized as management support for program and functional organizations for the entire Center. Specific functions include resources and budget management, program control, contracting and procurement, personnel management, institutional support, financial management and management information systems analysis, development, and maintenance.

Operations Support - This is a broad spectrum of activity that is required to maintain and operate facilities, buildings, and equipment, and to provide the normal housekeeping services and logistics support for the personnel who manage and conduct the affairs of the Center. Specific activities are:

Maintenance and operation of all buildings and facilities
Data processing and computer support
Reliability and quality assurance
Center-wide security and protection
Fire protection
Custodial services
Logistics support including transportation, supplies, etc.
Medical care of employees
Photographic and graphics support

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RESOURCE REQUIREMENTS BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
I. PERSONNEL AND RELATED COSTS	14,179	14,270	15,176	15,142
Summary of Fund Requirements				
A. Compensation and Benefits				
1. Compensation				
a. Permanent positions	12,061	12,200	12,805	12,762
b. Other than full time permanent	375	382	564	595
c. Reimbursable detailees	68	106	78	78
d. Overtime and other compensation	265	211	248	230
Subtotal, Compensation	12,769	12,899	13,695	13,665
2. Benefits	1,234	1,221	1,306	1,298
Subtotal, Compensation and Benefits	14,003	14,120	15,001	14,963
B. Supporting Costs				
1. Transfer of personnel	70	58	58	63
2. Personnel training	106	92	117	116
Subtotal, Supporting Costs	176	150	175	179
Total, Personnel and Related Costs	14,179	14,270	15,176	15,142
Explanation of Fund Requirements				
A. Compensation and Benefits	14,003	14,120	15,001	14,963
1. Compensation	12,769	12,899	13,695	13,665
a. Permanent positions	12,061	12,200	12,805	12,762

The 1981 estimate supports a permanent personnel complement of 461 positions. The current estimate for 1980 is increased from the 1980 budget estimate as a result of the October 1979 pay increase.

Basis of Cost for Permanent Positions

In 1981, the cost of permanent positions will be $12,762,000, a reduction of $43,000 from the 1980 current estimate. The estimates are derived from the following calculations:

Cost of permanent positions in 1980		12,805
Cost of increases in 1981		+279
Within grade and career advances:		
Full year effect of 1980 actions	+131	
Partial year effect of 1981 actions	+136	
Full year effect of 1980 pay increase	+12	
Cost decreases in 1981		-322
Turnover savings and abolished positions:		
Full year effect of 1980 actions	-124	
Partial year effect of 1981 actions	-148	
One less paid day in 1981	-50	
Cost ot permanent positions in 1981		12,762

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
b. Other than full time permanent positions				
1. Cost	375	382	564	595
2. Workyears	41	44	60	62

The 1980 current estimate increases from the 1980 budget estimate is due to the continuation of a part-time employment program, the reinstitution of the junior college cooperative training program, and

an increase due to the White House Research Apprenticeship program. This effort will support the following programs as shown:

Program	Workyears
Cooperative training	32
Opportunity programs	19
Summer employment	2
Other temporary employment	9
Total	62

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
c. Reimbursable detailees	68	106	78	78

The services of a small group of military officers are used in the Center's programs where such assignments are of mutual benefit to NASA and the respective service. Under the existing agreements, the parent organization is reimbursed for salaries and related costs. The reduction from the 1980 budget estimate to the 1980 current estimate is due to a reduction of one military detailee.

d. Overtime and other compensation	265	211	248	230

Overtime is restricted to emergency repairs and abnormal temporary workload. A substantial portion is used to prepare for test flights. The 1980 current estimate increase from the 1980 budget estimate reflects the Shuttle schedule slip into 1980, and the October 1979 pay increase.

2. Benefits	1,234	1,221	1,306	1,298
Following are the amounts of contribution by category:				
Civil Service Retirement Fund	879	869	942	941
Employee life insurance	37	42	43	43
Employee health insurance	256	270	265	263

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
Workmen's compensation	31	33	35	42
FICA	5	7	8	9
Severance pay	26	---	13	---
Total	1,234	1,221	1,306	1,298

The current estimate for 1980 is higher than the 1980 budget estimate due to the October 1979 pay increase. The 1981 estimate reflects the full year cost of the pay increase which is slightly offset by savings due to the full year effect of manpower reductions.

Workmen's compensation costs are based on the anticipated Department of Labor billings for 1980 and 1981.

B. Supporting Costs	176	150	175	179
1. Transfer of personnel	70	58	58	63

The costs associated with the transfer of personnel include movement of household goods, subsistenance and temporary expenses, real estate costs and miscellaneous moving expenses related to change of duty station.

2. Personnel training	106	92	117	116

Training funds provide for the maintenance and expansion of skills which are essential in carrying out the agency's many complex technical programs. The cost reflects tuition and related fees at a number of government and nongovernment institutions. The 1980 and 1981 amounts allow for announced increases in tuition costs and Civil Service Reform Act implementation training.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
II. TRAVEL	339	415	394	400
Summary of Fund Requirements				
A. Program Travel	204	280	266	270
B. Scientific and Technical Development Travel	24	31	28	29
C. Management and Operations Travel	111	104	100	101
Total, Travel	339	415	394	400
Explanation of Fund Requirements				
A. Program Travel	204	280	266	270

Program travel is directly related to the accomplishment of the Center's mission. Travel for program purposes is required for continued joint programs between DFRC and other Centers and includes the support of flight test techniques, flight measurements, avionics and flight control, and flight measurement development activities. The decrease from the 1980 budget estimate to the 1980 current estimate reflects a reduction in travel in 1980 to implement Section 112 of Public Law 96-86.

B. Scientific and Technical Development Travel	24	31	28	29

Scientific and technical development travel permits employees to participate in meetings and seminars with other representatives of the aerospace community. This participation allows them to benefit from exposure to technical advances outside Dryden, as well as to present accomplishments and problems to their associates. Many of the meetings consist of working panels convened to solve specific governmental problems. The decrease from the 1980 budget estimate to the 1980 current estimate reflects a reduction in travel in 1980 to implement Section 112 of Public Law 96-86.

C. Management and Operations Travel	111	104	100	101

Management and operations travel is used for the direction and coordination of general management matters. It includes travel in such areas as personnel, financial management, and procurement activities; travel of the Center's top management to NASA Headquarters and other NASA Centers; administrative training travel; and local transportation. The decrease from the 1980 budget estimate to the 1980 current estimate reflects a reduction in travel in 1980 to implement Section 112 of Public Law 96-86.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousandssof Dollars)		
III. FACILITIES SERVICES	2,449	2,661	3,185	3,150

The Dryden Flight Research Center (DFRC) is located on 521 acres and occupies a complex of facilities consisting of laboratory and office-type buildings as well as flight test facilities.

This complex encompasses 459,447 gross square feet of building space including two major buildings. Also included are seven major technical facilities. This physical plant houses an average daily on-Center population of 1,200 to 1,500 personnel. Many of the test facilities are utilized on schedules involving more than one shift.

Summary of Fund Requirements

A. Rental of Real Property	50	65	75	37
B. Maintenance and Related Services				
1. Facilities	1,267	1,048	1,384	1,422
2. Equipment	84	80	93	102
Subtotal	1,351	1,128	1,477	1,524
C. Custodial Services	740	1,015	1,196	1,089
D. Utility Services	308	453	437	500
Total, Facilities Services	2,449	2,661	3,185	3,150

Explanation of Fund Requirements

A. Rental of Real Property	50	65	75	37

This item provides for the rental of trailers to provide office, shop, laboratory, and storage space in support of the Space Shuttle Orbital Flight Test (OFT) program. The 1980 current estimate is increased

from the 1980 budget estimate due to an increase in OFT support in 1980. The decrease in 1981 is associated with the current OFT flight schedule.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
B. Maintenance and Related Services	1,351	1,128	1,477	1,524
1. Facilities	1,267	1,048	1,384	1,422

This activity involves all DFRC and facilities provided by the Air Force, including those used for Shuttle, and tracking and communication facilities. The increase in the 1980 current estimate over the 1980 budget estimate and the increase in the 1981 estimate is due to negotiated support contractor increases.

a. Maintenance and repair services (30 workyears of effort)	1,168
b. Engineering services (four workyears of effort)	136
c. Supplies and materials	21
d. Other services	97

2. Equipment	84	80	93	102

This activity involves three workyears of effort for the maintenance of facility-type equipment by a support service contractor. The increase in the 1980 current estimate from the 1980 budget estimate and in 1981 are due to negotiated support contractor rate increases.

C. Custodial Services	740	1,015	1,196	1,039

This activity involves a total of 45 workyears of effort to provide for security, janitorial, and refuse handling. The increase in funding required in the 1980 current estimate is based on an increased level of effort to support the OFT program. The decrease in 1981 is related to the current OFT flight schedule.

1. Janitorial services (18 workyears of effort)	511

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		

This activity includes:
a. Janitorial services
b. Refuse

2. Security guard services (27 workyears of effort)..... 578

This activity includes:
a. Security of all on-site Government facilities and equipment
b. Mail and messenger service
c. Badging of all on-site personnel and visitors

D. Utilities.....	308	453	437	500

Utility services are purchased through Air Force contracts with regional utility companies. Costs are based on Air Force projected rates. The major amount is for electricity with lesser amounts for natural gas, fuel oil, water and sewage services. A summary of the proposed DFRC utilities budget for 1981 is as follows:

1. Electricity (14,000 mWh).....	373
2. Natural gas (22,000 K cu. ft.).....	80
3. Fuel oil (45,000 gals.).....	29
4. Water and sewage.....	16
5. Other.....	2
Total.....	500

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
IV. TECHNICAL SERVICES	408	458	665	789
Summary of Fund Requirements				
A. Automatic Data Processing				
1. Equipment	103	---	28	229
2. Operations	110	261	221	330
Subtotal	213	261	249	559
B. Scientific and Technical Information				
1. Library	19	15	15	17
2. Education and Information	55	66	249	65
Subtotal	74	81	264	82
C. Shop Support and Services	121	116	152	148
Total, Technical Services	408	458	665	789
Explanation of Fund Requirements				
A. Automatic Data Processing	213	261	249	559
1. Equipment	103	---	28	229

Concerns the support purchase and lease of equipment that is necessary to satisfy the payroll, personnel, accounting and management information systems requirements of NASA and DFRC management. The increase in the 1980 current estimate reflects an equipment purchase to begin development of an accounting information system. The 1981 estimate includes a one time purchase of accounting system hardware to support the accounting information system currently being developed.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
2. Operations (seven workyears of effort).....	110	261	221	330

This function includes administrative key punch and programming services required to support the management information system. The decrease in the 1980 current estimate from the 1980 budget estimate reflects a reduction in programming requirements. The increase in 1981 operations reflects additional software redesign and development needed to support the purchase of the new accounting hardware system.

B. Scientific and Technical Information.....	74	81	264	82
1. Library.....	19	15	15	17

Provides for the purchase of books, supplies, and materials for the operation of the Dryden Flight Research Center library.

2. Education and Information.....	55	66	249	65

Provides for the gathering and dissemination of information about the Center's program to the mass communications media, the general public, and to the educational community at the elementary and secondary school levels. Assistance to the mass communications media includes the gathering and exposition of newsworthy material in support of media requests, and takes such forms as press kits, news releases, television and radio information tapes and clips, and feature material. The 1980 current estimate exceeds the 1980 budget estimate due to the funding of the Public Affairs Office (PAO) in support of Shuttle flights scheduled in FY 1980. The 1981 estimate is due to the reduced PAO requirements based on the current Shuttle schedule.

C. Shop Support and Services.....	121	116	152	148

Provides funding for four workyears of support service contractors for graphics, safety, and audio visual. The 1980 current estimate exceeds the 1980 budget estimate due to a slight increase in supplies, contract support costs and Shuttle support.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
V. MANAGEMENT AND OPERATIONS	1,693	1,987	2,282	2,200
Summary of Fund Requirements				
A. Administrative Communications	431	379	602	551
B. Printing and Reproduction	159	36	92	90
C. Transportation	231	309	292	328
D. Installation Common Services	872	1,263	1,296	1,231
Total, Management and Operations	1,693	1,987	2,282	2,200

Explanation of Fund Requirements

A. Administrative Communications	431	379	602	551

Includes estimates for Federal Telecommunications Systems (FTS), local telephone and exchange service, rental of TWX equipment, and four telephone operators provided under a support service contract. The 1980 current estimate exceeds the 1980 budget estimate due to increased telephone rates, installation of a new direct dial switchboard and the addition of one telephone operator. The 1981 estimate reflects a reduction in main lines and telephone instruments.

1. Local telephone service..... 369

This funding covers the service for 535 main lines, 792 telephone instruments at the Center, and five main lines to Lancaster, California. Also included are the lease of switchboard equipment, commercial toll charges, and the support service contract for four telephone operators.

2. Long distance telephone service..... 179

This category reflects funding to support 26 FTS lines.

3. Other communications services..... 3

This funding covers the teletype (TWX) service.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
B. Printing and Reproduction	159	36	92	90

Includes the contractual publication of information and materials, and the related composition and binding operations. All common processes of duplication, including photostating, blue printing and microfilming are included. The 1979 actual includes the one-time purchase of a Xerox 9400 copier. The 1980 current estimate is increased as Xerox lease and maintenance costs have been transferred from Installation Common Services. This cost amounts to about $50,000 per year and was transferred so that costs would be correctly aligned with the proper function.

C. Transportation	231	309	292	328

Provides funds for Government bills of lading issued to common carriers to move freight by rail, truck, water, and air; to fund shipments by United Parcel Services; and contract support of eight workyears for the Center's general purpose vehicles. The decrease from the 1980 budget estimate to the 1980 current estimate is due to a deferral in the purchase of motor vehicles for the truck fleet until 1981. The increase in 1981 is due to the purchase of two more motor vehicles than planned in 1980.

D. Installation Common Services	872	1,263	1,296	1,231

This category provides for: physical examinations for DFRC pilots; funding for the Occupational Health Support contract; Test Center for Shuttle support; supplies, materials, and equipment to support the general administrative effort; rental of equipment; and the supply management support service contract. The increase in the 1980 current estimate from the 1980 budget estimate reflects full year funding of the occupational health contract. This increase will be slightly offset with a decrease in the purchase of supplies and materials. The decrease in 1981 is due to reduced Shuttle support requirements.

1. Pilot physicals and occupational health 233

This category includes the costs for DFRC pilot's physicals performed by the Lovelace Clinic in Albuquerque, New Mexico.

2. Air Force Flight Test Center (AFFTC) support 78

This category includes reimbursement to the Air Force for services and miscellaneous supplies and materials provided in support of the Space Shuttle Orbital Flight Test (OFT) program.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		

3. Supplies and equipment..... 242

This category funds office supplies and equipment, and miscellaneous common service supplies and equipment.

4. Rental of equipment..... 16

Rental equipment is mostly office (e.g., photocopy) machines that are more economical to rent than to buy.

5. Supply management services..... 583

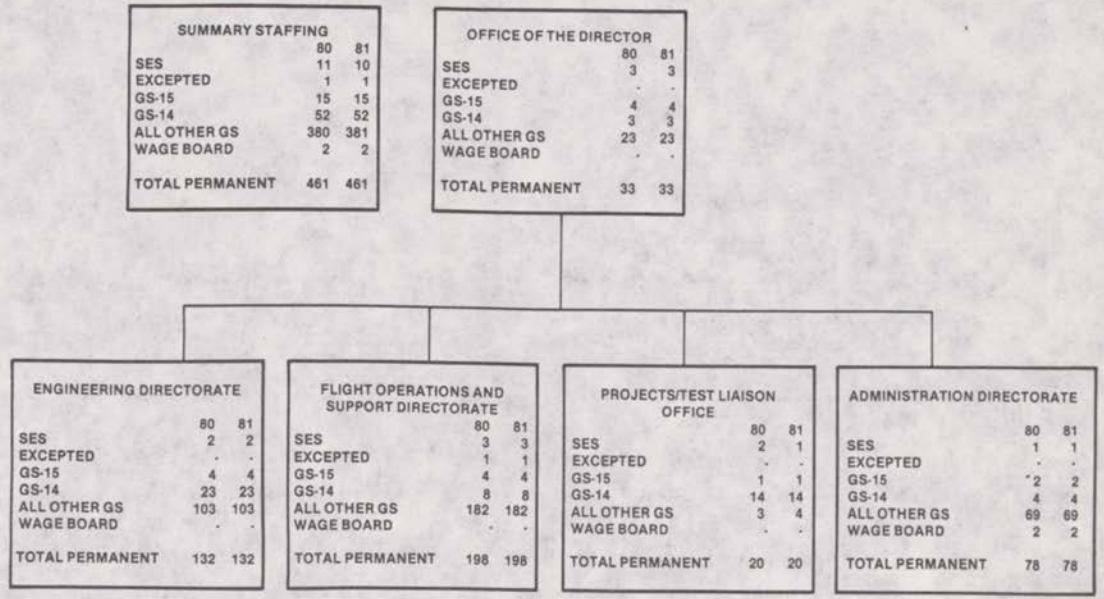
Provides funding for supply system operation by support service contractor.

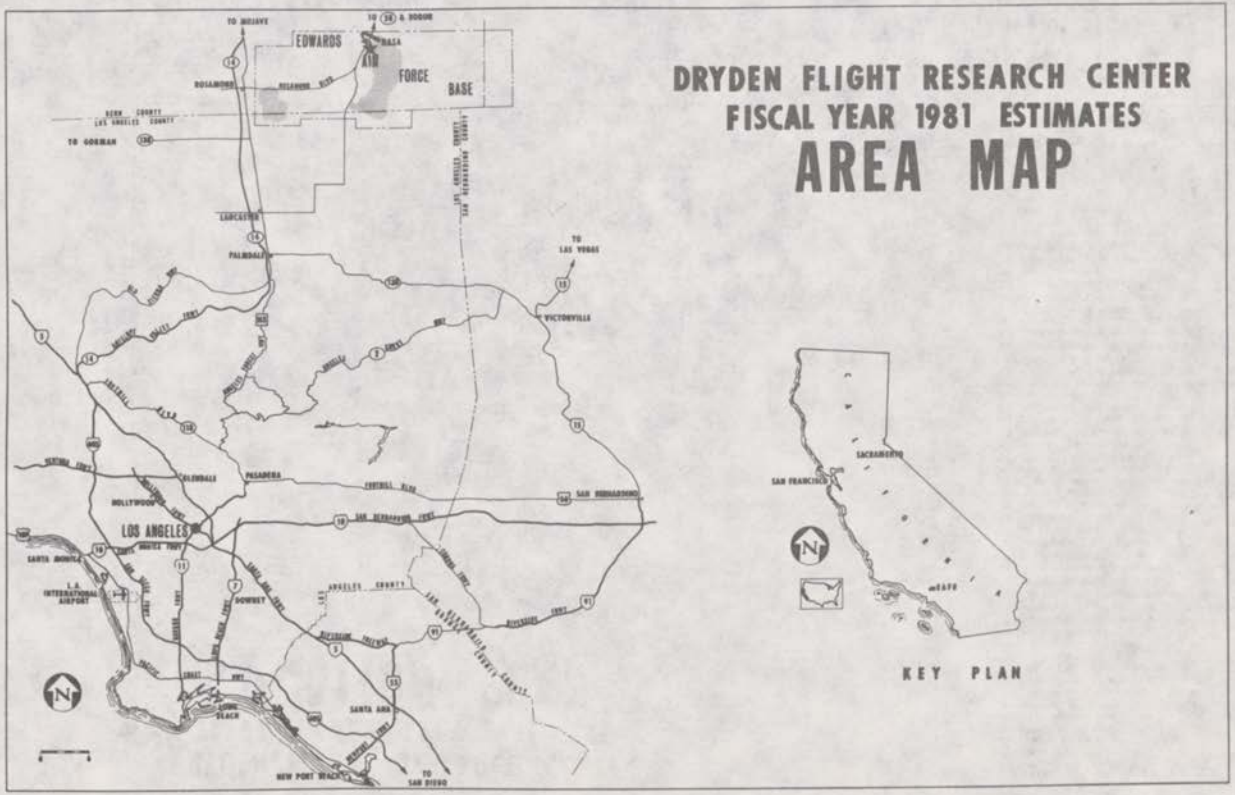
6. Postage..... 41

7. Maintenance of equipment..... 28

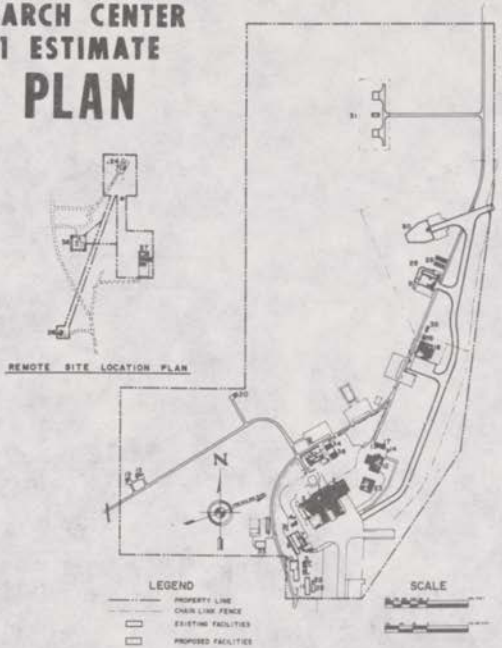
8. Other services..... 10

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
HUGH L. DRYDEN FLIGHT RESEARCH CENTER




DRYDEN FLIGHT RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
AREA MAP
EDWARDS
AIR FORCE BASE
NASA
TO MOJAVE
TO GORMAN
LANCASTER
PALMDALE
VICTORVILLE
TO LAS VEGAS
PASADENA
HOLLYWOOD
LOS ANGELES
SANTA MONICA
L.A. INTERNATIONAL AIRPORT
DOWNEY
LONG BEACH
SANTA ANA
NEW PORT BEACH
TO SAN DIEGO
SAN BERNARDINO
SACRAMENTO
SAN FRANCISCO
KEY PLAN

DRYDEN FLIGHT RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATE
LOCATION PLAN



EXISTING FACILITIES

1 LABORATORY BUILDING (4800)
2 AIRCRAFT CONSTRUCTION AND MODIFICATION HANGAR (4801)
3 MAIN HANGAR (4802)
4 AIRCRAFT TIRE REPAIR SHOP (4803)
5 TRAILER PARK AND MODULAR BUILDINGS
6 BOILER HOUSE (4806)
7 SHOPS (A.G.E., MODEL, BATTERY, GARAGE) (4806)
8 STORAGE BUILDING (4807)
9 WAREHOUSE NO 2 (4808)
10 WAREHOUSE NO 3 (4809)
11 WAREHOUSE NO 4 (4810)
12 FLIGHT LOADS RESEARCH BUILDING (4820)
13 PAINT SPRAY BUILDING (4821)
14 PAINT STORAGE BUILDING (4822)
15 COMMUNICATIONS BUILDING (4824)
16 MAINTENANCE DOCK (4826)
17 WOOD SHOP (4830)
18 WAREHOUSE NO 5 (4831)
19 RADAR BUILDING (4870)
20 100FT. TOWER, BORESITE TARGET ASSEMBLY AND EQUIP. BUILDING (4887)
21 CENTRAL STANDBY ELECTRICAL POWER FACILITY (4889)
22 STORAGE BUILDING (4804)
23 AIRCRAFT SERVICING DOCK (4823)
24 FPS-16 RADAR FACILITY (4982)
25 WAREHOUSE NO 6 (4827)
26 100 FT. TOWER, BORESITE TARGET ASSEMBLY AND EQUIP. BUILDING (4981)
27 SHUTTLE HANGAR (4833)
28 SHUTTLE SHOP (4834)
29 SHOP TRAILER COMPLEX (4854)
30 SHUTTLE MATING STRUCTURE (4860)
31 PROPELLANT FUEL AND OXIDIZER STORAGE AREA (4855)
32 INTEGRATED SUPPORT FACILITY (4825)
33 WAREHOUSE NO 7 (4832)
34 PAO TRAILERS
35 PUMP STATION NO 1 (4853)
36 TRAINING TRAILERS
37 SFBC STDN SPACE SHUTTLE ALT FACILITY (4918)
38 RCA EARTH STATION (4817)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
DRYDEN FLIGHT RESEARCH CENTER
EDWARDS, CALIFORNIA

FY 1981 ESTIMATE
LOCATION PLAN

SHEET NO. 1 OF 1 SHEETS
NOTES
SIZE D
MSN-D-009-78

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HUGH L. DRYDEN FLIGHT RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES



RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 1981 ESTIMATE

LANGLEY RESEARCH CENTER

DESCRIPTION

The Langley Research Center is located at Hampton, Virginia. It is situated between Norfolk and Williamsburg, Virginia, in the tidewater area of Hampton Roads. The Center utilizes 810 acres of Government-owned land, divided into two areas by the runway facilities of Langley Air Force Base. The West Area consists of 787 acres, all owned by NASA. The East Area comprises 23 acres under permit from the Air Force. Runways, some utilities and certain other facilities are used jointly by NASA and the Air Force. In addition, there are 110 acres of NASA-owned land located in the city of Newport News, Virginia, and 3,276 acres under permit from the Department of Interior. The total acreage presently owned, under permit, or leased, is 4,196. The total capital investment of the Langley Research Center, including fixed assets in progress and contractor-held facilities at various locations, as of September 30, 1979, was $566,553,000.

CENTER ROLES AND MISSIONS

Langley Research Center (LaRC) continues to play a major role in the development of aeronautics and space technology in the United States.

Langley has developed recognized areas of technical excellence within the civil service staff and facilities of superior merit; that is, major technical facilities which constitute a national resource. The principal and supporting roles are:

PRINCIPAL

Long-Haul Aircraft Technology - developing a technology base for improving long-haul aircraft as a cost effective, safe and environmentally compatible transportation mode.

General Aviation Aircraft Technology - developing and maintaining an engineering technology base related to improving general aviation aircraft.

Fundamental Aerodynamics - advancing the general state of the art, both theoretical and experimental.

Acoustics and Noise Reduction - conducting research and developing a technology base related to reducing aircraft noise.

Aerospace Vehicle Structures and Materials - developing a technology base for facilitating advances.

Avionics Technology - developing a technology base related to improving avionics.

Military Support - providing technical support to military aviation in areas consistent with other LaRC aeronautics roles and LaRC unique capabilities.

Advanced Space Vehicle Configurations Technology - developing a technology base related to advanced configurations, including advanced space transportation concepts.

Sensor and Data Acquisition Technology - developing a technology base for sensors and data acquisition devices.

Technology Experiments in Space - developing and managing the Long Duration Exposure Facility. Defining and developing experiments in areas consistent with other LaRC space roles.

Environmental Quality Monitoring Technology - developing improved techniques for environmental monitoring. Includes research, experiment development/management, data analysis, and investigator management and specialized ground/aircraft investigations. Also includes development of Shuttle payloads related to environmental monitoring.

SUPPORTING

Rotorcraft Technology - contributing to the development of the technology base with emphasis on structures aeroelasticity, acoustics, noise, and avionics components.

Hypersonic Propulsion Systems - contributing to the technology base of air breathing propulsion systems by advancing the state of the art of hypersonic propulsion.

Planetary Entry Technology - providing planetary and earth entry aerothermodynamics experimental and analytical data.

Computational Fluid Dynamics - contributing to the software technology base.

Upper Atmospheric Research - mission analysis, sensor development, data interpretation and utilization for remote sensing; contributing to model development.

Launch Vehicle Procurement - develop and procure for science/applications missions, including Scout launch vehicle.

SUMMARY OF RESOURCES REQUIREMENTS

FUNDING PLAN BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
I. Personnel and Related Costs	88,191	89,940	95,405	95,782
II. Travel	1,947	2,154	1,899	2,021
III. Facilities Services	8,803	10,192	10,914	12,537
IV. Technical Services	2,296	2,032	1,802	2,453
V. Management and Operations	5,406	5,940	6,020	6,352
Total, fund requirements	106,643	110,258	116,040	119,145

Distribution of Permanent Positions by Program

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Direct Positions				
Space Transportation Systems	50	44	47	44
Space shuttle	13	4	5	2
Expendable launch vehicles	37	40	42	42
Space and Terrestrial Applications	243	223	220	220
Space applications	225	211	202	204
Technology utilization	18	12	18	16
Aeronautics and Space Technology	1,987	1,983	1,997	2,005
Aeronautical research and technology	1,430	1,470	1,471	1,482
Space research and technology	557	513	526	523
Subtotal, direct positions	2,280	2,250	2,264	2,269
Center Management and Operations Support Positions	725	740	716	711
Total, permanent positions	3,005	2,990	2,980	2,980

PROGRAM DESCRIPTION

	Permanent Positions (Civil Service)
SPACE SHUTTLE	2

In 1981, civil service personnel will continue to work on test and evaluation of propellant dynamics.

	Permanent Positions (Civil Service)
EXPENDABLE LAUNCH VEHICLES	42

The expendable launch vehicle program at Langley provides centralized procurement of the Scout Launch Vehicle. In 1981, civil service personnel will support a program which includes the procurement of launch vehicle hardware, launch services, engineering, and maintenance.

The 1981 launches under this program will be conducted from sites located at the Western Test Range in California, and the San Marco platform off the coast of Kenya, Africa.

SPACE APPLICATIONS	204

The space applications program at Langley is characterized by a research capability that is a national resource for understanding environmental problems and for developing related monitoring systems. The Center's technical expertise is widely recognized in the areas of remote sensing of the Earth's atmospheric trace species and analytical atmospheric modeling. In the area of Upper Atmospheric Research, Langley civil service personnel will continue to study the Earth's atmosphere to assess any changes caused by man and to determine whether or not there is any associated change in the transmission of solar radiation. Effort will be continued in the definition of experiments for the Spacelab/Shuttle which will provide atmospheric measurements of trace constituent, clouds, aerosols, and temperature in the troposphere and stratosphere.

The Center's sensor development program encompasses the broadest possible range of advanced remote sensing techniques, including correlation gas filter radiometry and interferometry, laser heterodyne radiometry, and lidar.

A significant improvement in our understanding of man's impact on the stratosphere and climate will be obtained from the combination of Langley developed statistical/theoretical models and the comprehensive global data set provided by spaceborne sensors such as Nimbus-7, Stratospheric Aerosol and Gas Experiment (SAGE), and the Halogen Occultation Experiment (HALOE). The HALOE instrument will measure stratospheric species involved in ozone destruction by chlorine chemistry.

Studies of the Earth's radiation budget will be fundamental to the understanding of climate phenomena. Langley has the responsibility for the science, sensor development, and data management for the Earth Radiation Budget Experiment, a prime element in NASA's support of the National Climate Program. Preliminary radiation budget studies, based on Nimbus data, are examining the relationship of radiation budget to such climatological parameters as cloudiness, snow and ice cover, and sea surface temperature.

A unique Langley marine research capability of coupled laboratory tests, field tests, data processing algorithm and display development, and predictive model development has been demonstrated. The Langley program will provide the technology base for design of future integrated remote sensing systems for increasing our understanding of water pollution problems.

	Permanent Positions (Civil Service)
TECHNOLOGY UTILIZATION	16

The overall objective of the NASA Technology Utilization program is to enhance economic growth and contribute to the technological solution of public problems through the transfer of new technology resulting from aeronautical and space research and development efforts to the non-aerospace segments of the economy.

In 1981, civil service personnel will provide the following support:

1. Expedite the application of new technology by compressing the time required from generation of technology to its use in the economy.

2. Encourage the use of aerospace technology in non-aerospace segments of the economy having problems amendable to technological solutions.

3. Understand more fully the technology transfer process and its impact and systematically manage and optimize the process.

AERONAUTICAL RESEARCH AND TECHNOLOGY	1,482

The aeronautical research and technology program at Langley is characterized by the dynamic interaction between a broad spectrum of technical disciplines, the application of discipline research to specific technology requirements, demonstrations of particular technology applications, and the indepth look at future technology requirements. The diversity of activities in such disciplines as materials, structures, flight stability and control, avionics, and aerodynamics provides the expertise to pursue the broader problems such as those involved in the terminal configured vehicle and aircraft energy efficiency technology programs. The unique wind tunnel and computing facilities at Langley compliment the expertise of the technical staff to produce a broad cohesive program in aeronautical research.

The aerodynamics activity at Langley encompasses extensive theoretical, experimental, and applications activities. Basic work in fluid and flight mechanics involves theoretical and experimental determination of

aerodynamic flows and complex aircraft motions. The program utilizes the unique Langley capabilities made possible by the STAR Computer and recently developed cryogenic wind tunnel testing techniques which provide the capability of simulating full-scale Reynolds numbers at transonic speeds.

Aspects of the problems which are studied include airfoil and wing design, flowfield analysis, configuration design processes, noise and analysis, propulsion system integration, fuel efficiency, flight dynamics, and economic feasibility. Tunnel testing techniques will be further enhanced by combining the technology developed for non-optical positioning sensing of models with the superconducting coil technology to provide for the design and construction of an advanced magnetic balance and suspension system. The STAR Computer will be used in the areas of far-field jet noise, 3-D potential flow programs, and in the solution of 2-D and 3-D Navier-Stokes equations. Generation and documentation of the aerodynamic behavior of new airfoils will be furthered by the continued definition of the aerodynamic characteristics of a range of supercritical airfoils. Application of advanced transonic theories to the design of improved 3-D wings will be continued and evaluated by wind tunnel tests. Wind tunnel and flight tests will be continued on general aviation aircraft configurations having the potential for practical stall immunity and means for spin avoidance. An improved data base for the aircraft noise prediction computer program will be developed so that noise contours can be predicted within 1.5dB accuracy. Other activities in the acoustics and noise reduction research include research on jet noise, duct acoustics, forward speed effects on fan noise, interior noise, rotating blade noise, atmospheric propagation, noise predictions, and community impact and annoyance produced by aircraft noise. Transport and General Aviation Operations Research will add to aircraft safety and productivity. In the area of aircraft energy efficiency technology, major activities include continuation of work required for the design and testing of a laminar flow control wing box, cover panel and ducting, and for the design of a laminar flow control compatible supercritical airfoil section for flight test evaluation; the establishment of design data for high aspect ratio supercritical wings; investigations of high lift aerodynamics configurations for advanced transports; and the evaluation of performance benefits achievable by incorporating winglets and wing tip extensions to wide-body transports. This technology also has application to improved mission performance for general aviation aircraft and for advanced maneuvering air combat aircraft and missile systems and is being investigated in relation to subsonic, supersonic, and hypersonic configuration concepts. In the area of supersonic configurations, improved aerodynamic platforms will be experimentally determined by subsonic, transonic, and supersonic wind tunnel tests.

The materials and structures effort is directed at the development of new and improved structural materials, manufacturing processes, and design technology to improve the structural efficiency, reliability, and durability and to reduce design costs of airframes and components. This activity is focused on research on advanced composite materials, computer aided analysis and design technology, and development of analytical or semiempirical fatigue and life prediction methodology. Use of active controls for minimization of aeroelastic response, reduced static stability, and minimization of gust and maneuver loads is being pursued in both theoretical and wind tunnel studies.

Emerging technological advances in computer systems will continue to be exploited to significantly increase the utility and reduce the cost of engineering computations. A finite element computational device using microprocessor components will be defined in 1981 that is capable of reducing computational costs and/or times by a factor of ten over present devices.

The avionics work at Langley includes technology development in aircraft guidance and navigation, aircraft control systems, crew station avionics, and integration and interfacing techniques. Also, major efforts in aircraft flightpath management and operations technology and active controls technology for conventional takeoff and landing (CTOL) are being conducted in this program area. The work includes requirements analyses, design studies, systems and component technology development, ground simulation and technology validation, and proof-of-concept validation through experimental flight programs. The Langley expertise in the avionics area is being applied to terminal configured vehicle systems and operations technology, broadly applicable technology for development of low-cost Global Positioning System (GPS) navigation hardware and software, advanced control laws for various aircraft classes, intersystems communications networks for enhanced interfacing and integration of functions within an aircraft, and advanced technology for improved display media and pilot/system interfaces in aircraft cockpits. Emphasis in 1981 will be on investigations of the capacity, efficiency, and safety potential of cockpit-displayed air traffic information concepts with elements of an advanced air traffic control system, the development of technology for enhanced function and hardware integration to increase aircraft systems reliability and reduce operating costs, definition of requirements and technology to facilitate general aviation single-pilot guidance and control in Instrument Flight Regime (IFR) environments, and the investigation of concepts and technology which will result in highly accurate aircraft navigation capability utilizing the GPS . Other avionics technology applications are also found in work on advanced digital flight control systems, fluidics instrumentation for general aviation aircraft, and the development of mathematical tools to investigate and enhance reliability prediction and assessment, control algorithm design, and pilot describing functions.

	Permanent Positions (Civil Service)
SPACE RESEARCH AND TECHNOLOGY	523

The space research and technology program at Langley is characterized by work in several discipline areas and the application of this discipline expertise to current and future technology requirements. Longer range studies are directed at defining the technology requirements for future space systems and missions.

The objective in the materials area is to establish and demonstrate the required technology for application of advanced materials for a wide variety of space applications. Material systems and applications include: high temperature composites with long life capability for use as structural materials in future space

transportation systems; high temperature metallic materials for thermal protection systems; and high stiffness, low weight, low thermal expansion composites for large, long-life space structures. Environmental effects on the mechanical and physical properties of materials are being studied utilizing specialized facilities and laboratories. An integral part of the research activity is the definition of new experimental testing and research facility requirements which will assure that the reliability and durability of future space structures can be adequately predicted and assessed.

The goal of the activities in the area of structures is to provide validated analysis and design methodology, design concepts, and dynamics and control methodology required for efficient long-life space transportation and payload structures. High temperature metallic heat shield concepts and actively cooled structural and propulsion concepts for advanced Space Transportation Systems are being derived and evaluated using specialized laboratories and wind tunnels. A complete radiation heat transfer, large deflection, and nonlinear materials property analysis capability will be available in 1981. Analysis, design, and loads determination methodology for deployable and erectable large space platforms, antennae, and booms are being studied as part of a multi-Center, multidisciplinary program for advanced technology. By mid-1982, an improved structural analysis methodology for substantially improved computational efficiency will be developed and verified. It will include the effects of plasticity, large deflections, large rotations, and other sources of nonlinear behavior, and will require application of evolving advanced numerical techniques, computer software and computer hardware.

An extensive program in electronic component technology development, data processing and sensor development is conducted at Langley. Sensor developments include laser back-scatter and fluorescence techniques for water quality measurements, continuously tuneable infrared laser techniques, and high power/high pressure tuneable gas lasers for the measurement of low concentration atmospheric constituents. In 1981, Langley will complete design and analysis studies to meet the requirements for fabrication of a solar occultation Laser Heterodyne Spectrometer experiment to measure stratospheric constituents in the 9-12um region, and will design and evaluate an array of microwave radiometer receivers for high resolution ($\pm$1 km) oceanographic sensing.

Specific devices required to support the development of a charged coupled device onboard data processor are being developed and evaluated. The broad objective of this work is to develop an onboard processor technology base for remote sensing vehicles with the potential of leading to a 1,000-fold decrease in the density of data sent back to Earth processing stations. The evaluation of a solid state data storage system using bubble domain technology is underway at Langley. The overall objective is to provide an adequate bit solid state data storage system suitable for replacing tape recorders in many aerospace vehicle applications. Other space electronics technology efforts are focused on detectors for remote sensing (e.g., infrared and pyroelectric devices), spacecraft attitude control (using magnetically suspended momentum storage or vernier pointing devices), and multipurpose, user-oriented, software development verification and validation techniques.

The objectives of the Langley program in entry technology are to develop the aerothermodynamic technology required for the design and operation of advanced vehicle systems for space and global transportation, and to provide Space Shuttle support. The objectives are being met through the application of analytical techniques and unique Langley facilities in the areas of Earth orbit transportation, aerodynamics, heat transfer, real gas effects, planetary entry, radiative heating and hypervelocity gas dynamics. Theoretical and experimental efforts in the areas of ablation product radiation and absorption, highly blown shock layer probe flight mechanics, and mass loss and shape change will be pursued to develop a sufficient data base to minimize planetary mission cost, maximize scientific return and ensure a high probability of mission success.

The Langley programs in Space Technology Shuttle Payloads involve a variety of tasks focused on extending basic research and technology development into the space environment when economically feasible, and/or when the objectives can be achieved only in space.

	Permanent Positions (Civil Service)
CENTER MANAGEMENT AND OPERATIONS SUPPORT	711

Center Management and Operations Support is defined as that support or service being provided to all Langley Research Center organizations which cannot be directly identified to a benefiting program or project. The civil service personnel involved are:

Director and Staff - The Center Director, Deputy Director, and immediate staff; e.g., Legal, Patent Counsel, Equal Opportunity, Public Affairs, and Safety.

Management Support - Includes a wide range of activity categorized as management support for programs and functional organizations for the entire Center. Specific functions include resource and budget management, program control, contracting and procurement, personnel management, property management, financial management, resource control and management information systems and analysis.

Operations Support - This is a broad spectrum of activity that is required to maintain and operate facilities, buildings, and equipment; and to provide the normal housekeeping services and logistics support for the personnel who manage and conduct the affairs of the Center. Specific activities are:

Maintenance and operation of all buildings and facilities
Reliability and quality assurance
Custodial services
Logistics support including transportation, supplies, etc.
Photographic and graphic support

RESOURCE REQUIREMENTS BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
I. PERSONNEL AND RELATED COSTS	88,191	89,940	95,405	95,782
Summary of Fund Requirements				
A. Compensation and Benefits				
1. Compensation				
a. Permanent positions	78,275	79,276	84,270	84,321
b. Other than full-time permanent positions	1,114	1,211	1,441	1,491
c. Overtime and other compensation	516	597	632	632
Subtotal, Compensation	79,905	81,084	86,343	86,444
2. Benefits	7,706	8,161	8,367	8,603
Subtotal, Compensation and Benefits	87,611	89,245	94,710	95,047
B. Supporting Costs				
1. Transfer of personnel	60	105	66	66
2. Personnel training	520	590	629	669
Subtotal, Supporting Costs	580	695	695	735
Total, Personnel and Related Costs	88,191	89,940	95,405	95,782

Explanation of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
A. Compensation and Benefits	87,611	89,245	94,710	95,047
1. Compensation	79,905	81,084	86,343	86,444
a. Permanent positions	78,275	79,276	84,270	84,321

The funds shown above will support 2,980 permanent positions in 1981. The increase in cost from the 1980 budget estimate to the 1980 current estimate is due primarily to the October 1979 pay increase, partially offset by savings from the reduction of 10 permanent positions.

Basis of Cost for Permanent Positions

In 1981 the cost of permanent positions will be $84,321,000, an increase of $51,000 over 1980. This increase results from the following:

Cost of permanent positions in 1980		84,270
Cost increase in 1981		+1,539
Within grade and career advances:		
Full year effect of 1980 actions	+681	
Partial year effect of 1981 actions	+764	
Full year effect of 1980 pay increases	+94	
Cost decreases in 1981		-1,488
Turnover savings and abolished positions:		
Full year effect of 1980 actions	-668	
Partial year effect of 1981 actions	-504	
One less paid day in 1981	-316	
Cost of permanent positions in 1981		84,321

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
b. Other than full-time permanent positions				
1. Cost	1,114	1,211	1,441	1,491
2. Workyears	121	137	144	148

The 1981 distribution of workyears is as follows:

Distribution of Other than Full-Time Permanent Workyears

Program	Workyears
Cooperative training	80
Summer employment	18
Opportunity programs	39
Other temporary employment	11
Total	148

The increase from the 1980 budget estimate to the 1980 current estimate reflects the continuation of the part-time employment program and the institution of the White House Research Apprenticeships program. The increase from the 1980 current estimate to the 1981 estimate is due to the scheduled build-up of the Research Apprenticeships program.

c. Overtime and other compensation	516	597	632	632

The use of overtime and other compensation is limited to emergency repairs and work that cannot be accomplished during normal working hours. This includes the monitoring of on-site contracts being performed during off-duty hours and wind tunnel work required at night to take advantage of off-peak rates. The increase from the 1980 budget estimate to the 1980 current estimate is due primarily to the October 1979 pay increase.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
2. Benefits	7,706	8,161	8,367	8,603
Following are the amounts of contribution by category:				
Civil Service Retirement Fund	5,492	5,680	5,953	6,010
Employee life insurance	245	349	284	298
Employee health insurance	1,619	1,803	1,732	1,850
Workmen's compensation	301	300	363	405
FICA	23	29	35	40
Severance pay	26	---	---	---
Total	7,706	8,161	8,367	8,603

The increase from the 1980 budget estimate to the 1980 current estimate is due primarily to the October 1979 pay increase, partially offset by the savings from the reduction of 10 permanent positions. The increase in 1981 over the 1980 current estimate is related to the increases in personnel compensation. The workmen's compensation costs are based on the Department of Labor billings for 1980 and 1981.

B. Supporting Costs	580	695	695	735
1. Transfer of personnel	60	105	66	66

Transfer of personnel costs include actual expenses involved in the movement and temporary storage of employees' household goods, subsistence and temporary expenses, real estate costs, and miscellaneous moving expenses. The current 1980 and 1981 estimate reflect 1979 experience.

2. Personnel training	520	590	629	669

The increase from the 1980 budget estimate to the 1980 current estimate is due to announced tuition increases and requirements for Civil Service Reform Act implementation training. The 1981 estimate assumes the same level of effort as 1980.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
II. TRAVEL	1,947	2,154	1,899	2,021
Summary of Fund Requirements				
A. Program Travel	1,381	1,478	1,478	1,573
B. Scientific and Technical Development Travel	249	265	265	282
C. Management and Operation Travel	317	411	156	166
Total, Travel	1,947	2,154	1,899	2,021
Explanation of Fund Requirements				
A. Program Travel	1,381	1,478	1,478	1,573

Program travel is directly related to the accomplishment of the Center's mission. Travel for program purposes reflects the continuing effort in space research, aircraft technology, flight simulation, fluid mechanics, airborne science and applications, and space applications. The 1981 estimate provides for essentially the same level of travel activity as in 1980.

B. Scientific and Technical Development Travel	249	265	265	282

Scientific and technical development travel permits employees to participate in meetings and technical seminars with other representatives of the aerospace community. This participation allows them to benefit from exposure to technological advances outside LaRC, as well as to present both accomplishments and problems to their associates. Many of the meetings are working panels convened to solve certain problems for the benefit of the Government. The 1981 estimate provides for essentially the same level of travel activity as in 1980.

C. Management and Operations Travel	317	411	156	166

Management and operations travel is used for the direction and coordination of general management matters. It includes travel in such areas as personnel, financial management, and procurement activities; travel of the

Center's top management to NASA Headquarters and other NASA Centers; and local transportation. The decrease from the 1980 budget estimate to the 1980 current estimate reflects a reduction in travel to implement Section 112 of Public Law 96-86. The 1981 estimate provides for essentially the same level of travel activity as in 1980.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
III. FACILITIES SERVICES	8,803	10,192	10,914	12,537

Langley Research Center (LaRC) is located on 787 acres of grounds in a complex made up of laboratory and office type buildings as well as research wind tunnels.

This complex encompasses 2,074,145 gross square feet of building space including 11 major buildings. Also included are 18 major technical facilities. This physical plant houses an average daily on-Center population of 4,200 to 4,500 personnel. Many of the test facilities are utilized on more than one shift/or during off peak hours.

Summary of Fund Requirements

A. Maintenance and Related Services				
1. Facilities	649	624	680	759
B. Custodial Services	1,753	1,980	1,980	2,329
C. Utility Services	6,401	7,588	8,254	9,449
Total, Facilities Services	8,803	10,192	10,914	12,537

Explanation of Fund Requirements

A. Maintenance and Related Services				
1. Facilities	649	624	680	759

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This activity provides funds for maintenance and repair of aging administrative facilities and utility lines. This activity also provides for 12 workyears of effort to accomplish grounds maintenance. The increase in the 1980 current estimate over the 1980 budget estimate is to accommodate work deferred from 1979. The 1981 request reflects a continuation of the 1980 maintenance and repair effort at approximately the same level.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
B. Custodial Services	1,753	1,980	1,980	2,329

This activity involves 108 workyears of effort at LaRC to provide for janitorial and security services. Also included are funds for fire protection services provided by the city of Hampton. Estimates for 1980 current and 1981 are based upon recently concluded wage increases for janitors and security guards. The 1981 estimate provides for the full year affect of wage increases negotiated in 1980. Services remain at the current level.

C. Utilities Services	6,401	7,588	8,254	9,449

Included in this item is the purchase of electric service from Virginia Electric and Power Company (VEPCO), fuel oil from a local supplier, and water and sewage charges. Also included are funds for heat and steam services from the USAF-Langley for East area facilities and, beginning in 1981, purchase of steam from the city of Hampton for facilities located in the West area of LaRC.

A breakdown of the utilities costs is as follows:

1. Electricity (138,000 mWh)	7,307
2. Fuel oil (1,265,000 gals.)	569
3. Heat and steam (USAF)	247
4. Water and sewage	102
5. Steam (City of Hampton)	1,224

The increase in the 1980 current estimate over the 1980 budget estimate is the result of recent VEPCO rate increases. The 1981 estimate reflects a reduction of 12 million kilowatt hours of electricity due to revised programmatic requirements. All other estimates reflect the full year effect of 1980 rate increases.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
IV. TECHNICAL SERVICES	2,296	2,032	1,802	2,453
Summary of Fund Requirements				
A. Automatic Data Processing				
1. Equipment	467	311	86	270
2. Operations	1,346	1,368	1,333	1,745
Subtotal	1,813	1,679	1,419	2,015
B. Scientific and Technical Information				
1. Library	125	101	136	142
2. Education and Information	358	252	247	296
Subtotal	483	353	383	438
Total, Technical Services	2,296	2,032	1,802	2,453
Explanation of Fund Requirements				
A. Automatic Data Processing	1,813	1,679	1,149	2,015

Funds for the Center's business computer complex which provides the accounting and management information data required by the Center and NASA are provided for in this function. Included are equipment lease, purchase and maintenance; paper and other expendable supplies; small miscellaneous contracts; and a 33 work-year level of effort support service contract for programming and operations.

1. Equipment	467	311	86	270

This activity includes the lease and purchase of equipment associated with Langley's business computer complex. The reduction in the 1980 current estimate from the 1980 budget estimate is due to the acquisition of items in 1979 that had originally been planned for 1980. The 1981 estimate reflects a level of routine equipment replacement and update.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
2. Operations	1,346	1,368	1,333	1,745

This estimate includes ADP equipment maintenance, supplies, and the support service contract for programming and operations. The reduction in the 1980 current estimate from the 1980 budget estimate is due to the postponement of minor program updating until 1981. The 1981 estimate also reflects the full year cost of support service contract rate increases anticipated in 1980.

B. Scientific and Technical Information	483	353	383	438

This estimate provides support service contract assistance in the operation of the technical library and Visitor Information Center. Also included are funds for public information services. The slight increase in the 1980 current estimate over the 1980 budget estimate is due to the addition of several acquisitions deferred from 1979. The 1981 estimate reflects activity approximately level with the 1980 effort.

1. Library	125	101	136	142

Nine workyears of support contract effort are for the operation of the Center's technical library. The increase in the 1980 current estimate is due to the increase of one support service contract workyear and increased wage rates. The 1981 estimate reflects the same level of effort provided in 1980.

2. Education and information	358	252	247	296

Funding for all the Center's public affairs activities is included in this estimate. Included are nine workyears of support contract effort for operation of the Visitor Information Center; coordination of tours and special events; construction and transportation of exhibits; and other miscellaneous educational and information programs. The reduction in the 1980 current estimate from the 1980 budget estimate is due to the movement into 1979 of several small purchases originally planned for 1980. The 1981 estimate reflects a level of operations approximately equal to the 1980 effort.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
V. MANAGEMENT AND OPERATIONS	5,406	5,940	6,020	6,352
Summary of Fund Requirements				
A. Administrative Communications	1,079	1,182	1,187	1,377
B. Printing and Reproduction	157	177	182	193
C. Transportation	1,313	1,360	1,422	1,568
D. Installation Common Services	2,857	3,221	3,229	3,214
Total, Management and Operations	5,406	5,940	6,020	6,352
Explanation of Fund Requirements				
A. Administrative Communications	1,079	1,182	1,187	1,377

This estimate includes funds for local telephone and exchange costs; Federal Telecommunications System (FTS) service; and datafax and telegraph service. The increase in the 1980 current estimate over the 1980 budget estimate is due to an increase in service rates. The 1981 estimate provides for the full year effect of rate increases for communication services.

1. Local telephone service..... 870

This estimate provides for local telephone and exchange costs. The 1981 estimate provides for the full year effect of rate increases.

2. Long distance telephone services..... 492

These funds provide for long distance telephone service for the FTS. The 1981 estimate provides for the full year effect of rate increases for this service.

3. Other communications services..... 15

Included in this activity are costs for other miscellaneous communications such as teletype and datafax services. The 1981 estimate provides for the full year effect of rate increases for these services.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
B. Printing and Reproduction	157	177	182	193

This estimate provides for special printing and reproduction supplies, and a four workyear support service contract effort for reproduction services. The increase in the 1980 current estimate over the 1980 budget estimate is due to an increase in support service contract wage rates. The 1981 estimate provides for the full year effect of a previously negotiated wage increase in support service contract costs.

C. Transportation	1,313	1,360	1,422	1,568

This activity includes the operation, maintenance, and purchase of motor vehicles; shipping transportation and freight charges; a 41-workyear support service contract effort for pickup and delivery of freight furniture, and other bulk objects; and a seven-workyear support service contract effort for operation and maintenance of the NASA-1 aircraft. This effort also includes all of the NASA-1 aircraft fuel, equipment, and expendable supplies. The increase in the 1980 current estimate over the 1980 budget estimate is due to an increase in support service contract wage rates. The 1981 estimate provides for the full year effect of the support contractor wage increases and the full year effect of rate increases for other services.

D. Installation Common Services	2,857	3,221	3,229	3,214

These funds will provide for 77 workyears of support service contract effort for medical services, mail delivery, stock issue and warehousing, and other general administrative support. Also included are the rental and maintenance of office copy machines and equipment, minority programs, and other administrative services and supplies. The 1981 estimate provides for a slightly reduced level of service from that provided in the 1980 current estimate.

1. Center management and staff 343

This function includes 13 workyears of support service contract effort and general supplies and equipment purchases for all administrative support organizations at the Center. The 1981 estimate reflects the full year effect of previously negotiated wage rate increases in support contract costs.

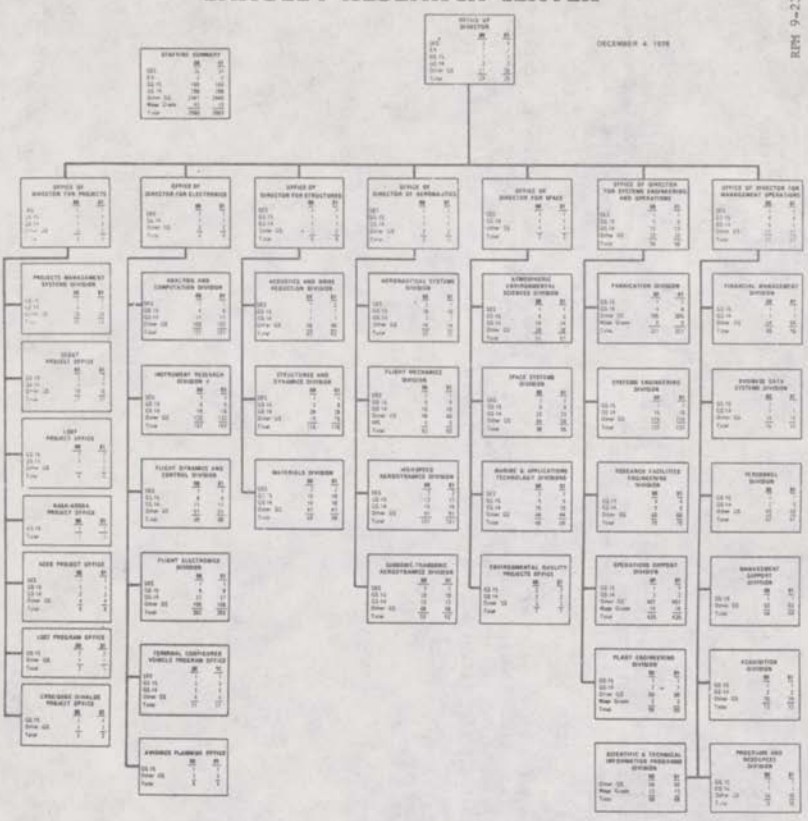
	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
2. Medical services				432

This function provides 11 workyears of effort for occupational and environmental health services, included are dispensary services; emergency ambulance service; medical examinations; and health physics and industrial hygiene services. The 1981 estimate provides for the full year effect of a previously negotiated increase in the cost of support contractor medical services.

3. Installation support services				2,439

This function includes 53 workyears of support service contract effort for mail delivery, stock issuance and warehousing operations and micrographics services. Also included are the purchase, maintenance, and rental of office copy machines, typewriters and other office equipment, and postage costs. The 1981 estimate provides for the full year effect of a previously negotiated increase in cost of support contractors.

LANGLEY RESEARCH CENTER



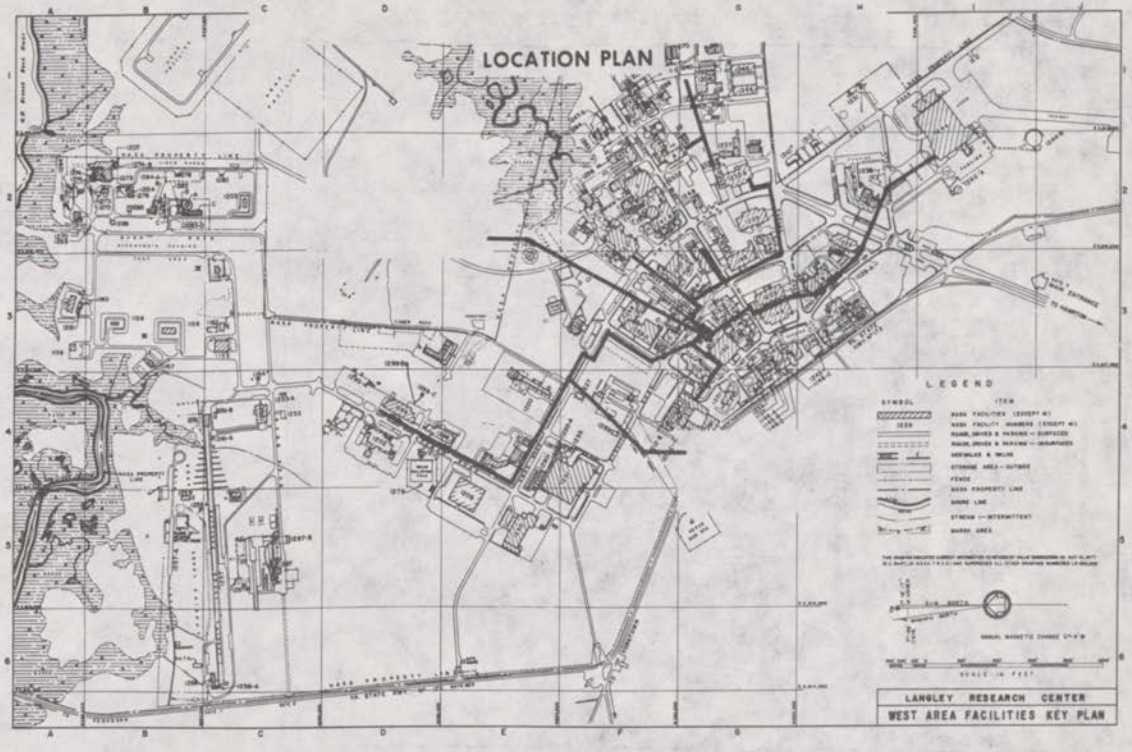


LANGLEY RESEARCH CENTER AND VICINITY

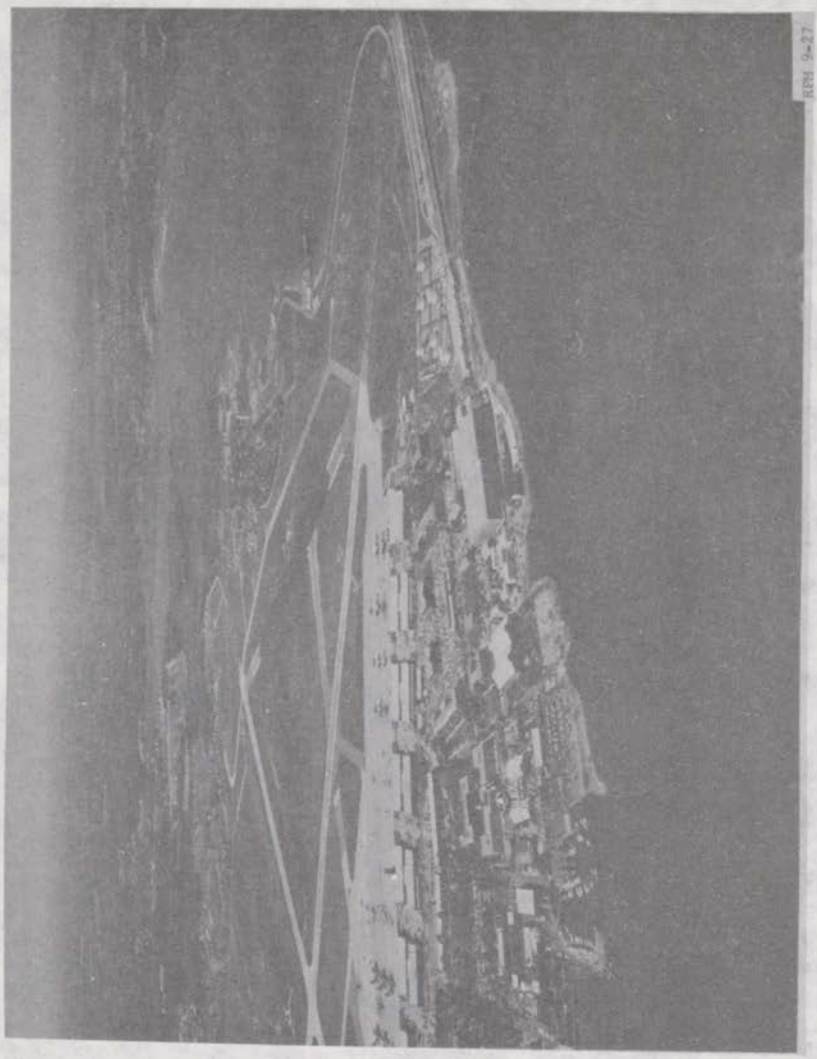
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LANGLEY RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES




STS 9-26


KEM 9-27

RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 1981 ESTIMATES

LEWIS RESEARCH CENTER

DESCRIPTION

The Lewis Research Center occupies two sites in north central Ohio. The original site, established in 1941 adjacent to the Cleveland-Hopkins International Airport, has 366 acres including 14 acres leased from the City of Cleveland. There are over 100 buildings and structures, including wind tunnels, test chambers, laboratories and other research facilities.

The Plum Brook Station, established in 1956, is located south of Sandusky, Ohio, about 50 miles west of Cleveland, on land formerly occupied by the Plum Brook Ordinance works. There are 5,853 acres owned and approximately 47 acres in easements. There are 69 buildings and 99 concrete storage bunkers. A 100 KW Electric Wind Turbine Generator Facility designed to be operated remotely is in operation for a program jointly sponsored by the Department of Energy and NASA. During 1975, consistent with our future research and technology needs, the principal facilities were placed in a standby mode.

The total capital investment of the Lewis Research Center and the Plum Brook Station, including fixed assets in progress and contractor-held facilities at various locations as of September 30, 1979, was $449,036,000.

CENTER ROLES AND MISSIONS

The Lewis Research Center was established in 1941 as an aircraft engine research laboratory to meet immediate wartime needs for superior aircraft propulsion systems. Since then, Lewis has developed and constructed many outstanding facilities for testing full-scale aircraft engines and engine components, chemical rocket engines, electric propulsion, space and terrestrial power generation systems and space communication systems. The principal and supporting roles are:

PRINCIPAL

Aeronautics - Development of an advanced technology base for high performance civil and military aircraft propulsion systems within environmental, safety and energy constraints. Development of a technology base to advance the state of the art in aeronautical propulsion systems and components, including engine noise reduction, high temperature materials and structures, improved engine efficiency, pollution control, computational fluid mechanics and technical support to military aviation programs.

Launch Vehicle Procurement - Management and operation of the Centaur launch vehicle system for scientific and applications missions for Government and commercial users.

Space Propulsion Systems Technology - Development and maintenance of the space propulsion systems technology base, including associated structures and materials work.

Space Energy Processes and Systems Technology - Development and maintenance of the technology base, including associated structures and materials work.

Energy Technology - Conducting energy-related research and development, primarily on a reimbursable basis, with broad emphasis on solar, gas turbine, ground propulsion and other appropriate terrestrial energy systems.

Communications Systems Technology - Development of communications technology, including high power microwave and millimeter-wave components and systems oriented towards satellite-based applications. Includes flight experiment development and management.

SUPPORTING

Environmental Observations - Development of remote sensing technology and systems for applications to water quality in the Great Lakes.

SUMMARY OF RESOURCES REQUIREMENTS

FUNDING PLAN BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
I. Personnel and Related Costs	74,251	80,524	82,203	84,262
II. Travel	1,002	1,208	1,169	1,244
III. Facilities Services	9,565	10,894	11,312	12,307
IV. Technical Services	681	429	885	1,043
V. Management and Operations	1,958	2,745	2,256	2,504
Total, fund requirements	87,457	95,800	97,825	101,360

Distribution of Permanent Positions by Program

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Direct Positions				
Space Transportation Systems	108	84	84	71
Space flight operations	---	1	1	1
Expendable launch vehicles	108	83	83	70
Space Science	5	---	---	---
Planetary exploration	1	---	---	---
Life sciences	4	---	---	---

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Space and Terrestrial Applications	122	122	122	122
Space applications	111	111	111	111
Technology utilization	11	11	11	11
Aeronautics and Space Technology	1,967	1,969	1,969	1,982
Aeronautical research and technology	1,193	1,198	1,198	1,211
Space research and technology	378	375	375	375
Energy technology	396	396	396	396
Subtotal, direct positions	2,202	2,175	2,175	2,175
Center Management and Operations Support Positions	656	660	660	660
Total, permanent positions	2,858	2,835	2,835	2,835

PROGRAM DESCRIPTION

	Permanent Positions (Civil Service)
SPACE FLIGHT OPERATIONS	1

The Lewis Research Center provides scientific and engineering consultation and technical support for the Solar Electric Propulsion System being conducted by the Marshall Space Flight Center. The consultation and support is in the area of electrical propulsion systems, with special emphasis on ion field effects.

EXPENDABLE LAUNCH VEHICLES	70

The Centaur Launch Vehicle program provides launch vehicles and launch operations for automated space missions. The program includes the procurement of vehicle systems hardware, launch services, engineering and management support as well as maintenance and operation of ground support equipment.

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In 1981, civil service personnel working on the Centaur Launch Vehicle program will continue to support the launching of both Government and commercial payloads. Currently, three Atlas-Centaur launches and a back-up are scheduled in support of the Navy FLTSATCOM and the INTELSAT V program for COMSAT.

	Permanent Positions (Civil Service)
SPACE APPLICATIONS	111

Space Applications at the Lewis Research Center consists of space communications and environmental observations. In 1981, Lewis civil service personnel will continue to support these programs as follows:

Communications - Lewis, as the responsible Center for communications research and development, is studying the capabilities and costs of various advanced satellite communications systems concepts directed at providing additional frequency bands and improved communication service. The studies are being focused on the needs of the public and private sectors, both nationally and internationally. Lewis is working on experimental systems with possible application to both the ground and space segments of any future advanced communications systems. Lewis has begun a technology development program to expand the communication bands useable for communications in order to meet the increasing needs for additional frequencies. The principal focus of the program is the 20 to 30 gigahertz band. Additional research and technology efforts dealing with a wide range of frequency bands are also being conducted.

Environmental Observations - Carrying out its role of applying NASA's technology to regional needs, Lewis is developing and applying remote sensing technology to important areas of earth surface characteristics. Program milestones include verification of remote sensing data for organic and inorganic matter in the Great Lakes and completing the evaluation of coastal zone color scanner algorithms.

TECHNOLOGY UTILIZATION	11

In 1981, Lewis civil service personnel in the Technology Utilization program will be involved in transfer of new knowledge and innovative technology resulting from NASA R&D programs for application in industry, the public sector, and medicine. The primary objectives are to: (1) increase the return on the national investment in aerospace R&D; (2) shorten the time from discovery to application; (3) aid the movement of new knowledge to potential users; and (4) contribute to the development of improved means of transferring the new knowledge to other places of potential applications.

	Permanent Positions (Civil Service)
AERONAUTICS RESEARCH AND TECHNOLOGY.....	1,211

Lewis' major responsibility within aeronautics is propulsion. The general goal of Lewis is to provide the advanced technology base for developing high-performance civil and military aeronautical propulsion systems which are economical, fuel-conservative, and reliable, and which operate within minimum environmental impact. The civil service personnel in 1981 will be involved in conducting the ongoing program at the Center as described below:

In aeronautical propulsion-related research, the goal is to develop an understanding of the physical phenomena related to propulsion systems and components including aeroelasticity phenomena, computational fluid mechanics, low and high temperature composite materials, fatigue failure mechanisms, emission characteristics in reciprocating and turbine engines, alternate fuels characterization, noise generation mechanisms, and integrated control concepts.

The major goal in the components technology program is to advance the state of the art in engine components including composite fan blades, low aspect ratio compressor stages, core turbine cooling, blade clearance controls, advanced transmissions, prevaporizing combustors, two-dimensional nozzles, supersonic inlets, high and low speed propellers, bearings, seals, and instrumentation.

In engine systems technology, Lewis is studying problems encountered in complete engines and propulsion systems including engine performance at various altitudes, inlet flow distortion effects, dynamic component interactions, thrust augmentation, advanced control systems, techniques for reduced fuel consumption, engine emission and noise reduction, propulsion system-airframe interactions, aviation safety and icing research technology associated with propulsion systems.

Within the aeronautics program at Lewis, work is being performed on a number of major project areas including materials for advanced turbine engines, energy efficient engine, variable cycle engine, advanced low emissions combustors engine component improvement, quiet short-haul research aircraft, supersonic cruise research, advanced turboprops, advanced rotorcraft transmissions and broad specification fuels.

An extensive effort in materials and structures development supports the aeronautics propulsion program. The scope of this program involves both metallic and non-metallic materials and their application to advanced aircraft engines. Areas of emphasis include the development of alloys and matrix composites capable of higher operating temperatures, with longer operating lifetimes, and lower fabrication costs. The fatigue and fracture behavior of alloys under operating conditions and the development of operating life prediction techniques are an integral part of this materials development effort.

	Permanent Positions (Civil Service)
SPACE RESEARCH AND TECHNOLOGY	375

The major roles of the Lewis Research Center in Space Research and Technology are to advance the state of the art and maintain a technology base for advanced propulsion and power systems, including associated materials and structures work and space power processing. In 1981, civil service personnel will be used in the activities described below.

The Lewis space propulsion programs include chemical and electric propulsion technology and component and systems development. The chemical propulsion program emphasizes advanced engine systems and components required for future space systems beyond the capability of the Space Shuttle. Improved components and methods of life prediction are being developed and demonstrated, advanced fuel-oxidant combinations are being tested, and complete engine systems tests are being conducted. Technology developments include advanced cooling techniques, fabrication techniques and materials for rocket chambers and nozzles, and advanced high pressure fuel/oxidant feed systems.

Electric propulsion supports both primary propulsion and auxiliary propulsion applications. The primary propulsion technology program consists of further thruster performance verification tests, performance testing of supporting power processor systems to deliver power to the thruster and its controls, and the integration testing of complete thruster systems, including the thruster, power processor, propellant storage and distribution system, thruster gimbal mechanism, controllers, and thermal control systems. Auxiliary electric propulsion meets spacecraft requirements for maneuvering, station keeping and altitude control. The present program objectives are to verify the performance of a one-millipound thruster, develop and test thruster power systems, and perform complete system verification tests.

Space power generation studies include solar photovoltaic and electrochemical energy conversion. The photovoltaic program is directed towards an improvement in solar cell efficiency, reduced cost, and improved operating life. Electrochemical research and development supports extended operating life and improved energy density for space batteries and fuel cell components and systems. Lewis is also conducting a program to advance the state of the art of microwave power amplifiers for potential future applications in communications and power transmission.

The interactions of the space plasma environment with high voltage power systems and components are being studied and technology is being developed to control these interactions and prevent power system failures.

The Lewis program in space materials technology emphasizes the development of improved materials for advanced space power generation, propulsion and communications systems. Studies include space environmental effects on superalloys and composites, and lubrication problems in mechanical components.

	Permanent Positions (Civil Service)
ENERGY TECHNOLOGY	396

Civil service personnel will be involved in ongoing energy research and development projects related to meeting program milestones of 1981 and subsequent years.

Lewis provides a supporting research and technology base in terrestrial energy conversion and advanced ground propulsion under sponsorship of the Department of Energy. Presently under development are large wind turbogenerators (200 to 2,500 kilowatts) to help meet public power requirements and photovoltaic power systems where their application appears practical. Other programs at Lewis supporting stationary power generation include improved coal-fired utility gas turbine and magnetohydrodynamic system studies. Energy storage systems for stationary power applications are also under development.

Ground propulsion systems development at Lewis include advanced heat engines and electric vehicles. The major thrust of the heat engine project is to advance the technology level of the auto gas turbine and Stirling engine propulsion systems such that their application to automotive propulsion would be practical and cost effective. The electric vehicle project provides near-term technology improvements to existing electric vehicle components and systems.

Program milestones for 1981 include completion of design and initiation of hardware fabrication for advanced electric and hybrid vehicle propulsion systems; the testing of ceramic components in auto gas turbine engines for automotive application; and completion, installation and initial operation of a two and one-half megawatt wind turbine.

CENTER MANAGEMENT AND OPERATIONS SUPPORT	660

Center Management and Operations Support is defined as that support or services being provided to all Lewis Research Center organizations which cannot be directly identified to a benefiting program or project. The civil service personnel involved are:

Director and Staff

The Center Director, Deputy Director and immediate staff, e.g., Technology Utilization, Equal Opportunity, Public Affairs, Reliability and Quality Assurance, Shuttle Assessment Office and Chief Scientist.

Management Support

Includes a wide range of activity categorized as management support for programs and functional organizations for the entire Center. Specific functions include resource and budget management, legal and patent counsel, program control, contracting and procurement, personnel management, property management, financial management, environmental health, resource control and management information systems and analysis.

Operations Support

This is a broad spectrum of activity that is required to maintain and operate facilities, buildings, and equipment; and to provide the normal housekeeping services and logistics support for the personnel who manage and conduct the affairs of the Center. Specific activities are:

Maintenance and operation of all buildings and facilities
Data processing and computer support
Reliability and quality assurance
Centerwide security and protection
Fire protection
Custodial services
Logistics support including transportation and supplies
Medical care of employees
Photographic and graphic support

RESOURCE REQUIREMENTS BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
I. PERSONNEL AND RELATED COSTS	74,251	80,524	82,203	84,262
Summary of Fund Requirements				
A. Compensation and Benefits				
1. Compensation				
a. Permanent positions	65,394	71,057	72,143	73,673
b. Other than full time permanent positions	995	909	1,177	1,249
c. Overtime and other compensation	1,068	1,142	1,408	1,502
Subtotal, Compensation	67,457	73,108	74,728	76,424
2. Benefits	6,488	6,998	7,061	7,361
Subtotal, Compensation and Benefits	73,945	80,106	81,789	83,785
B. Supporting Costs				
1. Transfer of personnel	8	58	39	46
2. Personnel training	298	360	375	431
Subtotal, Supporting Costs	306	418	414	477
Total, Personnel and Related Costs	74,251	80,524	82,203	84,262

Explanation of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
A. Compensation and Benefits	73,945	80,106	81,789	83,785
1. Compensation	67,457	73,108	74,728	76,424
a. Permanent positions	65,394	71,057	72,143	73,673

The funds shown will support 2,835 permanent positions in 1981, the same level as 1980.

Basis of Cost for Permanent Positions

In 1981, the cost of permanent positions will be $73,673,000. The increase of $1,530,000 from the 1980 level results from the following:

Cost of permanent positions in 1980		72,143
Cost increases in 1981		+3,856
Within grade and career advances:		
Full year effect of 1980 actions	+747	
Partial year effect of 1981 actions	+778	
Full year effect of 1980 pay increases	+1,063	
Change in reimbursements	+1,268	
Cost decreases in 1981		-2,326
Turnover savings and abolished positions:		
Full year effect of 1980	-940	
Partial year effect of 1981 actions	-1,076	
One less paid day in 1981	-310	
Cost of permanent positions in 1981		73,673

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
b. Other than full time permanent positions				
1. Cost	995	909	1,177	1,249
2. Workyears	121	98	127	132

The 1981 plan includes 132 workyears which will support the following programs:

Distribution of Other than Full Time Permanent Workyears

Program	Workyears
Cooperative training	48
Summer employment	14
Opportunity programs	35
Other temporary employment	35
Total	132

The increase from the budget estimate to the current estimate in 1980 reflects the continuation of the part-time employment program, a new machinist apprentice program and the White House Research Apprenticeships program. The increase in the 1981 program is due to the scheduled build-up of the White House Research Apprenticeships program.

c. Overtime and other compensation	1,068	1,142	1,408	1,502

The increase in overtime and night differential in 1980 and 1981 is related primarily to the full year cost of the October 1979 pay increase and an increase of direct cost due to a decrease in reimbursable compensation. Total overtime hours remain relatively constant.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
2. Benefits	6,488	6,998	7,061	7,361
Following are the amounts of contribution by category:				
Civil Service Retirement Fund	4,495	4,974	5,000	5,198
Employee life insurance	169	251	200	218
Employee health insurance	1,424	1,489	1,453	1,586
Workman's compensation	330	248	363	313
FICA	38	30	40	41
Severance pay	27	---	---	---
Other Benefits	5	6	5	5
Total	6,488	6,998	7,061	7,361

The increase in 1981 is due primarily to the full year's effect of the October 1979 pay increase and promotions reflected in the compensation estimates. Workmen's compensation costs are based on the Department of Labor billings for 1980 and 1981.

B. Supporting Costs	306	418	414	477
1. Transfer of personnel	8	58	39	46

The increase in transfer of personnel in 1980 and 1981 is due to increased recruiting to meet the requirements of maintaining a constant complement.

2. Personnel training	298	360	375	431

About 38% of the training cost is for technically oriented training. Another 33% is provided specifically for the scientific and engineering staff. The remaining 29% supports other programs, including administrative and clerical. The 1980 and 1981 levels include funds for announced increases in tuition, and for the Civil Service Reform Act implementation training.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
II. TRAVEL	1,002	1,208	1,169	1,244
Summary of Fund Requirements				
A. Program Travel	778	1,004	972	1,034
B. Scientific and Technical Development Travel	131	130	126	134
C. Management and Operations Travel	93	74	71	76
Total, Travel	1,002	1,208	1,169	1,244
Explanation of Fund Requirements				
A. Program Travel	778	1,004	972	1,034

Program travel is directly related to the accomplishment of the Center's mission and accounts for approximately 83% of the travel costs. It provides funds necessary to manage major contractual programs in aeronautical research and technology, space propulsion, materials research and development and energy technology. Program travel is also essential to the management and procurement of launch vehicles. The decrease from the 1980 budget estimate to the 1980 current estimate reflects a reduction in travel to implement Section 112 of Public Law 96-86. The 1981 estimate provides for essentially the same level of travel activities as in 1980.

B. Scientific and Technical Development Travel	131	130	126	134

Scientific and technical development travel permits employees to participate in meetings and seminars with other representatives of the aerospace community. This participation allows them to benefit from exposure to technological advances outside Lewis, as well as to present both accomplishments and problems to their associates. Many of the meetings are working panels convened to solve certain problems for the benefit of the Government. The decrease from the 1980 budget estimate to the 1980 current estimate reflects a reduction in travel to implement Section 112 of Public Law 96-86. The 1981 estimate provides for essentially the same level of travel activities as in 1980.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
C. Management and Operations Travel	93	74	71	76

Management and operations travel is required for the direction and coordination of general management matters. It includes travel in such areas as personnel, financial management, procurement, travel of the Center's top management to NASA Headquarters and other NASA Centers, and local transportation. The decrease from the 1980 budget estimate to the 1980 current estimate reflects a reduction in travel to implement Section 112 of Public Law 96-86. The 1981 estimate provides for essentially the same level of travel activities as in 1980.

III. FACILITIES SERVICES	9,565	10,894	11,312	12,307

Lewis Research Center (LeRC) occupies 366 acres of grounds with a complex of 170 buildings and structures, encompassing 2,208,301 square feet. This physical plant houses an average daily on-Center population of 3,200. Many of the test facilities are utilized on more than one shift and during off-peak hours.

The estimates also include certain resources associated with plant needs at the component installation, the Plum Brook Operations Division.

Summary of Fund Requirements

A. Maintenance and Related Services				
1. Facilities	1,296	930	1,266	1,365
2. Equipment	79	76	84	84
Subtotal	1,375	1,006	1,350	1,449
B. Custodial Services	1,739	2,075	2,250	2,353
C. Utility Services	6,451	7,813	7,712	8,505
Total, Facilities Services	9,565	10,894	11,312	12,307

Explanation of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
A. Maintenance and Related Services	1,375	1,006	1,350	1,449
1. Facilities	1,296	930	1,266	1,365

This activity provides for the operation and maintenance of facilities at the main Installation at Cleveland and Plum Brook Station, involving 25 support contractor workyears. At Cleveland, facilities maintenance requires 18 workyears of support contractor effort: one for engineering design, six for grounds maintenance, and eleven for maintenance of heating, ventilating, and air-conditioning (HVAC) equipment. Maintenance of buildings and grounds at Plum Brook Station requires seven workyears of support contractor effort.

The increase in the 1980 current estimate over the 1980 budget estimate, and the increase in the 1981 budget estimate over the 1980 current estimate is due to an increase of 11 support contractor workyears at Cleveland for HVAC maintenance.

2. Equipment	79	76	84	84

Funding in this category is required for periodic replacement and updating of facilities maintenance and repair shop equipment. The increase in the 1980 current estimate over the 1980 budget estimate is due to unexpected equipment failures.

B. Custodial Services	1,739	2,075	2,250	2,353

This activity involves 122 workyears of support contractor effort, 106 at Cleveland and 16 at Plum Brook Station, to provide for security, janitorial, and fire protection services. The actual costs at Cleveland for 1979 were lower than anticipated due to problems encountered while negotiating a contract for window and floor cleaning; consequently, the cleaning services were not fully utilized. Estimates for 1980 and 1981 reflect full-year costs for services at both Cleveland and Plum Brook Station.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
1. Security (57 workyears)				1,156
2. Janitorial (65 workyears)				1,038
3. Other services				159

Other services include rubbish disposal, fly ash removal, and industrial cleaning of walls, lights and windows on an as needed basis.

C. Utilities Services	6,451	7,813	7,712	8,505

The 1981 estimate covers the projected consumption at Lewis and the Plum Brook Test Station. Electrical power is provided by the local utility company with locally procured fuel oil being used as a central plant fuel at both sites. Natural gas is the primary heating fuel used at Lewis with oil as a back-up fuel, depending on the market situation. Fifteen workyears of contractor effort provide for the operation of the central heating plant. The decrease in the 1980 current estimate from the 1980 budget estimate is the result of a slight downward revision in the estimate of utility rates. The increase in 1981 is due to utility rate increases and the addition of a new purchased services contract for operation of the Center's electrical power substation, which will cost $175,000. The distribution of the utilities budget is as follows:

1. Electricity (161,448/mWh)	6,298
2. Natural gas (574,000 K cu. ft.)	1,611
3. Fuel oil (36,000 gals.)	41
4. Water and sewage	190
5. Operation of electrical power substation	175
6. Operation of central heating plant	190

IV. TECHNICAL SERVICES	681	429	885	1,043

Summary of Fund Requirements

A. Automatic Data Processing				
1. Equipment	15	13	20	22

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
2. Operations	110	213	143	192
Subtotal	125	226	163	214
B. Scientific and Technical Information				
1. Library	---	43	---	---
2. Education and Information	556	160	722	829
Subtotal	556	203	722	829
Total, Technical Services	681	429	885	1,043

Explanation of Fund Requirements

A. Automatic Data Processing	125	226	163	214

The funding provides for administrative data processing including equipment maintenance, programming and operation.

1. Equipment	15	13	20	22

Funding in this category is required for the periodic replacement and updating of administrative ADP equipment. The increase in the 1980 current estimate over the 1980 budget estimate is due to the addition of acquisitions deferred from 1979. The 1980 level of activity is continued in 1981.

2. Operations	110	213	143	192

The 1981 increase provides for a cost of living increase in the support contractor agreement and an increase in work load due to an expanding computer function. The decrease in the 1980 current estimate from the 1980 budget estimate is due to postponing full-scale expansion activities until 1981. Keypunch services formerly provided by support contract are now acquired as purchased services.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
B. Scientific and Technical Information	556	203	722	829

Included in this activity are the purchase of pamphlets, supplies, and materials required for the operation of the Lewis Research Center educational programs, public information services, and the operation of the Visitor Information Center.

1. Library	---	43	---	---

Planned acquisitions which appeared in the 1980 budget estimate have been cancelled.

2. Education and Information	556	160	722	829

Funding for operation of the Visitor Information Center, conduct of tours and special events, construction and transport of special exhibits, and related activities are included in this category. The increase in the 1980 current estimate over the 1980 budget estimate is due to the transfer from Headquarters, a contract of 12 support contractor workyears and an increase in supplies and materials.

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V. MANAGEMENT AND OPERATIONS	1,958	2,745	2,256	2,504
Summary of Fund Requirements				
A. Administrative Communications	626	751	656	731
B. Printing and Reproduction	4	5	4	4
C. Transportation	477	601	557	629
D. Installation Common Services	851	1,388	1,039	1,140
Total, Management and Operations	1,958	2,745	2,256	2,504

Explanation of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
A. Administrative Communications	626	751	656	731

This estimate provides for leased lines and equipment for local and long distance telephone service, Federal Telecommunications Service (FTS), trunklines for Federal communications, and nontelephone communications including telex, advanced records system, datafax and teleconference equipment. The decrease in the 1980 current estimate from the 1980 budget estimate is the result of an effort to constrain the growth of costs in this function. The 1981 estimate assumes the same level of service as in 1980, provided at higher rates.

1. Local telephone service..... 339

This activity includes the leased lines and equipment necessary to serve the Center. This service is comprised of approximately 1,785 instruments, 800 stations and 40 incoming and outgoing lines.

2. Long distance telephone service..... 357

Commercial long distance costs, FTS costs, and overseas calls are included in this category.

3. Nontelephone communications..... 35

This estimate includes funds for one telex instrument, one GSA teletype, advanced record systems unit, one "rapidfax," one "datafax," four teleconference units, oceanic cable service, and postage.

B. Printing and Reproduction	4	5	4	4

This activity includes general administrative printing services.

C. Transportation	477	601	557	629

This function includes services for moving and hauling, packing and crating, motor vehicles special maintenance, procurement, aircraft operation and maintenance. One support contractor workyear is utilized

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at Plum Brook Station for heavy equipment maintenance. The decrease in the 1980 current estimate from the 1980 budget estimate is the result of efforts to constrain costs in this function. The 1981 estimate assumes the same level of services as 1980.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
D. Installation Common Services	851	1,388	1,039	1,140

This funding provides for 41 workyears of support contractor effort to support Center management and staff activities, medical services, and various Installation support services. The decrease in the 1980 current estimate from the 1980 budget estimate is due to a reduction in purchases of supplies and materials.

1. Center management and staff..... 81

This funding provides for a support service contract for Center management and administrative records keeping.

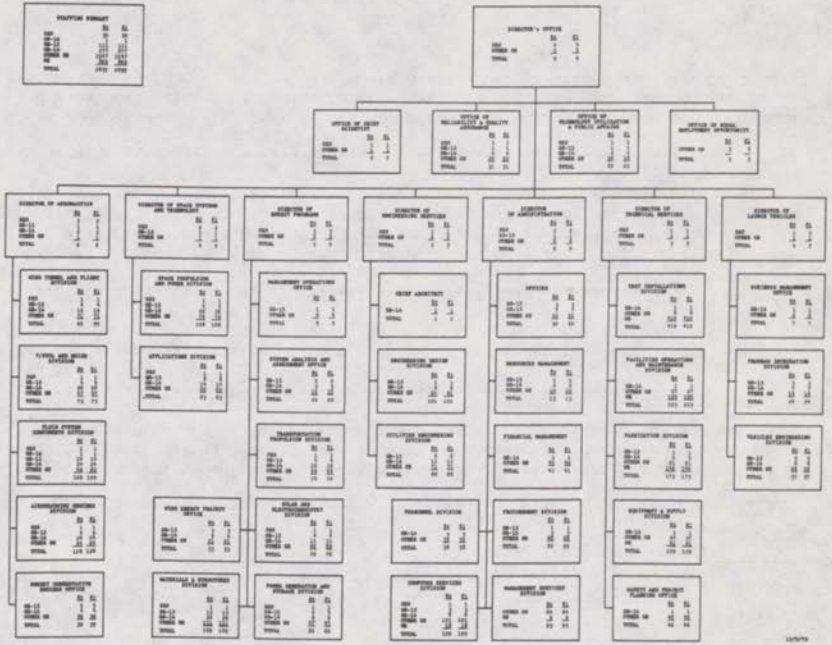
2. Medical services..... 315

At Cleveland this category includes the cost of our staff examinations clinic support service contract and medical supplies and special x-ray and medical examinations for our in-house occupational medicine program. These services are provided by six workyears of support contractor effort. At Plum Brook Station two workyears of support contractor health physicist effort is required to monitor the nuclear reactor.

3. Installation support services..... 744

This function includes 33 workyears of support contractor effort for mail and package distribution services, and stock issue and warehouse operations. Also included are the purchase and maintenance of office machines and equipment. Twenty-eight of the workyears are utilized at Cleveland and five at Plum Brook Station.

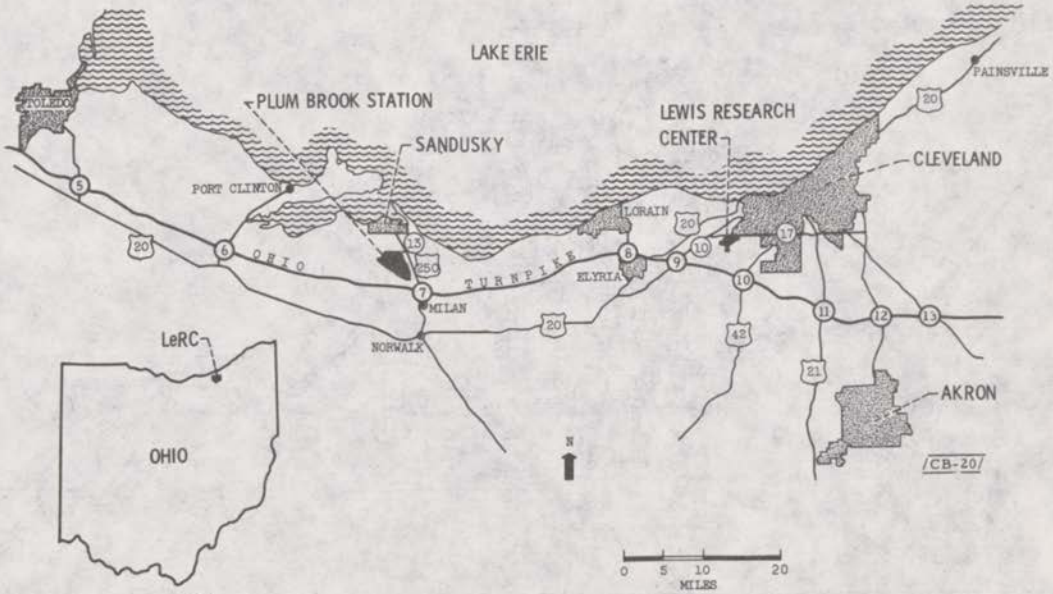
National Aeronautics and Space Administration
Organization and Staffing Chart
LEWIS RESEARCH CENTER
Cleveland, Ohio



RPM 10-22

LEWIS RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES

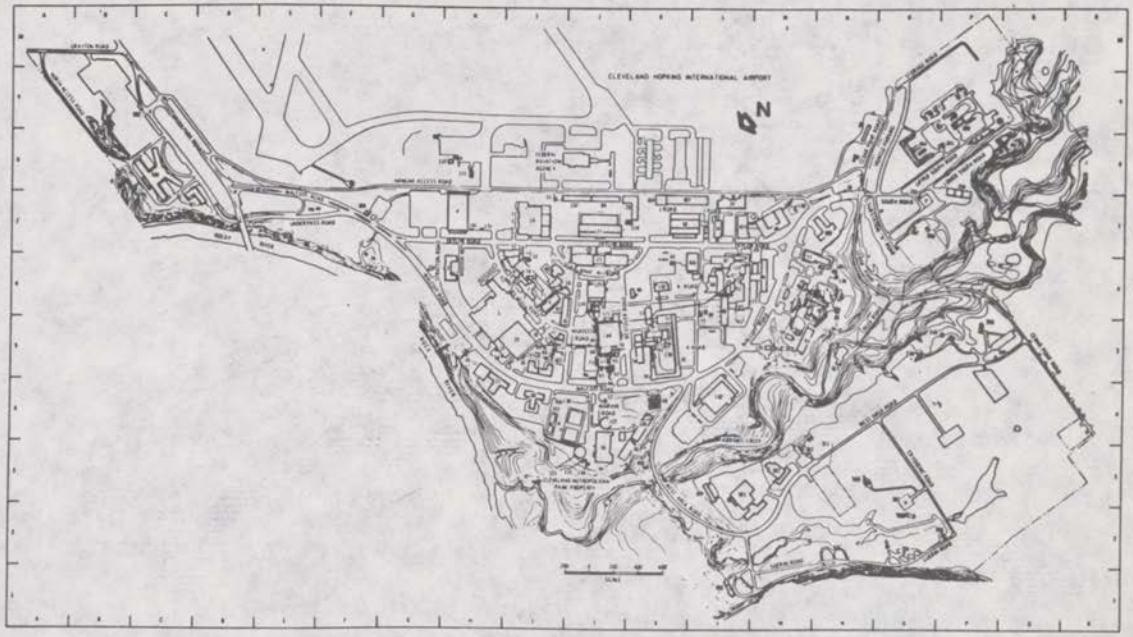
AREA MAP



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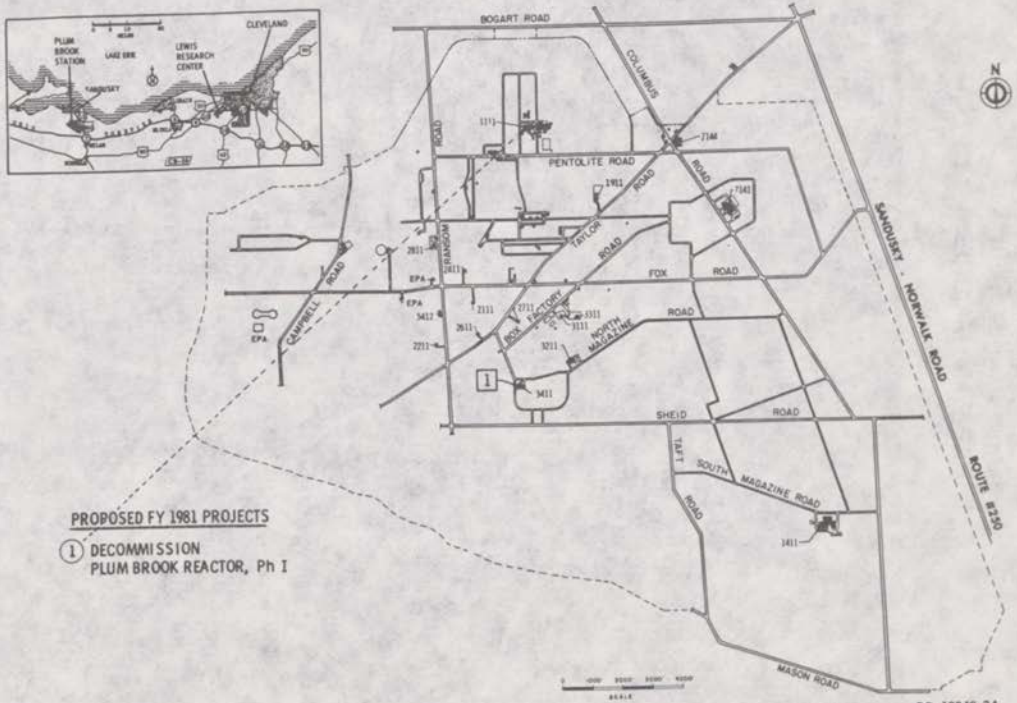
LEWIS RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES
LOCATION PLAN



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LEWIS RESEARCH CENTER
PLUM BROOK STATION
FISCAL YEAR 1981 ESTIMATES

LOCATION PLAN



REVISED DECEMBER 5, 1979

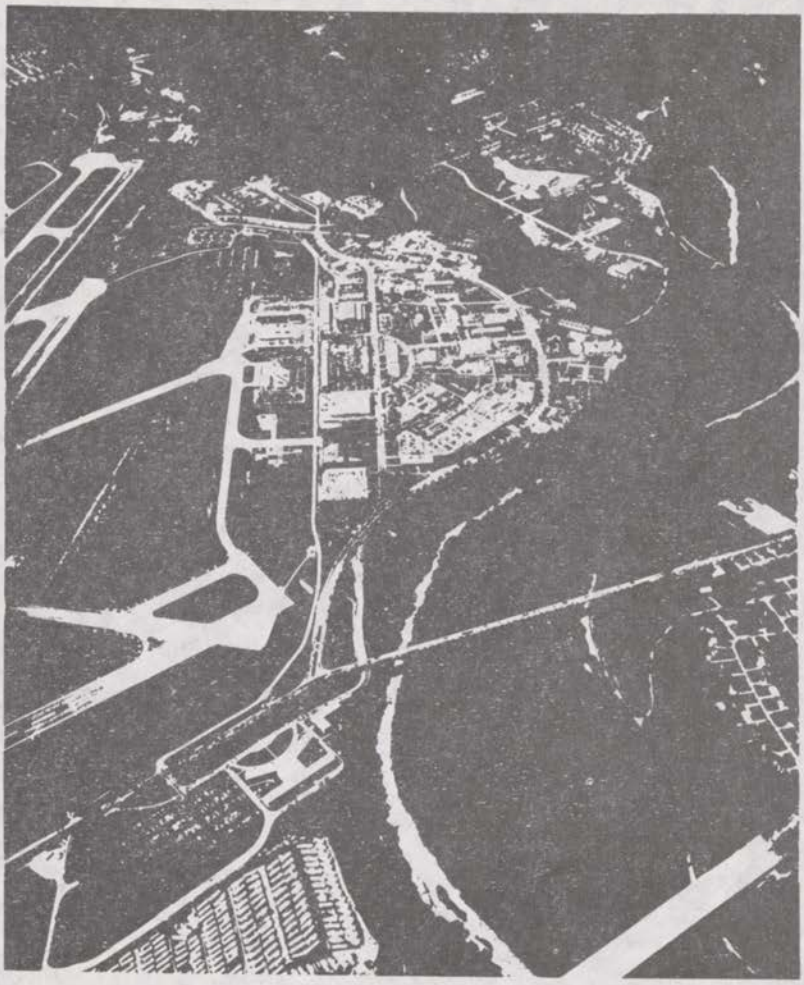
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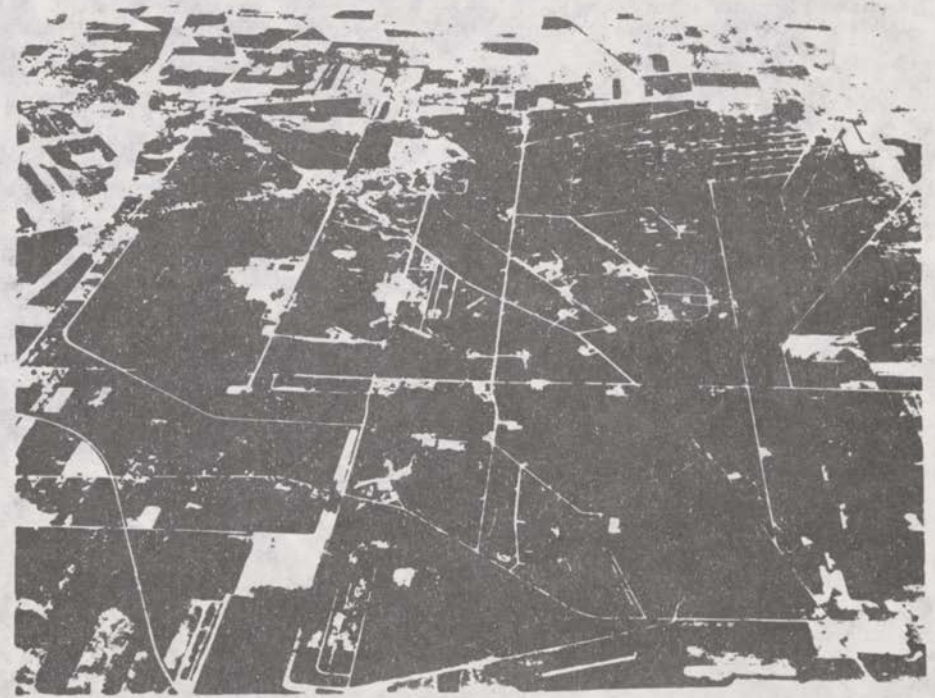
LEWIS RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES

CLEVELAND FACILITIES



LEWIS RESEARCH CENTER
FISCAL YEAR 1981 ESTIMATES

PLUM BROOK FACILITIES



RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 1981 ESTIMATES

NASA HEADQUARTERS

DESCRIPTION

NASA Headquarters is located at 400 Maryland Avenue, SW, Washington, DC, and occupies other buildings in the District of Columbia, Maryland and Virginia. Except for some office space leased in the District of Columbia and a storage area in Virginia, personnel occupy Government-owned buildings.

HEADQUARTERS ROLES AND MISSIONS

The mission of the National Aeronautics and Space Administration Headquarters is to plan and provide executive guidelines for the implementation of national space and aeronautics programs consistent with the objectives stated in the National Aeronautics and Space Act of 1958, as amended. These objectives are to:

1. Extend our knowledge of the Earth, its environment, the solar system, and the universe;

2. Expand practical applications of space technology;

3. Develop, operate, and improve manned and unmanned space vehicles;

4. Improve the civil and military usefulness of aeronautical vehicles, while minimizing their environmental effects and energy consumption;

5. Disseminate pertinent findings to potential users; and

6. Promote international cooperation in peaceful activities in space.

The following offices at Headquarters assist management in carrying out the technical aspects of the mission:

Office of Space Transportation Systems: Responsible for the research, development and operations of space flight programs including the Space Shuttle, the essential element of the Space Transportation System that will be used to conduct the space operations of the 1980's. The Space Transportation System consists of the Shuttle, a reusable manned vehicle; and the Spacelab, an experiments payload carrier being developed by the European Space Agency. Transportation Systems office also has program responsibility for expendable launch vehicles. (A new Headquarters program office has been established to be responsible for operations of the Space Transpor-

tation System, and is currently under study in regard to the organizational structure and staffing).

Office of Space Science: Responsible for scientific research and development effort utilizing a variety of flight system and ground-based observations to increase man's knowledge of the universe. The Earth, Sun, Moon, the planets, interplanetary space, other stars and galaxies, and the interaction among those bodies and systems are all objects of these investigations. The Life Sciences program is also under the direction of the Office of Space Science.

Office of Space and Terrestrial Applications: Responsible for conducting research and development activities leading to demonstration and transfer of space-related technology and capabilities which can be effectively applied and used for practical benefits on Earth. These research and development activities involve the following program areas: resource observation, environmental observation, space communications, material processing in space, technology transfer, and technology utilization.

Office of Aeronautics and Space Technology: Responsible for the aeronautical space and energy research and technology programs. The aeronautics program develops technology culminating in safer, more efficient, economical and environmentally acceptable air transportation systems which are responsive to national needs. The space research and technology program provides a technology base which anticipates the technical needs and provides technology options for future space activities. The energy program provides an interface with and support to the Department of Energy in the execution of interagency related activities conducted by NASA. The Office of Aeronautics and Space Technology is also responsible for coordinating the total NASA program of supporting research and technology related to specific programs and projects to insure a comprehensive properly balanced agency research and technology program.

Office of Space Tracking and Data Systems: Responsible for the development, implementation, and operation of tracking, data acquisition, command, communications, and data processing facilities, systems and services required for support of all NASA flight missions. This office also provides centralized planning and systems management for the administrative communications of NASA installations.

Research and Program Management (R&PM) funding is used to support the staffing and operation of NASA Headquarters in Washington, DC. The overall capability of the agency to operate effectively is dependent upon sufficient R&PM funds to hire and support a Headquarters workforce to furnish direction and coordinate the accomplishment of the Agency mission. This portion of the budget is prepared to accomplish the following objectives:

- To provide a balanced Agency Headquarters workforce capable of planning, formulating, advocating and providing executive direction to national programs to implement the objectives stated in the National Aeronautics and Space Act of 1958, as amended.

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- To provide a balanced Headquarters supporting workforce capable of providing necessary administrative, operational and logistical support to those Headquarters elements concerned with carrying out the mission of the National Aeronautics and Space Administration.

- To provide adequate facilities to house the workforce in Washington, DC.

- To provide for technical, administrative and logistical support necessary to facilitate accomplishment of NASA goals and objectives as administered by the Headquarters.

The Headquarters workforce consists of a professional and clerical staff organized into the program offices indicated above and appropriate supporting staff offices. Funding for pay, travel and necessary support services are included in this portion of the budget submission. Each office is assigned a function consistent with NASA Headquarters mission. The number of personnel authorized to an office is determined by Management based on the approved personnel ceiling for the Agency and the functions to be performed. The composition of the staff of an office is determined by the head of the office based on the office ceiling and the function to be performed. All personnel are appointed and paid consistent with classification standards established by Office of Personnel Management. Overall Agency direction is provided by the Administrator, and his personal office staff. He is assisted by heads of special and technical staff offices which perform functions necessary to the effective operation of the Agency and the Headquarters. Such offices are concerned with administration and management or support of the Headquarters. Included are such offices as the Chief Scientist, Chief Engineer, Comptroller, General Counsel, External Relations, Management Operations, Aerospace Safety Advisory Panel, Equal Opportunity, Procurement and the Inspector General. The Headquarters currently has eleven (11) installations throughout the U.S. which perform agency operational missions under direction of the Headquarters staff.

The Headquarters supporting personnel are organized to perform agency and Headquarters functions, although some elements perform only Headquarters support. For example, the Office of Headquarters Administration provides for support to the personnel and physical plant in Washington, while the Office of Personnel Programs provides both Headquarters and Agency direction and support with respect to personnel requirements.

Facilities consist of GSA leased space at FB-6, FB-10B and Reporters Building in Washington, DC, and a storage area in Virginia.

Technical support required by Headquarters is performed primarily by support service contractors. Currently, contractors support Headquarters automatic data processing and the scientific and technical information program. Administrative and logistical support is provided by the in-house workforce assisted by miscellaneous contract services. Such support includes communications, printing, supplies, materials, equipment, transportation, occupational medicine and health, and other administrative support services.

SUMMARY OF RESOURCES REQUIREMENTS

FUNDING PLAN BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
I. Personnel and Related Costs	54,268	55,893	60,267	64,037
II. Travel	2,769	2,697	2,836	3,236
III. Facilities Services	5,112	5,662	5,693	5,904
IV. Technical Services	15,550	15,989	14,557	16,378
V. Management and Operations	6,774	7,256	7,335	8,074
Total, fund requirements	84,473	87,497	90,688	97,629

Distribution of Permanent Positions by Program

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Direct Positions				
Space Transportation Systems	196	196	203	230
Space shuttle	77	70	89	89
Space flight operations	105	112	103	130
Expendable launch vehicles	14	14	11	11
Space Science	104	101	114	114
Physics and astronomy	51	48	60	60
Planetary exploration	30	30	31	31
Life sciences	23	23	23	23

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Space and Terrestrial Applications	111	114	114	114
Space applications	93	95	95	95
Technology utilization	18	19	19	19
Aeronautics and Space Technology	160	159	142	142
Aeronautical research and technology	82	81	74	74
Space research and technology	58	58	47	47
Energy technology	20	20	21	21
Space Tracking and Data Systems	46	46	50	52
Tracking and data acquisition	46	46	50	52
Subtotal, direct positions	617	616	623	652
Management and Operations Support Positions	888	877	897	933
Total, permanent positions	1,505	1,493	1,520	1,585

RESOURCE REQUIREMENTS BY FUNCTION

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
I. PERSONNEL AND RELATED COSTS	54,268	55,893	60,267	64,037
Summary of Fund Requirements				
A. Compensation and Benefits				
1. Compensation				
a. Permanent positions	46,773	48,236	50,080	53,497
b. Other than full time permanent positions	1,295	1,203	1,456	1,446
c. Reimbursable detailees	405	314	537	537
d. Overtime and other compensation	399	488	2,184	2,184
Subtotal, Compensation	48,872	50,241	54,257	57,664
2. Benefits	4,332	4,546	4,681	4,989
Subtotal, Compensation and Benefits	53,204	54,787	58,938	62,653
B. Supporting Costs				
1. Transfer of personnel	402	234	400	400
2. Office of Personnel Management services	101	140	140	146
3. Personnel training	561	732	789	838
Subtotal, Supporting Costs	1,064	1,106	1,329	1,384
Total, Personnel and Related Costs	54,268	55,893	60,267	64,037

Explanation of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
A. Compensation and Benefits	53,204	54,787	58,938	62,653
1. Compensation	48,872	50,241	54,257	57,664
a. Permanent positions	46,773	48,236	50,080	53,497

The cost for permanent positions is the largest part of personnel and related costs. The funds shown above will support 1,520 permanent positions in 1980 and 1,585 in 1981. The 65 additional positions in 1981 are required for the Office of the NASA Inspector General (25) and to support the Space Shuttle activities (40).

Basis of Cost for Permanent Positions

The estimate for permanent compensation (starting from prior year cost) is based upon the position structure at the start of the year, as modified by the addition of new positions and abolishment of existing positions, within grade advances, career advances, and the October 1979 pay increases. After these modifications, the year-end position structure is established and the cost effect for the year is calculated based on the estimated period that these modifications are in effect, as follows:

Cost of permanent positions in 1980		50,080
Cost increases in 1981		3,904
Within grade and career advances:		
Full year effect of 1980 actions	+811	
Partial year effect of 1981 actions	+727	
Full year effect of 1980 pay increases	+102	
65 additional positions	+2,264	
Cost decreases in 1981		-487
Turnover savings and abolished positions:		
Full year effect of 1980 actions	-282	
One less paid day in 1981	-205	
Cost of permanent positions in 1981		53,497

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
b. Other than full time permanent positions				
1. Cost	1,295	1,203	1,456	1,446
2. Workyears	141	108	139	141

The increase from the 1980 budget estimate to the 1980 current estimate is due to the effect of the 1980 pay increase, an increase in the part-time program, and the new White House Research Apprenticeship program. Within this program level estimate, the program is slightly skewed in 1980 to accommodate, within reasonable limits, a significant number of re-employed annuitants following the 1979 early-out retirement authority. The cost decrease in 1981 reflects a change in skill mix across the temporary program. The slight increase in the 1981 workyear estimate reflects the scheduled build-up of the White House Research Apprenticeship program. The 1981 plan includes 141 workyears, which will be used to support the following programs at the levels indicated below.

Distribution of Other Than Full Time Permanent Workyears

Program	Workyears
Cooperative training	12
Summer employment	21
Opportunity programs	42
Other temporary employment	66
Total	141

c. Reimbursable detailees	405	314	537	537

The services of a small group of military officer and civilian detailees from other government agencies are utilized by NASA Headquarters where such assignments are of mutual benefit. The number of personnel detailed varies from seven to sixteen, all of whom are assigned to Headquarters program offices with the exception of three that are assigned to the Office of Facilities. The current estimates for 1980 and 1981 will cover the cost of thirteen manyears, an increase of four from the 1980 budget estimate. The 1980 current estimate and the 1981 estimate reflect the cost of the October 1979 pay increase.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
d. Overtime and other compensation	399	488	2,184	2,184

The increase in the 1980 current estimate over the 1980 budget estimate reflects the 1980 pay increases. Included in the 1980 current estimate and the 1981 budget estimate is the Agency pool of $1,750,000 for the Senior Executive Service (SES) Rank and Performance awards.

2. Benefits	4,332	4,546	4,681	4,989
Following are the amounts of contributions by category:				
Civil Service Retirement Fund	3,294	3,365	3,518	3,755
Employees life insurance	141	217	156	166
Employees health insurance	731	733	792	830
Workmen's compensation	106	128	143	150
FICA	58	68	72	88
Severance pay	2	35	---	---
Total	4,332	4,546	4,681	4,989

In addition to compensation, NASA makes an employer's contribution to personnel benefits as authorized and required by law. The increase in the 1980 current estimate from the 1980 budget estimate reflects the cost of the October 1979 pay increases. The 1981 estimate includes benefit costs for the 65 additional permanent positions. Workmen's compensation costs are based on the Department of Labor bills for 1980 and 1981.

B. Supporting Costs	1,064	1,106	1,329	1,384

Supporting personnel costs provide for the expenses of moving employees to their initial duty station or reassignment; for security investigations and other recruitment costs; and for maintaining and expanding the skills of our employees. These costs are summarized as follows:

1. Transfer of personnel	402	234	400	400

Legislation enacted in 1966 provided that the Government would pay for certain relocation costs which are budgeted in this category, such as the expenses of selling and buying a home and the cost of family relocations. The estimated costs for 1980 and 1981 are based on the historical average cost of relocations estimated at Headquarters and in anticipation of bringing on board additional personnel to work in the Space Transportation Systems area.

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	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
2. Office of Personnel Management services	101	140	140	146

Headquarters reimburses the Office of Personnel Management (OPM) and others for investigation of new hires for the entire agency. The cost of investigations is a function of two variables, the number of investigations to be conducted, and the unit charge made by the Office of Personnel Management or other agencies. There is also a payment to OPM for Federal wage system surveys.

3. Personnel training	561	732	789	838

The maintenance and expansion of the skills is essential in carrying out the agency's many complex technical programs. Such training is provided within the framework of the Government Employees Training Act of 1958. Part of the training consists of courses offered by other Government agencies, usually for a fee. The remainder of the training is provided through nongovernmental sources. The costs are for tuition, fees and related costs for training at colleges, universities, technical institutions, and for the cost of seminars and workshops in which groups of Headquarters and Field Center employees receive training in subjects of agencywide interest. Such training is used to maintain and expand employee skills. The increase in the 1980 current estimate and 1981 levels of training over 1979 experience is due to new training requirements for the Civil Service Reform Act implementation.

II. TRAVEL	2,769	2,697	2,836	3,236
Summary of Fund Requirements				
A. Program Travel	1,210	1,201	1,448	1,713
B. Scientific and Technical Development Travel	413	305	305	323
C. Management and Operations Travel	1,146	1,191	1,083	1,200
Total, Travel	2,769	2,697	2,836	3,236

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
A. Program Travel	1,210	1,201	1,448	1,713

Program travel funds are used in support of NASA's research and development programs, such as the Space Shuttle, Space Flight Operations, Aeronautics and Space Technology, Space and Terrestrial Applications, Space Science, and other direct Research and Development (R&D) projects. This category represents approximately 53 percent of the Headquarters travel requirements for 1981. The increases in the current 1980 and 1981 estimates are a result of increased costs and travel associated primarily with Space Shuttle development and preparation for Space Transportation Systems Operations.

B. Scientific and Technical Development Travel	413	305	305	323

Scientific and technical development travel permits employees to participate in meetings and seminars with other representatives of the aerospace community. This participation allows personnel to benefit from exposure to technological advances in the field which arise outside NASA, as well as to present both accomplishments and problems to their associates. Many of these meetings are working panels convened to solve certain problems for the benefit of the Government.

C. Management and Operations Travel	1,146	1,191	1,083	1,200

Management and operations travel is for the direction and coordination of general management matters, travel by senior officials to review Center requirements and operations. Travel by functional managers in such areas as personnel, financial management, and procurement to assure agency policies and procedures are being implemented throughout the agency; local transportation; and Congressional travel. The decrease from the 1980 budget estimate to the 1980 current estimate reflects a reduction to implement Section 112 of Public Law 96-86. The increase in 1981 results from increased management travel associated with the Shuttle Program.

III. FACILITIES SERVICES	5,112	5,662	5,693	5,904

NASA Headquarters involves a complex of buildings in the District of Columbia, Maryland and Virginia. These are both Government-owned and leased buildings for which NASA must provide reimbursement to GSA in accordance with P.L. 92-313.

This complex encompasses some 556,790 gross square feet of building space including six buildings. This complex of primary office space supports an average daily Headquarters population of 2,000 personnel.

Summary of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
A. Rental of Real Property	4,476	4,866	4,882	5,011
B. Maintenance and Related Services	463	629	629	698
1. Facilities	463	629	629	698
C. Custodial Services	173	167	182	195
Total, Facilities Services	5,112	5,662	5,693	5,904

Explanation of Fund Requirements

A. Rental of Real Property	4,476	4,866	4,882	5,011

Public Law 92-313 requires that agencies be charged for space and related services provided by the General Services Administration (GSA) at approximate commercial equivalent rates. The amounts provided here covers the cost of office and warehouse space utilized by NASA Headquarters personnel. The 1980 current and the 1981 budget estimate reflects increased rental rates as projected by GSA.

B. Maintenance and Related Services	463	629	629	698
1. Facilities	463	629	629	698

This estimate includes maintenance, repair and alterations of buildings such as partition changes, telephone changes and general buildings maintenance. The 1981 estimate reflects increased requirements associated with anticipated changes in the utilization of office space in the building currently shared by NASA and the new Department of Education.

C. Custodial Services	173	167	182	195
1. Security guard service				190

These funds cover security guard service in the various Headquarters buildings. The 1980 current estimate and the 1981 budget estimate reflect projected rate increases.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
2. Security alarm systems				5

This estimate includes reimbursement to GSA for the installation and maintenance of the security alarm systems and equipment in the NASA Headquarters buildings.

IV. TECHNICAL SERVICES	15,550	15,989	14,557	16,378
Summary of Fund Requirements				
A. Automatic Data Processing				
1. Equipment	1,929	1,298	1,298	1,595
2. Operations	3,486	3,752	3,720	4,309
Subtotal	5,415	5,050	5,018	5,904
B. Scientific and Technical Information				
1. Library	203	184	213	223
2. Education and Information	9,479	10,295	8,866	9,764
Subtotal	9,682	10,479	9,079	9,987
C. Shop Support and Services	453	460	460	487
Total, Technical Services	15,550	15,989	14,557	16,378
Explanation of Fund Requirements				
A. Automatic Data Processing	5,415	5,050	5,018	5,904

This estimate provides for the lease, purchase, maintenance, programming and operations services of ADP equipment and involves one hundred support contractor manyears of effort in 1981.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
1. Equipment	1,929	1,298	1,298	1,595

The funding provides for the maintenance and lease of ADP equipment. The increase in 1981 is due to increased costs of leasing equipment and a slight increase in maintenance costs.

2. Operations	3,486	3,752	3,720	4,309

The decrease in the 1980 current estimate from the 1980 budget estimate is due to a reduction in the time sharing services. The increase in the 1981 estimate is due to the development of a medical information system.

B. Scientific and Technical Information	9,682	10,479	9,079	9,987
1. Libraries	203	184	213	223

The technical libraries provide reference acquisition, cataloging, translating and dissemination services to all NASA employees. The increases in the 1980 current estimate and the 1981 estimate are due to increased costs.

2. Education and information	9,479	10,295	8,866	9,764

Two major activities are contained in this subfunction. The first is educational-informational programs and the second is the NASA Headquarters scientific and technical information activity. The decrease in the 1980 current estimate from the 1980 budget estimate reflects some rephasing of support contract funding plans. The 1981 estimate reflects full funding of essentially the same level of services as in 1980 and provides for two hundred twenty-one support contract workyears of effort.

a. Education and information program 1.616

The education and information programs provide for the gathering and dissemination of information about the agency's programs to the mass communications media, the general public, and to the educational community at the elementary and secondary levels. Assistance to the mass communications media includes the gathering and exposition of newsworthy material in support of their requests, and takes such forms as press kits, news releases, television and radio information tapes and clips, and feature material. Research, development, and operational missions in aeronautics and space provide substantive knowledge and serve as an educational stimulus to students and teachers. NASA responds to expressed needs of students by developing curriculum supplements in space-related areas such as physics, biology, chemistry, and math; assistance to over

1,000 teacher workshops and professional education meetings (with over 30,000 teachers participating); and participation in science fairs. The largest single program is the Aerospace Education Science program, a touring space science education lecture demonstration unit. This program also provides for Equal Employment Opportunity exhibits and films to relate to high schools, colleges and the public, the key roles that women and minorities have in the U.S. Space Program.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
b. Scientific and technical information				8,148

The scientific and technical information activity includes the cost of the NASA Scientific and Technical Information Facility (STIF), documentation and publication services, systems development, and translation services. The largest requirement is the NASA Scientific and Technical Information Facility, with an estimated cost of $4.1 million in 1981. The cost of all other information services is estimated at approximately $4 million in 1981. These costs are for the documentation of worldwide aerospace journal and report literature; monographs and technical reviews; analyzing, evaluating, and testing new methods and systems in the field of scientific communications to increase the effectiveness of the technical information program; and translating foreign language technical books, reports, and journal articles required to meet the needs of NASA and its contractor scientific personnel to keep abreast of world developments in the space science and related fields.

C. Shop Support and Services	453	460	460	487

These funds provide for the continuation of studies on reliability, cost evaluations and NASA-wide Safety, Reliability and Quality Assurance Standards. They also provide for Graphic and Photo Processing Services. The increase in the 1981 budget over the 1980 current estimate is due to an increase in cost in supplies and materials for Graphic and Photo Processing Services.

V. MANAGEMENT AND OPERATIONS	6,774	7,256	7,335	8,074

Summary of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
A. Administrative Communications	1,399	1,520	1,602	1,717
B. Printing and Reproduction	940	1,124	990	1,002
C. Transportation	368	304	471	535
D. Installation Common Services	4,067	4,308	4,272	4,820
Total, Management and Operations	6,774	7,256	7,335	8,074

Explanation of Fund Requirements

A. Administrative Communications	1,399	1,520	1,602	1,717

Included in this category are the costs of leased lines, long distance tolls, telephone exchange services, and other communications. The increases from the 1980 budget estimate to the 1980 current estimate and in the 1981 budget estimate are due to rate increases for FTS, local telephone and exchange services, and long distance tolls.

1. Long distance telephone service 877

   Covers cost of leased lines and long distance tolls.

2. Nontelephone communications (Includes TWR) services 179

3. Other communication services 661

   Includes cost of operation of telephone exchange services.

B. Printing and Reproduction	940	1,124	990	1,002

Administrative printing includes funds for contractual printing and the related composition and binding operations. This includes services performed by other agencies, chiefly the Government Printing Office, or by commercial printing firms. All common processes of duplicating including photostating, blueprinting, micro-

microfilming, and other reproductions are included. The decrease in the 1980 current estimate from the 1980 budget estimate reflects a slight decrease in requirements for supplies and materials. The FY 1981 estimate provides for five workyears of support contractor effort.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
C. Transportation	368	304	471	535

Transportation services include rental of trucks, as well as the movement of supplies, materials, equipment and related items. Also included is the cost of operating and maintaining the administrative aircraft which is assigned to the Jet Propulsion Laboratory, but funded through NASA Headquarters.

The increases in the 1980 current estimate and the 1981 budget estimate are due to increased costs for fuel and parts for the operation and maintenance of the Beachcraft Queenaire administrative aircraft; and, in 1981, the replacement of an 11-year old 25-passenger bus at the Jet Propulsion Laboratory is required.

D. Installation Common Services	4,067	4,308	4,272	4,820

This function includes 19 workyears of support contractor effort and provides for those services which support the Headquarters generally, such as: patent services, maintenance and repair of office equipment and vehicles; minor Government services; contract histories; trucking and laboring services; medical services; international support services; contractor incentive awards; Equal Opportunity community relations and fellowships; Administrator's representation allowance; NASA management training facility study; overseas administration support and documentation; and administrative supplies, materials and equipment. The decrease from the 1980 budget estimate to the 1980 current estimate is due to a decrease in supplies and materials. The increase from the 1980 current estimate to the 1981 budget estimate includes funds for the development of Medical Monitoring Criteria and Procedures which involves the development of medical testing and treatment protocols for employees exposed while working with single and multiple toxic substances. The increase is also attributable to increased patent office fees.

1. Installation support services 2,418

This category includes 11 support contractor workyears and provides such services as Administrator's representation allowance, contract histories, minor Government services, labor and traveling services, overseas support, contractor incentive awards, Headquarters Equal Employment Opportunity community relations and fellowships, patent fees and services and Aerospace Fellowships.

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Thousands of Dollars)		
2. Medical services				503

This funding includes eight support contractor manyears of effort and provides for the services and required supplies of the medical health unit and includes the cost of the staff examinations support service contract as well as providing funds for the medical monitoring criteria and procedures.

3. Supplies, materials and equipment				1,899

This funding provides for the purchase and rental of office equipment and the supplies and materials required for the operation of NASA Headquarters.

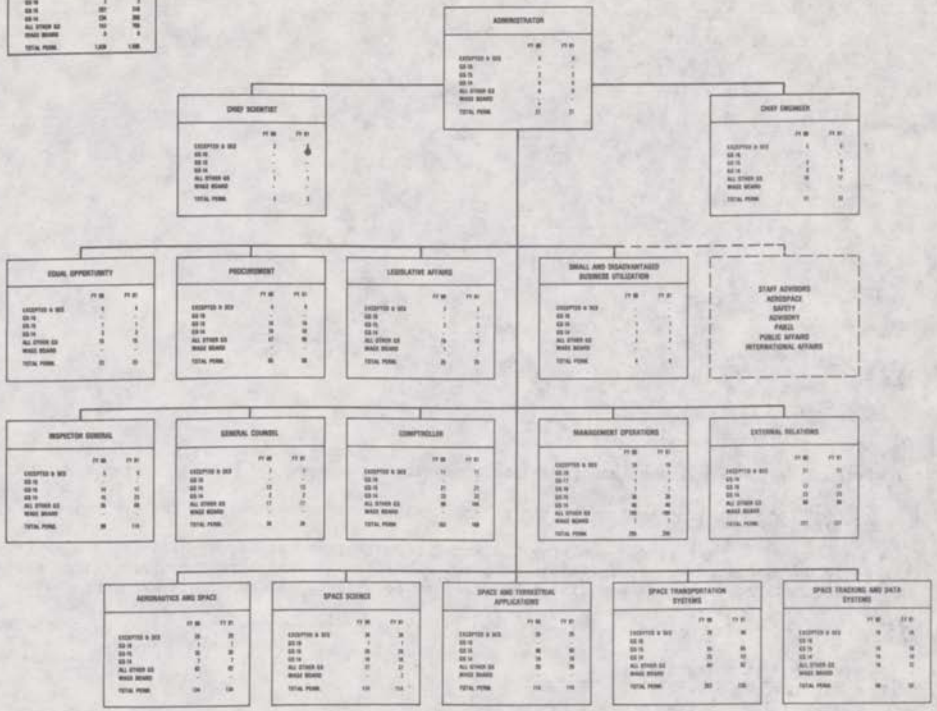
HEADQUARTERS

SUMMARY STAFFING

	FY 00	FY 01
EXCEPTED & SES	233	234
GS-15	1	1
GS-14	1	1
GS-13	1	1
GS-12	1	1
GS-11	297	298
GS-9	234	235
ALL OTHER GS	163	163
WAGE BOARD	3	3
TOTAL PERM.	1,434	1,436

ORGANIZATION AND STAFFING

NASA HEADQUARTERS



RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 1981 ESTIMATES

JET PROPULSION LABORATORY

DESCRIPTION

The Jet Propulsion Laboratory (JPL) is located in Pasadena, California, approximately 20 miles north of downtown Los Angeles. Subsidiary facilities are located at Goldstone, California (tracking and data acquisition), Edwards Air Force Base, California (propellant formulation and testing), and Table Mountain, California (open air testing and astronomy).

At Pasadena, the Laboratory occupies 176.2 acres of land of which 155.8 acres are owned by NASA and 20.4 acres are leased. At Goldstone, facilities are located on land occupied under permit from the Army. At Edwards Air Force Base, facilities are located on land occupied under permit from the Air Force. Facilities at Table Mountain are located on land occupied under permit from the Forest Service of the Department of Agriculture. The capital investment of the Jet Propulsion Laboratory, including the Deep Space Network, fixed assets in progress, and contractor-held facilities, as of September 30, 1979 was $412,400,000.

The Jet Propulsion Laboratory is a Government-owned installation of NASA, but it is also an operating division of the California Institute of Technology (Caltech) staffed with regular Caltech employees. Contract NAS7-100 between NASA and Caltech governs research, development, and related activities at the Laboratory, with facilities being provided under a separate facilities contract NAS7-270(F). The entire cost of operating the Laboratory is borne by the Research and Development appropriation, except for the lease or purchase of administrative aircraft and the purchase of passenger motor vehicles, which costs are funded from the Research and Program Management appropriation and are included in the NASA Headquarters budget presentation. Accordingly, the Research and Program Management type costs presented in this Special Analysis for JPL are for purposes of comparison only, and are not a part of the NASA Research and Program Management budget.

MISSION

The Jet Propulsion Laboratory has been assigned primary responsibility for the conduct of NASA programs concerned with scientific exploration of the planets, and interplanetary space using automated spacecraft. The Laboratory is also assigned to conduct selected automated earth-orbital missions. Implicit in these assignments is a broad range of engineering, scientific, and management functions devoted to:

1. Conduct complete spaceflight projects, including overall project management and all phases of project activity beginning with mission design and scientific justification and following with spacecraft design, development, testing, and flight operations.

2. Develop and operate the Deep Space Network which provides tracking and data acquisition services for all NASA projects involving flights of automated spacecraft beyond near-Earth orbits.

3. Continue programs of scientific investigation and supporting research and technology.

In more specific terms, Laboratory activities in support of NASA can be categorized as follows:

Planetary Exploration - Since the very beginning of the Nation's space activities, the Jet Propulsion Laboratory has devoted a major part of its effort to the Planetary Exploration program. The Mariner series of spacecraft was designed and developed by JPL, and the Laboratory has had project management responsibility for all Mariner missions, including the functions of integration, assembly, and testing of the spacecraft. The two most recently completed missions in the Mariner series are those of Mariner 9, which returned scientific data for nearly a year from an orbit around Mars, and Mariner 10, which gathered data in a close flyby of Venus followed by three separate encounters with Mercury.

The Laboratory has been a major participant in the Viking project, carrying out among other assignments the development of the two Orbiters which, with the two Landers, reached Mars during the summer of 1976. Although the primary and extended Viking missions have been successfully concluded, one Orbiter and both Landers continue to be operational at a low level of activity.

In the continuing series of planetary missions, the Jet Propulsion Laboratory has management responsibility for the Voyager Jupiter-Saturn missions. Two spacecraft were launched on August 20 and September 5, 1977, and encountered Jupiter in close flybys of the planet and its major satellites on March 5 and July 9, 1979. The encounters were extraordinarily successful in obtaining high resolution color photographs and other scientific data as planned. The launches occurred as intended during a time period when the relative positions of Jupiter and Saturn were uniquely favorable for the utilization of gravity-assist techniques to shorten flight times to Saturn. Both spacecraft are operating well and are on their planned trajectories to Saturn where they will arrive in Nomember 1980 and August 1981. The mission design includes an option to adjust the trajectory of the second spacecraft as it nears Saturn and enable it to continue on to Uranus. The spacecraft for these missions make maximum use of previous Mariner and Viking Orbiter designs and technology, consistent with the requirements of long-range communications, solar independent power, and the required flight times.

The Jet Propulsion Laboratory also has project management responsibility for the Galileo mission, which was a new project start in FY 1978. This mission is designed to orbit the planet Jupiter and send an instrumented probe into the planet's atmosphere. The atmospheric probe will make direct measurements of physical and chemical properties and will be designed to survive to a considerable depth. The orbiter will have a lifetime in orbit of some 20 months during which it will observe Jupiter and several of its major satellites at close range.

The International Solar Polar Mission is a cooperative effort with the European Space Agency (ESA). JPL has mission management responsibility as well as responsibility for the U.S. spacecraft and science. ESA has responsibility for the European spacecraft and science. The two spacecraft are scheduled to be launched early in 1983. They will utilize gravity-assist techniques at Jupiter to attain solar orbits nearly normal to the ecliptic plane, thus enabling scientific observations of the polar areas of the Sun and heretofore unexplored regions of interplanetary space.

Scientific Satellites - Consistent with its role as an alternate Center for Earth-orbital spacecraft development, the Laboratory has been selected to manage the Infrared Astronomical Satellite (IRAS) project. This project also involves international cooperation, with the spacecraft bus being designed and built in the Netherlands. The NASA Ames Research Center will be responsible for the infrared telescope. Development activities are in progress, and launch is scheduled for 1981.

The Laboratory also is the project manager for an atmospheric science satellite, named the Solar Mesosphere Explorer (SME), which is scheduled for launch in 1981 into a Sun-synchronous polar orbit. The spacecraft module is under contract, and the science instruments are being developed by the University of Colorado.

Space Applications - In support of the NASA Space Applications program, JPL is one of the principal centers for work in oceanographic applications of space technology. The Laboratory also conducts significant activities in upper atmospheric research; in the planning, development, and implementation of remote sensing techniques to observations of the Earth; and in the development of a strong geodynamics research program.

Supporting Research and Technology - The Jet Propulsion Laboratory maintains a strong program of supporting research and advanced technical development designed to provide sound technologies for present and prospective project assignments, and to further the general capabilities of NASA. Areas of involvement include spacecraft advanced development, autonomous systems, space power and propulsion systems, electronics, information systems technology, and basic research in such fields as fluid physics, polymer materials, and applied mathematics.

Science Program - The Laboratory participates in scientific experiments on both JPL-managed and non-JPL managed flight projects. This participation includes not only the performance of scientific investigations

but also a significant commitment to the development of scientific instruments for use in space missions. Ground-based research programs are carried out in the planetary sciences, physics and astronomy, and Earth and ocean physics. These activities involve broad collaboration with the scientific and academic communities and with staff members from other NASA field installations.

Spaceflight Operations - The Jet Propulsion Laboratory is responsible for the design, development, maintenance, and operation of NASA's worldwide Deep Space Network and a Mission Control and Computing Center. Tracking stations are located in California, Spain and Australia. These facilities provide support not only to JPL-managed flight missions, but also to projects such as Pioneer and Helios managed by other NASA installations and involving flights beyond near-Earth orbits. The Mission Control and Computing Center is located in Pasadena.

Distribution of Permanent Positions by Program

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Direct Positions				
Space Transportation Systems	4	---	---	---
Space Shuttle	4	---	---	---
Space Science	1,148	1,104	1,108	1,160
Physics and astronomy	162	177	197	202
Planetary exploration	964	908	882	931
Life sciences	22	19	29	27
Space and Terrestrial Applications	224	171	245	233
Space applications	212	157	235	227
Technology utilization	12	14	10	6
Aeronautics and Space Technology	266	261	298	299
Aeronautical research and technology	21	15	12	5
Space research and technology	229	230	265	265
Energy technology	16	16	21	29
Space Tracking and Data Systems	392	391	413	415
Tracking and data acquisition	392	391	413	415
Subtotal, direct positions	2,034	1,927	2,064	2,107

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
Direct Support	559	620	590	582
Center Management and Operations Support	1,093	1,151	1,126	1,110
Total, permanent positions	3,686	3,698	3,780	3,799

Summary of Fund Requirements

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
	(Thousands of Dollars)			
I. Personnel and Related Costs	114,547	113,934	126,168	126,855
II. Travel	4,132	3,800	4,805	5,572
III. Facilities Services	10,224	10,577	13,004	15,272
IV. Technical Services	2,847	2,966	3,074	3,319
V. Management and Operations	6,465	6,181	6,639	6,850
Total, fund requirement	138,215	137,458	153,690	157,868

SIMULATED RESEARCH AND PROGRAM MANAGEMENT BUDGET

EXPLANATION OF CHANGES

Personnel and Related Costs - The increase from the 1980 budget estimate to the 1980 current estimate is attributable to: (1) higher average salaries resulting from merit increases in 1979; (2) a higher manpower estimate for 1980; and (3) an increase in cost of benefits associated with (1) and (2). The decrease from 1980 current estimate to 1981 budget estimate is attributable to the reduction of positions planned in 1981.

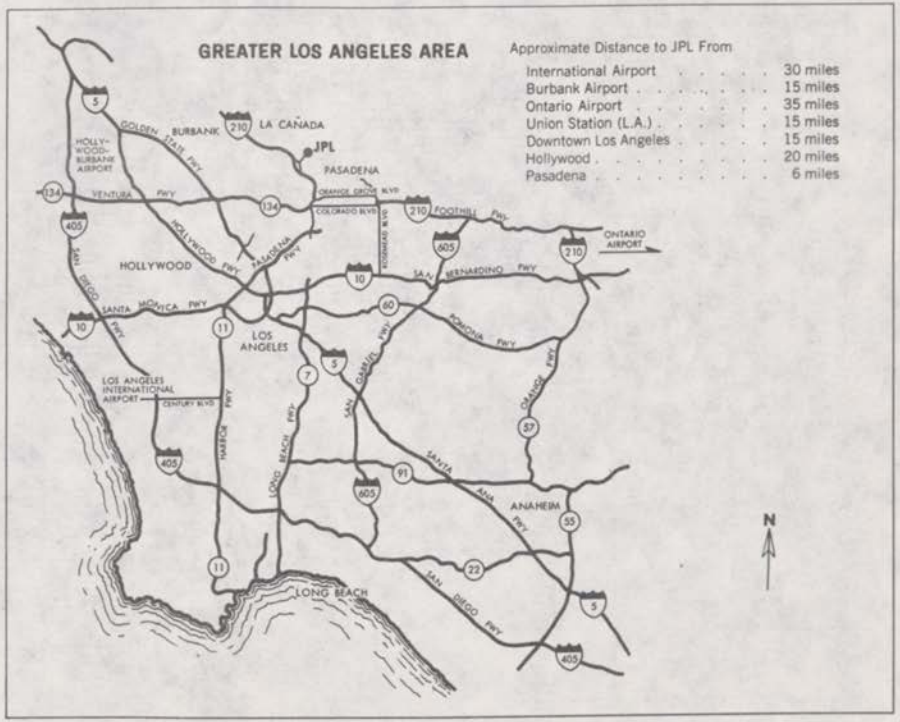
Travel - Travel remains at approximately the same level of effort with increases associated with higher airfares, lodging rates, and rental car costs.

Facilities Services - The increases from the 1980 budget estimate to the 1980 current estimate, as well as the increase in the 1981 budget estimate are required for the cost of maintenance, alterations and repairs, and for operation of facilities, including utilities costs. Also included is a minor portion for upgrading laboratory equipment.

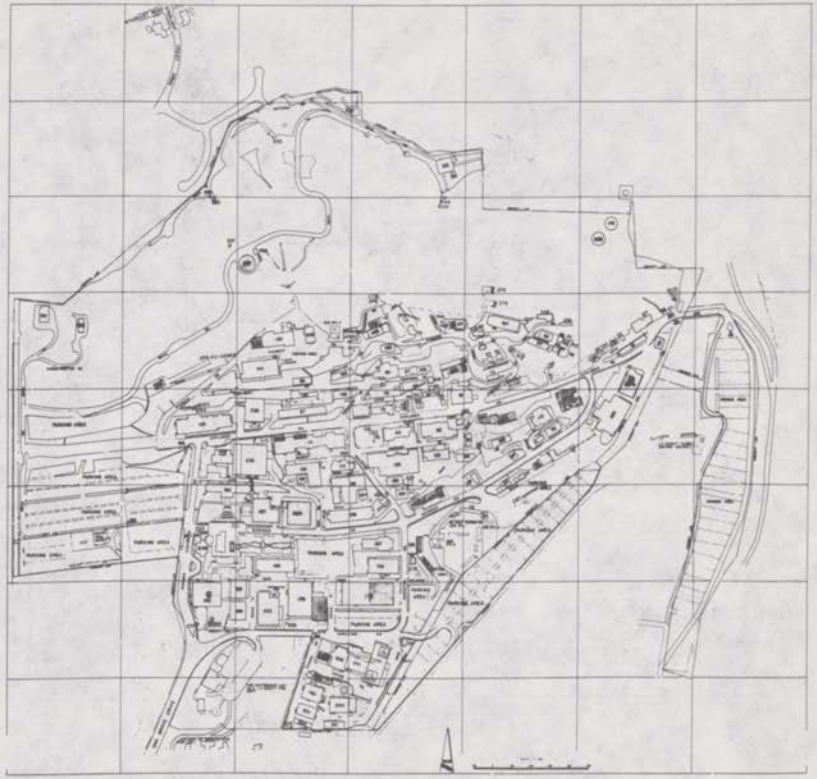
Technical Services - The increase is based on inflation for the same level of services now available.

Management and Operations - The increase is based on inflation for the same level of management and operations activities with a slight increase in communication activities.

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GREATER LOS ANGELES AREA
Approximate Distance to JPL From
International Airport . . . . . 30 miles
Burbank Airport . . . . . 15 miles
Ontario Airport . . . . . 35 miles
Union Station (L.A.) . . . . . 15 miles
Downtown Los Angeles . . . . . 15 miles
Hollywood . . . . . 20 miles
Pasadena . . . . . 6 miles
LA CAÑADA
JPL
PASADENA
BURBANK
HOLLY-WOOD-BURBANK AIRPORT
GOLDEN STATE FWY.
VENTURA FWY.
ORANGE GROVE BLVD.
COLORADO BLVD.
FOOTHILL FWY.
ONTARIO AIRPORT
HOLLYWOOD
HOLLYWOOD FWY.
PASADENA FWY.
SAN BERNARDINO FWY.
SAN DIEGO FWY.
SANTA MONICA FWY.
LOS ANGELES
POMONA FWY.
SAN GABRIEL FWY.
LOS ANGELES INTERNATIONAL AIRPORT
CENTURY BLVD.
HARBOR FWY.
LONG BEACH FWY.
ORANGE FWY.
SANTA ANA FWY.
ANAHEIM
LONG BEACH
SAN DIEGO FWY.
N

JET PROPULSION LABORATORY
LOCATION PLAN



SA 8

JET PROPULSION LABORATORY
LEGEND

Bldg. No.	Title	Location
11	Space Sciences Lab	E-2
13	Offices, Lab & Shop	D-3
18	Structural Test Lab	D-2
20	Shop Test Cell No. 2 (Liq)	D-2
23	Shop Test Cell No. 12 (Liq)	E-2
31	Test Cell (Liq)	E-2
32	Test Cell (Liq)	D-2
33	Test Cell (Liq)	D-3
34	Shop Test Cell No. 33 (Liq)	D-3
35	Mag Flux Tank Shelter	B-1
41	Hi-Temp Lab	D-3
42	Test Cell (Liq)	D-3
46	Shop Test Cell No. 42 (Liq)	D-3
47	Plant Protection	D-2
53	Conditioning Lab (Solid)	D-3
54	Blending Lab (Solid)	D-2
55	Mixing Lab (Solid)	D-2
57	Test Cell (Air Fuel)	C-2
58	Compressor Bldg	C-2
59	Chemistry Lab	D-3
65	Materials Lab	D-3
67	Microbiology Facility	B-2
71	Mechanics Stores	D-2
72	Engineering Offices	C-2
73	Utilities Area Storage	D-2
74	Test Cell (Chemistry)	D-3
77	Soil Science Lab	C-2
78	Hydraulics Lab	D-3
79	Wind Tunnel (20 inch)	C-2
80	Wind Tunnel (21 inch)	C-2
81	Battery Laboratory	E-2
82	Environmental Test Lab	C-2
83	Electronic Parts & Engineering	C-2
84	Test Cell & Solid Chemistry	D-2
85	Business Systems Office	C-2
86	Oxidizer Grinding (Solid)	D-2
87	Ovens (Solid)	D-2
88	Mixing Lab (Solid)	D-2
89	Processing Lab (Solid)	D-2
90	Shop Test Cell No. 51	D-2
91	Air Dryer (Wind Tunnel)	C-2
92	Cooling Tower (Wind Tunnel)	C-2
93	Vaporizer (Wind Tunnel)	C-2
97	Development Lab & Offices	D-2
98	Preparation Shop (Solid)	D-2
99	Chemistry Lab (Solid)	D-3
103	Fabrication Shop	E-3
106	Test Cell (Air Fuel)	C-2
107	Test Cell	E-2
109	Cooling Tower (Wind Tunnel)	C-2
110	Fuel Stor Tank	C-2
111	General Offices Bldg	B-2
114	Cafeteria & Offices	C-3
115	Heating Plant (Solid)	D-2
116	Propellant Storage Dock	D-3
117	Test Cell (Solid)	D-2
118	Cooling Tower	C-3
120	Cooling Tower	D-2
121	Employment Development Ctr	E-2
122	Engineering Offices	C-3
125	Combined Electronics	C-3
126	Systems Div Office Bldg	B-2
129	Test Cell (Chemistry)	D-3
130	Engineering Offices	C-2
133	Service Dock	C-2
134	Shop Test Cell	E-2
135	Guard Shelter	A-2
136	Cooling Tower	C-2
137	Cooling Tower	C-2
138	Engineering Offices	C-2
140	Magazine X Temp	C-2
141	Magazine X Temp	C-2
145	Magazine Propellant	D-2
147	Cooling Tower	D-2
148	Energy Conversion Lab	C-2
150	25-ft Space Simulator	B-2
152	Hazardous Chemical Stor	C-3
156	Computer Program Office	B-3
157	Engineering & Mechanics Bldg	C-3
158	Material Research Proc - Lab	C-3
159	Pump House (Water)	E-2
160	Sewage Lift Station	C-3
161	Telecommunications Lab	C-3
165	Cooling Tower	C-3
166	Cooling Tower	C-2
167	Cafeteria	B-3
168	Space Sciences Instrmt'l Sys Lab	B-3
169	Engineering Office Bldg	B-3
170	Fabrication Shop	C-3
171	Materials Service Bldg	C-4
173	Test Shelter	E-2
174	Cooling Tower	C-2
175	Water Reservoir	E-2
177	Transportation Garage	D-2
179	Spacecraft Assy Facility	B-3
180	Central Engineering Bldg	B-3
182	Bus Stop Shelter	E-2
183	Physical Science Lab	B-3
184	Electronic Stores	C-3
185	Programming Office	B-3
186	Space Sciences Div Bldg	A-3
187	Chemical Storage	D-3
188	Engineering Facilities Bldg	C-2
189	Electronics Lab - Annex	C-3
190	190A - Procurement Offices	B-4
191	Hazardous Test Bay	E-2
192	Propulsion Engineering	D-3
195	Guard Shelter	B-3
196	Guard Shelter	B-2
197	Solid-Propellant Process Lab	D-2
198	Guidance Lab	C-3
199	Celestial Simulator Bldg	C-3
200	Plant Engineering Services	B-4
201	Carpenter Shop	B-4
202	Procurement Offices	B-4
209	Illuminator Tower	D-1
210	Blaine Track	D-1
212	Antenna Lab	D-1
213	Cooling Tower 'A', 'B' & 'C'	B-2
218	Credit Union	B-3
220	C.R.S. Terminal Bldg	C-2
224	Sewer Lift Station	B-4
225	Guard Shelter - Meso	C-1
226	Solvent Storage Bldg	C-2
227	Guard Shelter	B-1
228	Cooling Tower (A & B)	B-2
229	Shielded Room Bldg	C-3
230	Space Flight Operations Facility	B-2
231	Paint Shop	B-4
233	Spacecraft Development Bldg	B-3
234	Lumber Stor Bldg	B-4
237	Cooling Tower	D-2
238	Telecommunications Lab	B-2
239	Low-Temp Solid Prop Mag	D-2
241	Shipping & Receiving	B-4
243	Remote Antenna Range Contr	B-1
244	Hi-Temp Stor Mag	D-2
245	Spectroscopy Lab	B-2
246	Soils Test Lab	C-2
248	10-ft Space Simulator	C-2
249	Visitor Reception Bldg	B-2
250	Guard Shelter	B-2
251	Gyro Lab	A-3
253	Low-Mag Interference Lab	A-3
255	Sewage Lift Station	B-1
256	Model Range Control Bldg	B-1
257	Guard Island	B-3
258	Water Reservoir	C-2
259	Liquid Nitrogen Bottling Stor	D-2
260	Illuminator Equipment Bldg	B-1
261	Material Storage	C-3
262	Radiometer Bldg	B-1
263	Protective Services Bldg	C-3
264	SFOF Sys Dev Lab	B-3
267	Water Reservoir	B-2
268	Pump House	B-1
269	Grounds Maintenance Bldg	C-4
270	Sewage Metering Station	A-3
271	Oil Barrel Stor	C-3
272	East Illuminator Bldg	C-1
273	East Illuminator Tower	C-1
274	Cooling Tower	C-3
275	Chemical Stor Prop Bldg	D-2
276	Chemical Stor Prop Bldg	D-2
277	Isotope Thermoelectric Lab	D-2
278	Helicopter Maint Hangar	C-2
279	Guard Island	B-3
280	Static Test Tower	D-2
281	Fireman / Guard Station	C-3
283	Metal Storage Building	C-3
284	Transportation Office Bldg	D-2
285	Arroyo Bridge	E-2
286	Guard Bldg. Arroyo	E-2
287	Island Guard Bldg	E-2
288	Project Equipment Storage	C-2
	'A' Gate	A-3
	'B' Gate	A-3
	'C' Gate	B-2
	'D' Gate	E-2
	'E' Gate	B-3
	'F' Gate	B-2
	'G' Gate	A-2

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JET PROPULSION LABORATORY
SA 10

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES

SUMMARY OF AERONAUTICAL RESEARCH AND TECHNOLOGY
OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Budget Estimate
		(Millions of Dollars)		
Research and development	264.1	300.3	308.3	290.3
Construction of facilities	76.5	62.5	62.5	45.3
Research and program management	178.5	194.1	199.5	207.7
Total	519.1	556.9	570.3	543.3
Number of direct positions (end of year) associated with aeronautical research and technology	3,723	3,772	3,733	3,772

The objectives of the Aeronautical Research and Technology program are to provide the Nation with the necessary technology for safer, more economical, more efficient, and environmentally acceptable air transportation; to maintain a strong U.S. competitive position in the international aviation marketplace; and to support the Department of Defense in maintaining the superiority of U.S. military aircraft.

The 1981 program supports these objectives by stressing the technology areas judged to be the most critical by special assessments, advisory groups, and by industry and other users of technology within and outside the Federal Government. The 1981 activities are designed to maintain a strong research and technology base position in the various technology disciplines. Strength in this fundamental research and technology is essential to the future development of new, improved aeronautical products. Emphasis will be placed on improving aircraft energy efficiency and performance; reducing noise and pollution; improving safety and terminal area operations; and on advancing long-haul and short-haul air transportation concepts.

In the area of transport aircraft technology, efforts to reduce aircraft noise and emissions, to improve terminal area safety and aircraft operations, and to evaluate the suitability of broad specification jet fuels for use in current and future commercial jet engines will continue. Major emphasis will be on aircraft energy efficiency technology efforts, including further testing of individual components to validate the technology for use in high-bypass turbofan engines as part of the energy efficient engine program and the evaluation of active control technologies in the energy efficient transport program.

Rotorcraft activities will continue to address rotor aerodynamics, structures, avionics, flight dynamics, terminal operations, engines and drive systems and rotor system design with new emphasis in FY 1981 on analytical modeling and systems verification. General aviation activities will emphasize the reduction of noise and emissions, improved crashworthiness, and an expanded stall/spin data base. In vertical take-off and landing technology, broad based technology for future military and civil aircraft applications will be continued. Supersonic cruise research will place emphasis on the interactions between the airframe and propulsion system, long-life structural tests, and the development and demonstration of critical low-speed technologies unique to variable cycle engines. Also, efforts in the area of high performance aircraft will continue on configuration aerodynamics and flight testing of highly maneuverable aircraft technology concepts.

The construction of facilities program for 1981 in support of aeronautical research and technology objectives includes completion of the modifications to the central air system at the Lewis Research Center, Cleveland, Ohio, for which initial funding was provided in FY 1980. The 1981 program also includes construction of a man-vehicle systems research facility, modification of the steam ejector system and thermal protection laboratory, and modification of the unitary plan wind tunnel at the Ames Research Center, Moffett Field, California; modifications to the avionics integration research laboratory, modifications to the aircraft landing dynamics facility, and completion of rehabilitation and modification of the gas dynamics laboratory at the Langley Research Center, Hampton, Virginia; and rehabilitation of electrical switchgear in the engine research building at the Lewis Research Center.

The research and program management funding provides for the civil service salaries, travel, electric power for wind tunnel operations, and other general installation costs necessary to conduct the aeronautics program.

RESEARCH AND DEVELOPMENT

ESTIMATED FY 1981 OBLIGATIONS FOR
EQUIPMENT TO BE PLACED AT NASA INSTALLATIONS

Program Budget Line Item	1981 (Thousands of Dollars)
Space Transportation Systems	95,494
Space Shuttle	(52,552)
Space Flight Operations	(42,942)
Expendable Launch Vehicles	(0)
Space Science	7,953
Physics and Astronomy	(4,559)
Planetary Exploration	(799)
Life Sciences	(2,595)
Space and Terrestrial Applications	15,213
Aeronautics and Space Technology	37,551
Aeronautical Research and Technology	(30,288)
Space Research and Technology	(7,168)
Energy Technology	(95)
Tracking and Data Acquisition	18,230
GRAND TOTAL	174,441

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SUMMARY OF MAJOR EQUIPMENT ACQUISITION OBLIGATIONS INCLUDED IN FY 1981 BUDGET

PROGRAM BUDGET LINE ITEM	RECEIVING INSTALLATION, BUILDING LOCATION, AND EAD CONTROL NUMBER	EQUIPMENT DESCRIPTION	PROGRAMMATIC PURPOSE	FY 1981 OBLIGATIONS ($ IN THOUS.)	RELATED FACILITY PROJECT
Space Shuttle	Johnson Space Center Bldg. 30, 72-78-03	Orbiter Data Reduction Complex	Computers to support post flight orbiter data reduction.	900	FY 1978 Modifications to administrative Bldg. 30. CofF Project 9370
Space Flight Operations	Johnson Space Center Bldg. 30, 72-77-04	Telemetry Processing Equipment	Provides interface between mission control center and space tracking data network.	1200	FY 1980 Modifications to MCC, Bldg. 30. CofF Project 9370
Space Flight Operations	Johnson Space Center Bldg. 30, 72-77-05	Master Interface Timing	Provides central timing system for the mission control center.	55	
Space Flight Operations	Johnson Space Center Bldg. 30, 72-78-01	Wide Band Recorder/ Switch	Provides capability for switching and recording all data input to the mission control center.	1028	
Space Flight Operations	Johnson Space Center Bldg. 30, 72-78-02	Display Control/Shuttle Data Processing Complex Interface	Provides display control system and its interface to Shuttle Data Processing Complex	2182	

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SUMMARY OF MAJOR EQUIPMENT ACQUISITION OBLIGATIONS INCLUDED IN FY 1981 BUDGET

PROGRAM BUDGET LINE ITEM	RECEIVING INSTALLATION, BUILDING LOCATION, AND EAD CONTROL NUMBER	EQUIPMENT DESCRIPTION	PROGRAMMATIC PURPOSE	FY 1981 OBLIGATIONS ($ IN THOUS.)	RELATED FACILITY PROJECT
Space Flight Operations	Johnson Space Center Bldg. 5, 72-78-07	Spacelab Simulator (SLS)	Simulator to train flight and ground crews for the operation and monitoring of Spacelab subsystems.	900	FY 1978 Modifications to accommodate Spacelab Support Module Simulator Bldg. 5
Space Flight Operations	Johnson Space Center Bldg. 30, 72-79-05	Flight Planning System III	Purchase of special equipment for design and documentation of missions with the intent of increasing the design capability to 60 flights/year.	1000	
Space Flight Operations	Johnson Space Center Bldg. 30, 72-79-06	Hardcopy Unit	To provide hardcopy of Digital Data Display from the SDPC.	284	

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SUMMARY OF MAJOR EQUIPMENT ACQUISITION OBLIGATIONS INCLUDED IN FY 1981 BUDGET

PROGRAM BUDGET LINE ITEM	RECEIVING INSTALLATION, BUILDING LOCATION, AND EAD CONTROL NUMBER	EQUIPMENT DESCRIPTION	PROGRAMMATIC PURPOSE	FY 1981 OBLIGATIONS ($ IN THOUS.)	RELATED FACILITY PROJECT
Space Flight Operations	Johnson Space Center Bldg. 30, 72-79-07	Payload Operating Control Center (POCC) Computer	To provide the capability to process command and control parameters from several independent payload data streams simultaneously.	10	
Space Flight Operations	Johnson Space Center Bldg. 30, 72-79-08	POCC Communications Interface	To provide capability to bring independent payload high rate data streams into JSC POCC.	1544	
Space Flight Operations	Johnson Space Center Bldg. 30, 72-79-09	Payload Data Interleaver System	Downlink system to accept and process digital data from Shuttle PDI.	586	
Space Flight Operations	Johnson Space Center Bldg. 30, 72-79-10	Text and Graphics System	System to provide for uplink of text and graphics information to the Shuttle.	610	
Space Flight Operations	Johnson Space Center Bldg. 30, 72-81-02	POCC Display Control	To provide display monitoring capability for experiment systems data.	443	
Space Flight Operations	Johnson Space Center Bldg. 30, 72-81-01	Reconfiguration Data Collection System (RDCS)	A computer system used to collect reconfiguration data and to construct tables necessary for the reconfiguration of the Mission Control Center.	120	
Space Flight Operations	Johnson Space Center Bldg. 12, 72-81-03	Univac 1108 Upgrade	Replacement of the central processing units and peripherals on Central Computing Complex.	960	

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SUMMARY OF MAJOR EQUIPMENT ACQUISITION OBLIGATIONS INCLUDED IN FY 1981 BUDGET

PROGRAM BUDGET LINE ITEM	RECEIVING INSTALLATION, BUILDING LOCATION, AND EAD CONTROL NUMBER	EQUIPMENT DESCRIPTION	PROGRAMMATIC PURPOSE	FY 1981 OBLIGATIONS ($ IN THOUS.)	RELATED FACILITY PROJECT
Physics and Astronomy	Goddard Space Flight Center 51-81-01	Science and Applications Computing Center (SACC) Upgrade	Replace SACC equipment with new computer system that will include an on-line mass storage device to meet OSS program requirements.	4740	Funding also supported by Planetary Exploration
Space Applications	Goddard Space Flight Center Bldg. 28, 51-81-02	VAS Assessment Processor	Utilization of geosynchronous VAS data in model impact studies.	412	
Space Applications	Goddard Space Flight Center Bldg. 22, 51-81-03	Goddard Modeling Activity Advance Computer System	Supplants and extends capability of existing Amdahl 470V/6 for applications in atmospheric sounding retrieval, data set assembly, atmospheric modeling, numerical forecast development in support of Global Atmospheric Research Program (GARP) and NASA Climate Research Program.	2850	
Space Applications	Goddard Space Flight Center Bldg. 22, 51-81-04	Goddard Modeling Amdahl Computer System	Lease and rental of major ADP System. (see 51-81-03)	281	
Space Applications	Goddard Space Flight Center Bldg. 22, 51-81-05	Goddard Modeling Terrabit Memory	For use on Amdahl Computer System to provide memory storage and retrieval to support additional programs.	250	
Space Applications	Goddard Space Flight Center Bldg. 28, 51-81-06	Landsat-D Ground Support System	System to support Landsat-D Mission. Specific requirements under development.	10200	

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SUMMARY OF MAJOR EQUIPMENT ACQUISITION OBLIGATIONS INCLUDED IN FY 1981 BUDGET

PROGRAM BUDGET LINE ITEM	RECEIVING INSTALLATION, BUILDING LOCATION, AND EAD CONTROL NUMBER	EQUIPMENT DESCRIPTION	PROGRAMMATIC PURPOSE	FY 1981 OBLIGATIONS ($ IN THOUS.)	RELATED FACILITY PROJECT
Aeronautical Research and Technology	Ames Research Center Bldg. N-233, 21-81-01	IBM 3033, or an equivalent performance general purpose computer system	Provides compatibility with present peripheral equipment and interactive operating system for interaction, on-line computing for wind tunnels, graphics, space shuttle, and general purpose computing at the Center.	5400	Funding also supported by Space Research and Technology and other programs.
Aeronautical Research and Technology	Marshall Space Flight Center Bldg. 4663, 62-81-01	Cal Comp Disc Systems	Provides mass storage capability for the U-1108 Computer.	204	Funding also supported by Space Research and Technology, Energy Technology, and OSTS Programs
Space Research and Technology	Marshall Space Flight Center Bldg. 4708, 62-80-02	PDP VAX 11/780 - NEEDS Data Base Management System	Required for Phase II of the End-to-End Data System (NEEDS) program, which is a program to develop an advanced real-time space data acquisition system.	800	

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SUMMARY OF MAJOR EQUIPMENT ACQUISITION OBLIGATIONS INCLUDED IN FY 1981 BUDGET

PROGRAM BUDGET LINE ITEM	RECEIVING INSTALLATION, BUILDING LOCATION, AND EAD CONTROL NUMBER	EQUIPMENT DESCRIPTION	PROGRAMMATIC PURPOSE	FY 1981 OBLIGATIONS ($ IN THOUS.)	RELATED FACILITY PROJECT
Tracking and Data Acquisition	Goddard Space Flight Center Bldg. 14, 51-80-04	Space Telescope Operations Control Center Data System	Required to conduct the real-time operation of the Space Telescope Observatory with planned mission life of 15 years. The data system will require new space area of 5,000 square feet.	4700	Space available
Tracking and Data Acquisition	Goddard Space Flight Center Bldg. 23, 51-81-01	New system to capture Spacelab payload data up to 50 Mbs, peak, of composite experiments, demultiplex and preprocess.	Required for support for early Spacelab missions.	3230	Space available
Tracking and Data Acquisition	Goddard Space Flight Center Bldg. 14, 51-81-02	Mission Operations Computing Facility (MOCF). Required to replace obsolete Spacecraft Control Computing System and provide more near real time support capability as well as greater reliability and economy of operation.	Provides mission operations support computer capability to GSFC POCC's as required.	3300	Space available

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SUMMARY OF MAJOR EQUIPMENT ACQUISITION OBLIGATIONS INCLUDED IN FY 1981 BUDGET

PROGRAM BUDGET LINE ITEM	RECEIVING INSTALLATION, BUILDING LOCATION, AND EAD CONTROL NUMBER	EQUIPMENT DESCRIPTION	PROGRAMMATIC PURPOSE	FY 1981 OBLIGATIONS ($ IN THOUS.)	RELATED FACILITY PROJECT
Tracking and Data Acquisition	Goddard Space Flight Center Bldg. 14, 51-80-02	POCC Pilot Model (POCCNET). This acquisition is the start of the design and procurement of several mini/midi computers and peripherals to be used as a nucleus for the new POCCNET pilot model POCC. The pilot model will demonstrate the concept of distributed processing, virtual peripherals, common software, shared resources and computer networking.	Required to support the mission control workload in the 1980's and beyond in order to meet quick turnaround, increased support efficiency requirements and to minimize development and recurring costs with each new mission. The POCCNET concept is envisioned as very cost effective in the TDRSS/STS/Spacelab/ MMS era.	1900	Space available
Tracking and Data Acquisition	Goddard Space Flight Center Bldg. 14, 51-80-03	Mission Operations Computing Facility (MOCF). Required to replace obsolete Flight Dynamics and Attitude computation system and provide more real time support capability as well as greater reliability and economy of operation.	Provides mission operations support computer capability to GSFC POCC's as required.	3100	Space available
Tracking and Data Acquisition	Wallops Flight Center 53-81-01	Impact Prediction System - Computer with Peripherals	Provide real-time impact prediction of sounding rockets launched from WFC.	2600	Space available Funding also supported by OSTA, OAST, and OSS Programs.

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BUDGET SUPPLEMENTAL
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
FISCAL YEAR 1980 ESTIMATES
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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1980

GENERAL STATEMENT

Supplemental Appropriation for Space Shuttle Program

A supplemental appropriation of $300.0 million is requested to provide the additional funding required for the Space Shuttle Program. The Space Shuttle is the key element of a versatile, economical space transportation system that will provide a wide variety of national and international users with round trip access to space beginning in the 1980's. This supplemental appropriation, when added to the $1,586.0 million appropriated for FY 1980 would provide a total of $1,886.0 million for the Space Shuttle Program within the Research and Development appropriation.

The additional funding is required in FY 1980 to sustain the pace of the Space Shuttle development efforts aimed at a first orbital flight during 1980, while allowing for the buildup of follow-on orbiter production activities on a schedule to meet critical civil and military Space Shuttle operational requirements. The funding requirement is due primarily to increased efforts in completing systems installation and test, particularly TPS, in prelaunch processing of the first orbital vehicle, and in systems qualification and certification testing across all elements of the program. These increased efforts have required more work than was planned resulting in a delay of the first manned orbital flight (STS-1) from the previous schedule of March 1980. Intensive development and testing activity is now proceeding in FY 1980 with the first orbital flight expected in the last half of 1980. Funding is being applied to Design, Development, Test and Evaluation activities at a rate which supports this plan while follow-on orbiter production activities are also proceeding on an orderly buildup. The FY 1980 supplemental appropriation will allow NASA to provide the planned FY 1980 funding for follow-on orbiter production activities. If the requested supplemental appropriation is not approved, it will be necessary to rebalance the program plan by adjusting the FY 1980 development and test activities and the follow-on orbiter production activities resulting in significant delays in the first orbital flight, the initial operational capability, and in the follow-on orbiter deliveries.

The following summary presents a comparison of the funding plan for Space Shuttle Research and Development contained in the FY 1980 budget request with the current plan including the requested supplemental appropriation:

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BUDGET SUPPLEMENTAL

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND DEVELOPMENT

BUDGET SUMMARY

(Thousands of Dollars)

	Budget Plan				
		FY 1980			FY 1981
	FY 1979 Actual	Presently Available	Proposed Supplemental	Revised Estimate	Budget Estimate
SPACE TRANSPORTATION SYSTEMS	2,011,600	2,103,300	300,000	2,403,300	2,738,200
Space shuttle	1,638,300	1,586,000	300,000	1,886,000	1,873,000
Space flight operations	299,700	446,600	---	446,600	809,500
Expendable launch vehicles	73,600	70,700	---	70,700	55,700
SPACE SCIENCE	505,400	600,800	---	600,800	668,000
Physics and astronomy	282,900	337,100	---	337,100	438,700
Planetary exploration	182,400	219,900	---	219,900	179,600
Life sciences	40,100	43,800	---	43,800	49,700
SPACE AND TERRESTRIAL APPLICATIONS	283,900	343,900	---	343,900	394,800
Space applications	274,800	331,800	---	331,800	381,700
Technology utilization	9,100	12,100	---	12,100	13,100
AERONAUTICS AND SPACE TECHNOLOGY	376,400	427,100	---	427,100	409,500
Aeronautical research and technology	264,100	308,300	---	308,300	290,300
Space research and technology	107,300	115,800	---	115,800	115,200
Energy technology	5,000	3,000	---	3,000	4,000
SPACE TRACKING AND DATA SYSTEMS	299,900	332,400	---	332,400	359,000
TOTAL RESEARCH AND DEVELOPMENT	3,477,200	3,807,500	300,000	4,107,500	4,569,500
OUTLAYS	3,138,749	3,653,900	200,000	3,853,900	4,234,200

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BUDGET SUPPLEMENTAL

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Research and Development
Budget Summary by Subfunction

	Subfunction		1979 Actual	FY 1980 Presently Available	FY 1980 Proposed Supplemental	FY 1980 Revised Estimate	FY 1981 Budget Estimate
253	Space flight	BA	2,011,600	2,103,300	300,000	2,403,300	2,738,200
		O	1,789,055	2,087,000	200,000	2,287,000	2,547,600
254	Space science, applications and technology	BA	901,600	1,063,500	---	1,063,500	1,182,000
		O	825,330	971,400	---	971,400	1,068,400
255	Supporting space activities	BA	299,900	332,400	---	332,400	359,000
		O	292,841	325,100	---	325,100	340,400
250	Subtotal, General Science, Space and Technology	BA	3,213,100	3,499,200	300,000	3,799,200	4,279,200
		O	2,907,226	3,383,500	200,000	3,583,500	3,956,400
402	Air Transportation	BA	264,100	308,300	---	308,300	290,300
		O	231,523	270,400	---	270,400	277,800
	Total	BA	3,477,200	3,807,500	300,000	4,107,500	4,569,500
		O	3,138,749	3,653,900	200,000	3,853,900	4,234,200

BA -- Budget Authority
O -- Outlays

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

AUTHORIZATION BILL

A BILL

To authorize a supplemental appropriation to the National Aeronautics and Space Administration for Research and Development.

Paragraph (1) of subsection 1 (a) of the National Aeronautics and Space Administration Act, 1980 (Public Law 96-48), is amended by striking out "$1,586,000,000" and inserting in lieu thereof "$1,886,000,000."

APPROPRIATION LANGUAGE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND DEVELOPMENT

For an additional amount for "Research and Development", $300,000,000; to remain available until September 30, 1981.

OFFICE OF SPACE TRANSPORTATION SYSTEMS — SPACE SHUTTLE PROGRAM

PROGRAM STATUS:

The Space Shuttle Program is in the final period of development toward the first orbital flight, targeted for the last half of 1980. All Space Shuttle system flight elements have been delivered to the Kennedy Space Center (KSC) for STS-1, other elements are proceeding in test and manufacture, and major ground test programs are being conducted. Hardware certification is continuing across all Space Shuttle elements.

The Mated Vertical Ground Vibration Test (MVGVT), conducted at the Marshall Space Flight Center (MSFC), was completed early in 1979, and the data has been used to update Space Shuttle system dynamic math models to predict the vehicle response under vibration during the launch and ascent phases of flight. The test elements used in the MVGVT were delivered to KSC for launch facility verification and tests, which were successfully completed. Orbiter 101 (Enterprise) was then returned to Palmdale, CA, where it will be used for future tests, removal of critical flightworthy parts, and possible use as part of a facility verification vehicle for the Vandenberg Air Force Base (VAFB). The Main Propulsion Test (MPT) series, which started in 1978 at the National Space Technology Laboratories (NSTL), continued through 1979. This includes three main engines mounted on an orbiter aft-fuselage, and an external tank. MPT progress has been slowed due to failures in testing and necessary engine modifications, but the test activity is now progressing. The successful full-duration MPT test lasting 550 seconds on December 17, 1979, represented a significant milestone in the main propulsion development program.

FY 1980 activities support preparations for the first orbital flight. Orbiter 102 (Columbia), which will be used for the Orbital Flight Test (OFT) Program, is in final assembly and checkout in the Orbiter Processing Facility (OPF) at KSC. Thermal protection system (TPS) installation problems have been a major cause for delay in this orbiter final assembly. In 1980, this orbiter will be delivered to the Vehicle Assembly Building (VAB) for assembly with the external tank (ET) and solid rocket boosters (SRB's) to prepare for launch. The orbiter Structural Test Article (STA) testing was completed by Lockheed in 1979, and the STA was transferred back to Rockwell in Palmdale, CA, for modification to become the second flight orbiter, Orbiter 099 (Challenger).

A number of technical problems (i.e., main fuel valve, turbine seal, steerhorn, and suspect weld wire) have occurred in 1979 during various phases of the main engine test program. However, we have now achieved close to 60,000 seconds of test time, and are on our way to the 80,000 second mark, which we expect to reach prior to STS-1. The first phase of the Preliminary Flight Certification (PFC) has been completed with over 5,000 seconds accumulated on one engine, and a second series of PFC testing on a second engine has started. The three engines which will be used for STS-1 have all completed acceptance test firings, are installed and are undergoing checkout in Columbia at KSC. Modifications will be made to these flight engines early in 1980 to correct recent problems detected during engine testing at NSTL.

The first flight ET has been delivered to KSC for use in STS-1, and three other tanks are in various stages of manufacture at the Michoud Assembly Facility (MAF). The fourth solid rocket motor (SRM) development firing and two qualification motor firings were accomplished during 1979, and the third and final qualification firing is planned for early 1980. In addition, the SRB components for the first orbital flight were delivered to KSC in 1979.

The flight hardware elements for STS-1 have been delivered to KSC and are progressing well through element processing toward stacking and mating into the overall assembled vehicle. The SRB's are stacked on the mobile launcher awaiting the ET. The ET checkout will be completed, and it will be mated with the SRB's during the first quarter of 1980. Columbia (which has been undergoing manufacturing, modifications, and testing throughout FY 1979) is being prepared for mating. Integrated vehicle processing is planned to continue through a flight readiness firing prior to launch. The primary orbital flight test landing station at Dryden Flight Research Center (DFRC) in California is operational and an alternate landing strip is being prepared at the White Sands Missile Range in New Mexico.

To establish a national fleet of operational orbiters, Space Shuttle production includes fabrication of two additional orbiters complete with flight engines, refurbishment of Orbiter 102 (Columbia) after its use in the orbital flight tests and early operations, and conversion of the orbiter STA to an operational orbiter (Orbiter 099, Challenger). Also included are the second series of launch and ground support equipment (GSE) at KSC for the simultaneous launch processing of two orbiters, systems integration and support, and initial operational spares and equipment. Activities planned in FY 1980 include: orbiter subsystem hardware fabrication for converting the STA to orbital flight capability, structures fabrication for Orbiter 103 (Atlantis), and main engine hardware fabrication. Procurement of GSE required for the "second line" launch capability at KSC, has already been initiated, and will continue.

During 1979, a number of important reviews of Space Shuttle Program management were held. One of the most important and consistant recommendations from the management reviews was the need for adequate reserves. Such funds have been programmed throughout the Space Shuttle elements for FY 1980, but it is essential that NASA plan for potential changes and systems upgrading required in the Space Shuttle Program to provide necessary modifications resulting from initial flight tests and changes to increase reliability and lower operating costs.

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In summary, the technical progress at this critical phase of the development effort has been substantial, but has not sustained the pace necessary to accomplish the prior FY 1980 budget plan, thus making it necessary to adjust program schedules and request a supplemental appropriation. A summary of additional funding requirements by program element follows.

RESEARCH AND DEVELOPMENT
(dollars in millions)

	FY 1980 Appropriation Presently Available	FY 1980 Current Estimate	Additional Funding Requested
Summary by Program Element			
Design, Development, Test, and Evaluation (DDT&E)			
Orbiter	420.8	560.9	140.1
Main Engine	140.6	140.6	-
External Tank	68.4	79.4	11.0
Solid Rocket Booster	57.5	61.2	3.7
Launch and Landing	143.2	188.4	45.2
Total DDT&E	830.5	1,030.5	200.0
Changes and Systems Upgrading	-	100.0	100.0
Production	755.5	755.5	-
Total	1,586.0	1,886.0	300.0

BASIS OF SUPPLEMENTAL FUND REQUIREMENT

The requirement for the requested supplemental appropriation in FY 1980 is a result of development problems, necessary program changes, the need for more work than was previously planned, particularly in the TPS and systems installation effort on the first orbital vehicle (Orbiter 102) at KSC, and increased systems qualification and certification testing across all elements of the program which have resulted in a delay in the first orbital flight. The impact of such difficulties has been hardware delivery

delays, increased engineering and manufacturing requirements in prime and subcontractor efforts, and significant deferrals of work content into FY 1980. The additional funding requested in the Supplemental Appropriation is required to continue the development efforts on schedule and to proceed with the follow-on orbiter fabrication activities.

DESIGN, DEVELOPMENT, TEST, AND EVALUATION (DDT&E)

	FY 1980 Appropriation Presently Available	FY 1980 Current Estimate	Additional Funding Requested
	(dollars in thousands)		
Orbiter DDT&E	420,800	560,900	140,100

STATUS

The Orbiter Columbia was assembled in Palmdale, CA, checked out, and delivered to the OPF at KSC in March 1979. Considerable open work was transferred with the vehicle. The majority of open work and manufacturing has been completed with the exception of the installation and testing of TPS tiles. Orbiter integrated tests will be completed early in 1980, and the vehicle will be prepared for stacking and prelaunch checkout in mid-1980.

Although the TPS represented the major orbiter problem during 1979, other difficulties were encountered in the auxiliary power units, avionics software, the landing wheels and tires, and structural modifications required by the latest derived loads data.

Tests of the STA, which has a flight type airframe, have been completed by Lockheed at Palmdale, CA. The vehicle has been returned to Rockwell at Palmdale, CA., and is undergoing modifications and updating to become the Challenger flight vehicle configuration. Orbiter 101 (Enterprise) completed full-scale ground vibration tests at MSFC, and was used at KSC for facility interface verification. The Enterprise has been shipped back to Palmdale, where hardware components will be used as test articles or for flight spares. The vehicle will be configured for facility verification at VAFB.

The overall avionics verification testing is underway at the Space Shuttle Avionics Integration Laboratory (SAIL) at the Johnson Space Center (JSC) for ascent, and at the Flight Systems Laboratory (FSL) at Rockwell at Downey, CA, for reentry. Verification tests of various acceptable but off-nominal environment Space Shuttle vehicle equipment conditions, as well as equipment failure conditions, are underway.

Initial testing is being conducted with the latest available flight software for the primary and backup flight control systems, and when the final configuration inspected flight software is received, the avionics flight verification testing will be completed. Engineering real-time simulations are being conducted to investigate flight control problem areas derived from structural and wind tunnel testing. Software modifications will be required to implement the changes resulting from the engineering simulations. Combined systems testing is planned at FSL to demonstrate the flight control actuation systems for the aerosurfaces and the main engine thrust vector controls with the Space Shuttle hydraulic system using the Flight Control Hydraulics Laboratories. Remote Manipulator System (RMS) verification testing on the guidance and control test stations at SAIL is also scheduled for 1980. Overall avionics verification testing will be conducted at SAIL to demonstrate the suitability of flight crew procedures and mission techniques using qualified flight crew members manning the crew station during verification tests. Final flight software initial conditions for the specific launch day data and vehicle configuration will be demonstrated prior to the STS-1 flight, and landing simulations on the Ames Research Center new moving base simulation facility are planned to provide further verification of the STS-1 landing capabilities and techniques.

Support activities managed by JSC will continue, including software modifications in the Mission Control Center (MCC), use of crew training simulators, development of government-furnished equipment such as space suits, and the performance of tests to support the orbiter project. The emphasis for FY 1980 is on preparation for the orbital flight tests.

The development of the Manned Maneuvering Unit (MMU) has been accelerated in order to have on-orbit TPS inspection and repair capability. A qualification unit and two flight articles will be produced, and crew training will begin on the contractor's simulator (Martin Marietta Corporation, Denver, CO). The MMU and associated equipment will be required in January 1981. It is not required for the first flight since the flight is designed for a benign environment and each tile will have been verified to safety factors of at least 1.4 times the full operational requirement.

BASIS OF SUPPLEMENTAL REQUEST

The increase in orbiter funding requirements of $140.1 million results largely from additional engineering and subcontractor activity due to problems encountered in the qualification and certification programs, and the additional effort required to complete the application and testing of thermal protection system tiles, and other subsystem installations at KSC. There have been a number of major changes such as on-orbit TPS repair and heads-up display, as well as numerous changes required to make the system operate properly as determined by the comprehensive test programs. In addition, there have been a number of subcontractor cost increases due to development and producibility problems. Examples include TPS tiles, auxiliary power unit, orbiter maneuvering system pod, the KU-band rendezvous radar, and the S-band communications subsystems. Other funding increases have been experienced in support areas caused by schedule delays, and in systems areas due to additional vehicle system testing planned for FY 1980.

	FY 1980 Appropriation Presently Available	FY 1980 Current Estimate	Additional Funding Requested
	(dollars in thousands)		
Main Engine DDT&E.....	140,600	140,600	---

STATUS

During FY 1979, problems with several main engine components continued to delay the test program causing the main engine project to accumulate fewer test seconds than planned. Engine development testing was proceeding at a good pace until a nozzle steerhorn failure (May 14, 1979) destroyed most of the internal parts of an engine. A main fuel valve failure on a Main Propulsion Test Article (MPTA) engine (July 2, 1979) caused a further temporary suspension of testing. During an MPTA test (November 4, 1979), an early shutdown was initiated when a high pressure oxygen turbopump (HPOTP) turbine seal failed on one of the engines. During the shutdown, another nozzle steerhorn failed, destroying most of the internal parts of an engine. Failure modes and causes of these failures (main fuel valve, nozzle steerhorn, HPOTP turbine seal) have been identified, modifications incorporated, and testing resumed. Another engine has been assigned to the MPT Program. The last MPT test (December 17, 1979) was a significant success, lasting for 550 seconds. As a result of the problems, completion of the MPT series in support of STS-1 has slipped to May 1980.

In spite of these problems, progress this year has been significant. The first certification cycle of the PFC Program was completed. Sixteen tests were conducted for a total of 5,245 seconds on one engine. This included four flight mission profile tests of 520 seconds, one flight mission profile over-stress test [102% rated power level (RPL)], and two abort mission simulations of 665 and 823 seconds. A repeat of the PFC certification cycle is now in progress on the same engine. Seven of the thirteen objectives have been accomplished with a total of 3,000 seconds accumulated to date. A total of four PFC certification cycles will be conducted on two or more engines with at least two certifications on one engine. To date, a total of approximately 530 tests have been conducted, accumulating over 60,000 seconds of operation, with about 175 tests and over 28,000 seconds at RPL. This past year we conducted about 130 tests and accumulated over 22,000 seconds of operation with about 100 tests and over 17,000 seconds at RPL. Thus, over 77% of the test seconds accumulated this past year have been at RPL or higher. Much of the time not at RPL is start, transient time and throttling time to various power levels to determine engine performance at the lower power levels.

Testing will continue on flight configured engines during 1980 leading to the main engine flight certification for STS-1. It is planned to accumulate approximately 80,000 seconds of test time prior to flight, including single engine, main propulsion testing, and PFC testing. The MPTA, consisting of a cluster of three engines, a flight-weight external tank, and the aft-fuselage of the orbiter, is maintained in the STS-1 configuration and will continue in testing during the fiscal year. Data from main propulsion testing will constitute a part of engine verification. PFC testing will be completed accumulating approximately 20,000 seconds on two or more engines. Single engine testing will also be intensive to prove the durability of each component of the system. Full power level (FPL, 109% of RPL) testing will start late in FY 1980. By mid-1980, all engine modifications will have been incorporated in the flight engines installed in Orbiter 102 to support the flight readiness firing and the first orbital flight.

In addition to the development and test work by Rocketdyne and the subcontractors, the main engine activities provide the necessary project support efforts. These efforts include the procurement of propellants for test firing the engine and its components, the maintenance of the engine systems hardware simulation laboratory, logistic support, and the evaluation of materials and processes.

	FY 1980 Appropriation Presently Available	FY 1980 Current Estimate	Additional Funding Requested
	(dollars in thousands)		
External Tank DDT&E.....	68,400	79,400	11,000

STATUS

During 1979, structural testing of the liquid hydrogen tank was successfully accomplished at MSFC. The ground vibration test tank was shipped to KSC where it was mated to a set of inert SRB's and the orbiter Enterprise for a thorough checkout of the launch facilities, ground support equipment, and supporting interface equipment. The tank was then shipped to MAF for storage and eventual reuse as a flight tank after modifications are accomplished.

During the summer of 1979, a design change was implemented to prevent the formation of ice on the tank protuberances, which if dislodged during ascent could damage the orbiter TPS. This will be accomplished by a newly designed KSC ground purge system and the addition of spray-on foam insulation (SOFI) and electrical heaters around the potential ice-forming areas. The determination of aerodynamic crossflows

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from the SRB's, and newly defined air loads which could exceed the cable trays' structural strength, will be resolved by the addition of large SOFI ramps. The first flight tank, delivered to KSC in mid-1979, is in the process of having these changes incorporated, including the ice/debris and air load SOFI ramps. It is expected that all modifications will be completed in early 1980.

Delivery to KSC of the second flight tank is planned for the third quarter of 1980. The third and fourth flight tanks will be structurally assembled, the TPS applied, and readied for shipment to KSC during the year. Deliveries of these two tanks will take place in FY 1981.

During FY 1980, a major engineering effort will be expended on the lightweight tank (LWT) design. The goal of reducing the weight of the tank by 6,000 pounds will be achieved by optimizing the thickness of the basic skin, ribs, and chords of the intertank, liquid oxygen, and liquid hydrogen tanks, with a minimum impact to the basic ET structure and fabrication process. Early in FY 1980, 20 percent of the LWT design had been released for raw material ordering and vendor fabrication of components. A preliminary design review was held during this quarter, and a critical design review is planned for May 1980 which will support the delivery of the first LWT for the seventh (STS-7) orbital flight mission.

In FY 1980, efforts are being undertaken to improve the producibility of the ET. The basic objective is to develop new techniques and processes to build the ET more efficiently and economically. Areas of activity include improved welding techniques and an automated inspection system; an alternate foam material for the liquid hydrogen tank aft dome; and improvements in tank priming, cleaning and protection. In the thermal protection area, SOFI, and ablator improvements are being developed, and improvements in the forming and chemical milling processes have started.

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BASIS OF SUPPLEMENTAL REQUEST

The ET estimate for FY 1980 has increased by $11.0 million. This increase was principally caused by changes, particularly to protect against protuberance icing and to accommodate additional air loads data. The ET project cost also grew because of increased estimates to perform weight reduction and the addition of an ET producibility effort to the development program.

	FY 1980 Appropriation Presently Available	FY 1980 Current Estimate	Additional Funding Requested
	(dollars in thousands)		
Solid Rocket Booster (SRB).....	57,500	61,200	3,700

STATUS

The main element in the SRB system is the SRM which is being developed by Thiokol, Wasatch Division, Utah. Other booster system elements such as the recovery system, Thrust Vector Control (TVC), attach structures, forward and aft-skirt, and separation motors are being procured separately. MSFC is performing designated systems integration tasks, and has the responsibility for total systems integration of the SRB effort.

In 1979, the booster separation motor qualification test firings were successfully completed, and the flight motors for the first two OFTs were delivered to KSC. The structural test program, to verify the major structural elements for flight loads, were completed during 1979, and water impact loads testing started. These tests are scheduled for completion early in 1980. Fabrication of the flight structural components is progressing very well, with delivery of the hardware required for the four OFTs completed. Fabrication of the parachutes for the orbital flights is continuing with the flight sets for the first two flight missions delivered to KSC. The TVC systems testing was completed at MSFC to verify the overall performance characteristics. Successful TVC system operation was completed during the SRM motor firings at Thiokol. The TVC systems for STS-1 have successfully completed hot firing and are installed on the flight aft-skirts. The booster assembly contractor has been actively involved with the assembly and checkout of the boosters for STS-1, and they have delivered the hardware to the VAB high bay area for stacking.

The component qualification test program for all the SRB major systems progressed satisfactorily with approximately a 75% completion of the qualification testing required for the first flight. The total test program is scheduled for completion in early 1980. During 1979 the fourth and final development motor was loaded and test fired. Two of the three SRM qualification tests of the flight configuration have been successfully fired, and the third will be tested in early 1980. All SRM segments for STS-1 have been delivered and stacked at KSC.

BASIS OF SUPPLEMENTAL REQUEST

The SRB estimate for FY 1980 has increased by $3.7 million. This additional funding requirement was caused by cost increases in the SRB subsystems, technical changes, and qualification test problems, as well as DDT&E flight hardware delivery delays to support the slipped development flight schedule.

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	FY 1980 Appropriation Presently Available	FY 1980 Current Estimate	Additional Funding Requested
	(dollars in thousands)		
Launch and Landing DDT&E.....	143,200	188,400	45,200

STATUS

Activation of the various launch and landing station sets has been paced to match the flight hardware development, certification, and readiness for flight. However, the launch support team has been fully implemented, and all personnel are on board and engaged in prelaunch checkout. The Space Shuttle landing stations at DFRC and KSC, and the OPF and Launch Processing Systems (LPS) at KSC were activated in FY 1979, and were operational at the beginning of FY 1980. The mobile launcher, parachute packing, propulsive element checkout (SRB, ET, SSME), and vehicle assembly stations in the VAB were activated in the first quarter of FY 1980. The launch pad and SRB retrieval and disassembly station are progressing on schedule toward activation and operational status in the third quarter of FY 1980. A second firing room and LPS control set will also be activated in FY 1980 to allow the development and checkout of ground test software in parallel with vehicle testing. During FY 1980 construction of facilities at White Sands is required to support orbiter processing in event of landings at that site.

Delivery and installation of most of the required KSC GSE was completed during FY 1979 and early FY 1980. About 98% of the required KSC provided GSE (approximately 290 models) and 90% of the contractor provided GSE (approximately 680 models) have been delivered and installed in the processing stations. Both GSE and flight systems replacement spares are being laid in, processing fluids are being supplied to support checkout and testing, and propellants are being accumulated for the first launch.

The processing station activation remaining for FY 1980 includes the completion of activation of the launch pad and SRB retrieval and disassembly stations. The fuel cell and hypergolic propellant loading systems are still in the test certification phase, an ice protection and purge swing arm is being installed at the launch pad, and the remaining GSE is being implemented on schedule.

The major portion of launch and landing work now is the operation of the station sets and the processing and launch of the flight vehicles. Processing includes test and checkout of the individual flight elements; stacking and mating of the elements to assemble the overall space vehicle; and testing, servicing, and launching the vehicle. The development contractors which provide on-site launch support includes Rockwell International, Martin Marietta, United Space Boosters, Inc. and Thiokol.

The Orbiter Columbia has been in processing in the OPF since its delivery to KSC in March 1979. It was delivered without some flight systems and TPS tiles installed and has since been undergoing manufacturing completion in parallel with systems testing. Most systems have now been tested. Some qualification and certification tests have been performed, and some performance and integration tests remain to be completed. The first flight ET was delivered in July 1979, and it is now being processed in the VAB. The first set of flight SRBs, which were delivered in November and December 1979, have undergone subassembly of skirts and nose frustrums to motor segments and stacking on the mobile launcher in the vehicle assembly station in the VAB.

The vehicle processing still to be accomplished in FY 1980 includes completion of fabrication and testing of the Orbiter Columbia; mating the ET, orbiter, and SRBs; and processing the mated vehicle through vehicle interface test, flight readiness firing, countdown, and launch. After launch, the SRBs will be retrieved and disassembled for refurbishment and reprocessing. The orbiter will land at DFRC after the STS-1 mission, be deserviced, then mated with the carrier aircraft and ferried back to KSC where it will be inspected repaired, and reprocessed, including the replacement of a number of TPS tiles. Other flight elements will be processed for STS-2 during FY 1980, and work on the turnaround of Columbia will be initiated immediately after STS-1.

BASIS OF SUPPLEMENTAL REQUEST

The primary reason for the $45.2 million additional funding in the launch and landing project for FY 1980 is the additional time and effort required to prepare for the launch of STS-1. This additional effort impacted the funding requirements because Orbiter 102 has been in processing in the OPF longer than planned, while the test and checkout phase of launch preparation is being completed. In addition, the test and checkout phase is proving to be more complicated and require more manpower than had originally been estimated. The capacity of the LPS computers required expansion, and many changes necessary to make the ground system operate properly continued to be required to prepare GSE for operational use.

CHANGES AND SYSTEMS UPGRADING

	FY 1980 Appropriation Presently Available	FY 1980 Current Estimate	Additional Funding Requested
		(dollars in thousands)	
Changes and Systems Upgrading Total.....	---	100,000	100,000

BASIS OF SUPPLEMENTAL REQUEST

Recent management and cost reviews at various levels throughout the Space Shuttle Program at NASA and with major contractors have emphasized the need for an adequate allowance for likely changes and potential systems modification to achieve improved performance. Such funds are necessary, particularily at this time, to provide for the modificatons which are most likely to result from the test programs, necessary changes to increase reliability and safety, and changes designed to lower operating costs of the space transportation system.

Space Shuttle system areas in which these changes and upgrading efforts are likely to be required include the elevon actuators, the radiator door configuration, the launch processing system, plus changes in the fuel cells, inertial measurement unit, and the auxiliary power unit. As these requirements develop and are approved, they will impact the funding estimates for either development or production and the funding will be applied accordingly.

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PRODUCTION
(dollars in millions)

	FY 1980 Appropriation Presently Available	FY 1980 Current Estimate	Change in Funds Required
Summary by Production Elements			
Orbiter	570.6	572.6	+2.0
Main Engine	109.9	123.6	+13.7
KSC Second Line	20.0	16.4	-3.6
Spares and Equipment	55.0	42.9	-12.1
Total	755.5	755.5	-

STATUS

Space Shuttle production provides for modification of the orbiter structural test article (STA) to orbital flight configuration (Orbiter 099), refurbishment of Orbiter 102 after the orbital flight test program (OFT) and early operations period, and the fabrication and assembly of two additional orbiters to establish a national fleet of operational orbiters. Production activities also include fabrication of main engines, preparation of the second series ("second line") of Space Shuttle ground processing and launch support equipment at KSC to permit simultaneous processing of two Space Shuttle vehicles, and the necessary Space Shuttle spares and equipment required to establish the initial inventory to support the operational flight rate capability of the Space Shuttle.

The structural test program performed at Palmdale, CA, utilizing the orbiter STA airframe, was completed in 1979. The test data is being used to certify the structural capability of the orbiter. After completion of the planned structural testing, the STA was returned to the Rockwell plant at Palmdale to be converted to an orbital configuration (Orbiter 099, Challenger). The modifications which have been started consist of the removal of specific elements and instrumentation required during testing; installation of a flight-type crew module; addition of functional subsystems such as the orbital maneuvering system, the reaction control system, the atmospheric revitalization system, and the flight control and communications systems; and the application of the TPS.

Fabrication and assembly of the major subsystems of Orbiter 103 (Atlantis), which is scheduled for delivery late in 1983, has begun at Rockwell International and at the major structural subcontractors. The crew module and the forward and aft-fuselage elements are in assembly at Rockwell; and the wings, vertical stabilizer, and mid-fuselage are in assembly at Rockwell's subcontractors. Some long lead ordering of critical parts was also accomplished for Orbiter 104 (Discovery) during FY 1979. During 1979 NASA defined a weight reduction program for implementation on Orbiters 099, 103, and 104. Funds appropriated for FY 1979 to maintain the option for possible fabrication of a fifth orbiter were used to begin procurement of critical long lead time items. NASA only ordered items which are common to a four or five orbiter program and not specifically for a fifth orbiter.

FY 1980 funding provides for continuation of long lead time material and component procurements for the flight engines required for the operational orbiter fleet. Engine component procurements include hot gas manifold and preburner body forgings, turbopump castings, main combustion chamber parts, and selected raw materials and plate stock for engine component fabrication. In addition, fabrication of liquid hydrogen and liquid oxygen high and low pressure turbopump components has been initiated, and assembly of the first set of production engines will begin during FY 1980.

In order to provide the "second-line" capability required at KSC during the operational years, the procurement of necessary ground and launch support equipment was initiated during FY 1979. This equipment will be installed in the OPF and the Launch Control Center at KSC. NASA has also initiated the procurement of flight crew equipment for the extravehicular mobility unit (spacesuit), communications equipment, and the portable oxygen system. In addition, procurements for ET and SRB rate tooling will be initiated in FY 1980.

The current FY 1980 estimates are the same in total as projected in the FY 1980 budget. There has been a rebalancing to reflect the revised delivery schedules and the acceleration of engines to provide backup hardware to support the development program.

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Program and Financing (in thousands of dollars)

OMB Cir A-11
Sec 39B

Research and Development

Identification Code:	Budget Plan (amounts for research and development actions programmed)			Costs and Obligations		
80-0108-4-1-999	1980	1980	1980	1980	1980	1980
Program by activities:	Presently available	Revised estimate	Proposed supplemental	Presently available	Revised estimate	Proposed supplemental
Direct program:						
1. Space transportation systems:						
(a) Space shuttle	1,586,000	1,886,000	300,000	1,601,000	1,851.000	250,000
(b) Space flight operations	446,600	446,600	---	412,100	412,100	---
(c) Expendable launch vehicle development and support	36,100	36,100	---	41,490	41,490	---
2. Scientific investigations in space:						
(a) Physics and astronomy	339,200	339,200	---	337,400	337,400	---
(b) Planetary exploration	219,900	219,900	---	209,300	209,300	---
(c) Life sciences	43,800	43,800	---	46,500	46,500	---
3. Space and terrestrial applications:						
(a) Space applications	364,300	364,300	---	362,110	362,110	---
(b) Technology utilization	12,100	12,100	---	9,300	9,800	---
4. Space research and technology	115,800	115,800	---	117,100	117,100	---
5. Aeronautical research and technology	308,300	308,300	---	279,700	279,700	---
6. Energy technology	3,000	3,000	---	3,700	3,700	---
7. Supporting activity:						
(a) Tracking and data acquisition	332,400	332,400	---	323,200	323,200	---
Total direct program	3,807,500	4,107,500	300,000	3,743,400	3,993,400	250,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Program and Financing (in thousands of dollars)

OMB Cir A-11
Sec 39B

Research and Development

Identification Code:	Budget Plan (amounts for research and development actions programmed)			Costs and Obligations		
80-0108-4-1-999	1980	1980	1980	1980	1980	1980
Reimbursable program:	Presently available	Revised estimate	Proposed supplemental	Presently available	Revised estimate	Proposed supplemental
1. Space transportation systems:						
(a) Space shuttle	22,820	22,820	---	25,990	25,990	---
(b) Space flight operations	91,660	91,660	---	84,940	84,940	---
2. Scientific investigations in space:						
(a) Physics and astronomy	610	610	---	790	790	---
(b) Planetary exploration	---	---	---	4	4	---
(c) Life sciences	233	233	---	230	230	---
3. Space and terrestrial applications:						
(a) Space applications	162,330	162,330	---	168,340	168,340	---
(b) Technology utilization	13,460	13,460	---	17,800	17,800	---
4. Space research and technology	-20	-20	---	719	719	---
5. Aeronautical research and technology	12,240	12,240	---	15,750	15,750	---
6. Energy technology	224,430	224,430	---	213,370	213,370	---
7. Supporting activity:						
(a) Tracking and data acquisition	4,410	4,410	---	4,240	4,240	---
Total, reimbursable program	532,173	532,173	---	532,173	532,173	---
Total program costs, funded	4,339,673	4,639,673	300,000	4,275,573	4,525,573	250,000
Change in selected resources (undelivered orders and stores)	---	---	---	488,991	538,991	50,000
10.00 Total	4,339,673	4,639,673	300,000	4,764,564	5,064,564	300,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Program and Financing (in thousands of dollars)

OMB Cir A-11
Sec 39B

Research and Development

Identification Code:	Budget Plan (amounts for research and development actions programmed)			Costs and Obligations		
80-0108-4-1-999	1980	1980	1980	1980	1980	1980
Financing:	Presently available	Revised estimate	Proposed supplemental	Presently available	Revised estimate	Proposed supplemental
Offsetting collections from:						
11.00 Federal funds	-412,130	-412,130	---	-412,130	-412,130	---
14.00 Non-Federal sources	-120,043	-120,043	---	-120,043	-120,043	---
Budget Authority:						
21.40 Unobligated balance available, start of year:						
For completion of prior year budget plans:						
Direct	---	---	---	-239,006	-239,006	---
Reimbursable	---	---	---	-185,885	-185,885	---
40.00 Budget authority (appropriation)	3,807,500	4,107,500	300,000	3,807,500	4,107,500	300,000

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Program and Financing (in thousands of dollars)

OMB Cir A-11
Sec 39B

Research and Development

Identification Code:	Budget Plan (amounts for research and development actions programmed)			Costs and Obligations		
80-0108-4-1-999	1980	1980	1980	1980	1980	1980
Relation of obligations to outlays:	Presently available	Revised estimate	Proposed supplemental	Presently available	Revised estimate	Proposed supplemental
71.00 Obligations incurred, net				4,232,391	4,532,391	300,000
72.40 Obligated balance, start of year				785,812	785,812	---
74.40 Obligated balance, end of year				-1,364,303	-1,464,303	-100,000
90.00 Outlays				3,653,900	3,853,900	200,000

Note: Reconciliation of budget plan to obligations:	1980 estimate		
	Presently available	Revised estimate	Proposed supplemental
Total budget plan	4,339,673	4,639,673	300,000
Add obligations of prior year budget plans	424,891	424,891	---
Total obligations	4,764,564	5,064,564	300,000

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STANDARD FORM 304
May 1969, Bureau of the Budget
Circular No. A-11, Revised
304-103

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
RESEARCH AND DEVELOPMENT
OBJECT CLASSIFICATION (in thousands of dollars)

A-11-34

Identification code 80-0108-4-1-999	1980 Presently Available	1980 Revised Estimate	1980 Proposed Supplemental
Direct obligations:			
~~11.1 Permanent positions~~			
~~11.3 Positions other than permanent~~			
~~11.5 Other personnel compensation~~			
~~11.8 Special personal services payments~~			
~~Total personnel compensation~~			
Personnel benefits:			
~~12.1 Civilian~~			
~~13.0 Benefits for former personnel~~			
~~21.0 Travel and transportation of persons~~			
22.0 Transportation of things	8,130	8,807	677
23.1 Standard level user charges	209	209	---
23.2 Communications, utilities and other rent	54,391	58,430	4,039
24.0 Printing and reproduction	2,600	2,790	190
25.0 Other services	3,722,066	3,998,100	276,034
26.0 Supplies and materials	161,060	173,010	11,950
31.0 Equipment	95,920	103,030	7,110
32.0 Lands and structures	1,050	1,050	---
~~33.0 Investments and loans~~			
41.0 Grants, subsidies, and contributions	1,080	1,080	---
~~42.0 Insurance claims and indemnities~~			
~~43.0 Interest and dividends~~			
~~44.0 Refunds~~			
99.0 Total direct obligations	4,046,506	4,346,506	300,000

STANDARD FORM 304
May 1969, Bureau of the Budget
Circular No. A-11, Revised
304-103

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
RESEARCH AND DEVELOPMENT
OBJECT CLASSIFICATION (in thousands of dollars)

A-11-34

Identification code 80-0108-4-1-999	1980	1980	1980
Reimbursable obligations:	Presently Available	Revised Estimate	Proposed Supplemental
~~11.1 Permanent positions~~			
~~11.3 Positions other than permanent~~			
~~11.5 Other personnel compensation~~			
~~11.8 Special personal service payments~~			
~~Total personnel compensation~~			
Personnel benefits:			
~~12.1 Civilian~~			
~~13.0 Benefits for former personnel~~			
~~21.0 Travel and transportation of persons~~			
22.0 Transportation of things	910	910	---
~~23.1 Standard level user charges~~			
23.2 Communications, utilities and other rent	2,330	2,330	---
24.0 Printing and reproduction	230	230	---
25.0 Other services	690,338	690,338	---
26.0 Supplies and materials	12,860	12,860	---
31.0 Equipment	10,660	10,660	
32.0 Lands and structures	730	730	---
~~33.0 Investments and loans~~			
~~41.0 Grants, subsidies, and contributions~~			
~~42.0 Insurance claims and indemnities~~			
~~43.0 Interest and dividends~~			
~~44.0 Refunds~~			
Total reimbursable obligations	718,058	718,058	---
99.0 Total obligations	4,764,564	5,064,564	300,000

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BUDGET AMENDMENT

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES

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SUMMARY

BUDGET AMENDMENT

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 AMENDED BUDGET ESTIMATES

GENERAL STATEMENT

The National Aeronautics and Space Administration, established October 1, 1958, conducts space and aeronautics activities for peaceful purposes for the benefit of all. NASA's activities are designed to maintain United States leadership in aeronautical and space research and technology, and it's utilization.

-- Extend our knowledge of the Earth, its environment, the solar system, and the universe;

-- Expand the practical applications of space technology;

-- Develop, operate, and improve manned and unmanned space vehicles;

-- Improve the civil and military usefulness of aeronautical vehicles, while minimizing their environmental effects and energy consumption;

-- Disseminate pertinent findings to potential users: and

-- Promote international cooperation in peaceful activities in space.

The President's civil space policy announced in October 1978 emphasized a balanced strategy of applications, science and technology development designed to:

-- Emphasize space applications that will bring important benefits to our understanding of Earth resources, climate, weather, pollution and agriculture;

-- Emphasize space science and exploration in a manner that retains challenge and excitement and permits the Nation to retain the vitality of its space technology base;

-- Take advantage of the flexibility of the Space Shuttle to reduce the cost of operating in space;

-- Assure American scientific and technology leadership in space;

-- Increase benefits for resources expended through closer integration of the national space programs;

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-- Demonstrate advanced technology capabilities in open and imaginative ways;

-- Foster space cooperation with nations by conducting joint programs;

-- Confirm our support of the continued development of a legal regime for space that will assure its safe and peaceful use for the benefit of all.

The NASA FY 1981 budget recommendation of $5,517.7 million provides for progress toward achievement of these objectives at a pace consistent with a constrained fiscal environment.

Space program elements in the recommended budget provide for progress in development of the operational capability and use of the Shuttle and related systems; in practical application of space capabilities in remote sensing of land and ocean conditions, in atmospheric studies, in materials processing and in communications; in exploration of the solar system and expansion of our knowledge of the universe; and in advancing the technology necessary for United States leadership in space. Major areas of emphasis include:

o Development, qualification and flight testing of the Space Shuttle and manufacture of the orbiter vehicles on a schedule consistent with the requirements of the Department of Defense. The Space Shuttle is progressing toward the initial flight tests, but the final preparations and ground testing required before these flight missions can be confidently undertaken are taking longer and requiring more effort than previously planned. The requirements of the Department of Defense and other Shuttle users, as well as the requirements of the NASA program, make it necessary to proceed as expeditiously as possible in achieving the capabilities of the Space Transportation System. Consistent with these requirements, it is necessary to recommend a Supplemental Appropriation of $300 million for FY 1980. The FY 1981 budget recommendation is based on the assumption that this Supplemental Appropriation will be approved;

o Continuation of the approved flight missions in Science and Applications, but with a revised plan for the Galileo mission to Jupiter to achieve the science objectives using separate launches of orbiter and probe spacecraft in 1984 rather than a combined spacecraft launch in 1982; a delay of the International Solar Polar Mission until 1985; a delay of approximately one year in the Earth Radiation Budget Experiment; and a delay of one to two years in flight experiments planned for future Spacelab Missions.

o Continuation of the basic and applied research activities essential to future capabilities and leadership in space;

o Carefully selected program enhancements and next step initiatives in the areas of practical applications of space capabilities and scientific exploration of space. Specifically, enhancements and initiatives in the area of practical applications, remote sensing and communications include the National Oceanic Satellite System in response to both military and civil requirements for remote sensing of ocean data and advanced

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technical development effort on an experimental wideband communications satellite. In the area of Space Science, development will be initiated on the Gamma Ray Observatory to conduct a comprehensive sky survey of the highest energy region of the electromagnetic spectrum.

Aeronautical research and technology activities in the recommended budget are necessary to advance aeronautical technology to ensure safer, more economical, efficient and environmentally acceptable air transportation systems which are responsive to current and projected national needs; to maintain the strong competitive position of the United States in the international aviation marketplace; and to support the military in maintaining the superiority of the Nation's military aircraft. The FY 1981 program continues emphasis on the fundamental research and technology base in all disciplines vital to aeronautics; on specific technology efforts directed toward major improvements in transport aircraft energy efficiency for operations and on systems technology to provide a basis for improved performance and safety for future vehicles in each major aircraft category. The FY 1981 program also continues focused efforts on aircraft energy efficiency technology to provide the basis for a major reduction in fuel requirements for transport aircraft; on design technology for future quiet, efficient, all weather rotorcraft; on variable flow propulsion technology; and, on other key areas of systems technology. Construction effort is proceeding on two major aeronautical facilities, the National Transonic Facility at the Langley Research Center and the Modification to the 40-by-80 foot Subsonic Wind Tunnel at the Ames Research Center. The facilities, which will considerably enhance the Nation's aeronautical research capability, are scheduled to come on line as operational facilities during FY 1982.

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Resources Summary

The budget for FY 1981 has been developed on the assumption that the FY 1980 Supplemental Appropriation of $300.0 million required for the Space Shuttle program will be approved on a timely basis. The total budget authority for FY 1980, including this supplemental appropriation, and a supplemental of $46.3 million requested to cover the increased salary costs that became effective in October 1979 pursuant to Executive Order 12165, totals $5,269.8 million. The amended budget authority recommended for FY 1981 totals $5,517.7 million with estimated outlays of $5,215.7 million. Civil service staffing levels are planned at 22,613 for the end of FY 1980 and 22,713 at the end of FY 1981.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

BUDGET SUMMARY
(Thousands of Dollars)

RESEARCH AND DEVELOPMENT	Budget Plan FY 1979	FY 1980	FY 1981 Request Pending	FY 1981 Proposed Amendment	FY 1981 Revised Request
Space Transportation Systems	2,011,600	2,403,300	2,738,200	-42,000	2,696,200
Space shuttle	1,638,300	1,886,000	1,873,000	---	1,873,000
Space flight operations	299,700	446,600	809,500	-42,000	767,500
Expendable launch vehicles	73,600	70,700	55,700	---	55,700
Space Science	505,400	600,800	668,000	-107,000	561,000
Physics and astronomy	282,900	337,100	438,700	-92,100	346,600
Planetary exploration	182,400	219,900	179,600	-4,300	175,300
Life sciences	40,100	43,800	49,700	-10,600	39,100
Space and Terrestrial Applications	283,900	343,900	394,800	-26,000	368,800
Space applications	274,800	331,800	381,700	-25,000	356,700
Technology utilization	9,100	12,100	13,100	-1,000	12,100
Aeronautics and Space Technology	376,400	427,100	409,500	-20,000	389,500
Aeronautical research and technology	264,100	308,300	290,300	-15,000	275,300
Space research and technology	107,300	115,800	115,200	-5,000	110,200
Energy technology	5,000	3,000	4,000	---	4,000
Tracking and Data Acquisition	299,900	332,400	359,000	-10,000	349,000
TOTAL RESEARCH AND DEVELOPMENT	3,477,200	4,107,500	4,569,500	-205,000	4,364,500
CONSTRUCTION OF FACILITIES	147,500	156,100	120,000	---	120,000
RESEARCH AND PROGRAM MANAGEMENT	934,069	1,006,186	1,047,154	-14,000	1,033,154
TOTAL	4,558,769	5,269,786[a/]	5,736,654	-219,000	5,517,654
OUTLAYS	4,196,472	5,002,600	5,439,700	-224,000	5,215,700

a/ Includes proposed supplementals as follows:
R&D $300,000,000 for Space Shuttle.
R&PM 46,286,000 for October 1979 pay raise.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

SUMMARY OF BUDGET AMENDMENT BY APPROPRIATION

OMB Cir A-11
Exhibit 39C

Budget appendix page	Heading	1981 Request pending	1981 Proposed amendment	1981 Revised request
787	Research and Development.....	$4,569,500,000	-$205,000,000	$4,364,500,000
791	Construction of Facilities.....	120,000,000	---	120,000,000
792	Research and Program Management.	1,047,154,000	-14,000,000	1,033,154,000
	Total.....	$5,736,654,000	-$219,000,000	$5,517,654,000

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES

SUMMARY OF APPROPRIATIONS
(Thousands of Dollars)

Appropriations	FY 1979	FY 1980	FY 1981 Request Pending	FY 1981 Proposed Amendment	FY 1981 Revised Request
Research and Development	3,477,200	4,107,500	4,569,500	-205,000	4,364,500
Basic appropriation	3,292,200	3,807,500	4,569,500	-205,000	4,364,500
Supplemental for Space Shuttle	185,000	---	---	---	---
Proposed supplemental for Space Shuttle	---	300,000	---	---	---
Construction of Facilities	147,500	156,100	120,000	---	120,000
Basic appropriation	147,500	156,100	120,000	---	120,000
Research and Program Management	934,069	1,006,186	1,047,154	-14,000	1,033,154
Basic appropriation	910,500	959,900	1,047,154	-14,000	1,033,154
Rescission, PL 96-7	-2,400	---	---	---	---
Supplemental appropriation for civilian pay raises, PL 96-38	25,969	---	---	---	---
Proposed supplemental for civilian pay raises	---	46,286	---	---	---
Total	4,558,769	5,269,786	5,736,654	-219,000	5,517,654

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES

SUMMARY RECONCILIATION OF APPROPRIATIONS TO BUDGET PLANS
(Thousands of Dollars)

Fiscal Year 1979	Total	Research and Development	Contruction of Facilities	Research and Program Management
Appropriation, PL 95-392	4,350,200	3,292,200	147,500	910,500
Rescission, PL 96-7	-2,400	---	---	-2,400
Supplemental Appropriation, PL 96-38	210,969	185,000	---	25,969
Unobligated balance lapsing	-261	---	---	-261
Total Budget Plan	4,558,508	3,477,200	147,500	933,808
Fiscal Year 1980				
Appropriation, PL 95-392	4,923,500	3,807,500	156,100	959,900
Proposed supplemental for Space Shuttle	300,000	300,000	---	---
Proposed supplemental for civilian pay raises	46,286	---	---	46,286
Total Budget Plan	5,269,786	4,107,500	156,100	1,006,186
Fiscal Year 1981				
Appropriation request pending	5,736,654	4,569,500	120,000	1,047,154
Proposed amendment	-219,000	-205,000	---	-14,000
Revised Request/Budget Plan	5,517,654	4,364,500	120,000	1,033,154

EXPLANATION OF BUDGET AMENDMENT

BUDGET AMENDMENT

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981

SUMMARY OF BUDGET AMENDMENT

The FY 1981 Budget Amendment for the National Aeronautics and Space Administration has the net effect of reducing the amounts budgeted for new obligational authority by $219 million and outlays by $224 million. The adjustments affect all three appropriations as follows:

1. Research and Development - A net decrease of $205 million in new obligational authority and $203 million in outlays. A total of $235 million decrease in new obligational authority has been assigned to major program areas as follows: • $107 million to various space science programs notably through schedule slips for the International Solar Polar Mission and a one to two year delay in achieving the planned flight rate for Spacelab experiments in physics and astronomy and life sciences; • $56 million to various space and terrestrial applications programs primarily through reductions and deferrals in planned Spacelab payloads, schedule slips in the Earth Radiation Budget Experiment and the Halogen Occultation Experiment, deferred initiation of lead time activities for an operational Landsat system, and decreased emphasis on technology transfer activities; • $15 million in aeronautical research and technology mostly from rephasing of the laminar flow control and energy efficient engine system technology activities; • $5 million from space research and technology; • $10 million from space tracking and data systems; and • $42 million from the space flight operations area through delaying the planned buildup of the space shuttle flight rate consistent with the other reductions. $30 million of the outlay reduction will be accomplished through a revised schedule of payment for the second Spacelab which is being manufactured by the European Space Agency.

These decreases are partially offset by increases totalling $30 million in new obligational authority to provide for cost increases in the Landsat D program which were unknown and thus not included in the original FY 1981 budget request. These increases are occuring at both Hughes Aircraft Company and General Electric Company and are under intensive review within the Agency at this time.

2. Construction of Facilities - Decreases totalling $7 million in outlays only through delaying contract award dates for selected FY 1980 projects.

3. Research and Program Management - Decreases totalling $14 million in new obligational authority and $14 million in outlays through deliberate delay in filling civil service vacancies as they occur and reduced installation support activities.

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RESEARCH AND DEVELOPMENT

BUDGET AMENDMENT

FISCAL YEAR 1981 ESTIMATES

RESEARCH AND DEVELOPMENT PLAN FOR OFFICE OF SPACE TRANSPORTATION SYSTEMS

	1979	1980		1981		
	Actual	Budget Estimate	Current Estimate	Request Pending	Budget Amendment	Revised Request
			(Thousands of Dollars)			
Space Shuttle	1,638,300	1,886,000	1,886,000	1,873,000	---	1,873,000
Space flight operations	299,700	467,300	446,600	809,500	-42,000	767,500
Expendable launch vehicles	73,600	70,700	70,700	55,700	---	55,700
Total	2,011,600	2,424,000	2,403,300	2,738,200	-42,000	2,696,200

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BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE TRANSPORTATION SYSTEMS/
OFFICE OF SPACE TRANSPORTATION OPERATIONS

SPACE FLIGHT OPERATIONS PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS
(Thousands of Dollars)

	1979	1980		1981			
	Actual	Budget Estimate	Current Estimate	Request Pending	Budget Amendment	Revised Request	Page No. (Jan Subm)
Space transportation systems operations capability development..	64,500	69,800	54,100	89,000	-10,000	79,000	RD 2-3
Development, test and mission support.....	177,200	172,600	172,600	183,500	---	183,500	RD 2-13
Advanced programs.....	7,000	13,000	13,000	10,800	-2,000	8,800	RD 2-19
Spacelab.....	26,700	58,800	58,800	151,700	-2,000	149,700	RD 2-21
Space transportation system operation	24,300	153,100	148,100	374,500	-28,000	346,500	RD 2-23
Total.....	299,700	467,300	446,600	809,500	-42,000	767,500	
Distribution of Program Amount by Installation:							
Johnson Space Center.....	145,752	170,800	140,850	210,700	-2,400	208,300	
Kennedy Space Center.....	66,154	71,700	87,800	138,500	---	138,500	
Marshall Space Flight Center.....	72,554	208,450	197,350	436,700	-39,400	397,300	
National Space Technology Laboratories.....	5,900	5,500	5,500	5,200	---	5,200	
Goddard Space Flight Center.....	5,556	6,700	7,800	7,100	---	7,100	
Jet Propulsion Laboratory.....	---	---	200	200	---	200	
Langley Research Center.....	---	---	100	100	---	100	
Headquarters.....	3,784	4,150	7,000	11,000	-200	10,800	
Total.....	299,700	467,300	446,600	809,500	-42,000	767,500	

BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

OFFICE OF SPACE TRANSPORTATION SYSTEMS/
OFFICE OF SPACE TRANSPORTATION OPERATIONS

SPACE FLIGHT OPERATIONS PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
		(Thousands of Dollars)		
Space Transportation Systems (STS) Operations				
Capability Development	89,000	-10,000	79,000	RD 2-3
STS upper stages	39,000	-10,000	29,000	RD 2-5
Multimission and payload support equipment	13,000	---	13,000	RD 2-7
Mission control center upgrading	15,800	---	15,800	RD 2-8
Payload and operations support	11,200	---	11,200	RD 2-9
Thrust augmentation	10,000	---	10,000	RD 2-11
Development, Test, and Mission Support	183,500	---	183,500	RD 2-13
Research and test support	32,400	---	32,400	RD 2-14
Data systems and flight support	40,200	---	40,200	RD 2-15
Operations support	45,900	---	45,900	RD 2-16
Launch systems support	65,000	---	65,000	RD 2-17
Advanced Programs	10,800	-2,000	8,800	RD 2-19
Spacelab	151,700	-2,000	149,700	RD 2-21

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	1981 Request Pending	Budget Amendment (Thousands of Dollars)	Revised Request	Page No. (Jan Subm)
Space Transportation Systems Operations.....	374,500	-28,000	346,500	RD 2-23
Space Shuttle operations.....	320,500	-24,500	296,000	RD 2-24
Spacelab operations.....	1,600	---	1,600	RD 2-24
Upper stage operations.....	32,900	-2,000	30,900	RD 2-24
Payload support Operations.....	19,500	-1,500	18,000	RD 2-24
Total.....	809,500	-42,000	767,500	

EXPLANATION OF BUDGET AMENDMENT

Space Transportation System (STS) Operations Capability Development

Space transportation systems upper stages.....	39,000	-10,000	29,000	RD 2-5
Multimission and payload support equipment.....	13,000	---	13,000	RD 2-7
Mission control center (MCC) upgrading.....	15,800	---	15,800	RD 2-8
Payload and operations support.....	11,200	---	11,200	RD 2-9
Thrust augmentation.....	10,000	---	10,000	RD 2-11
Total.....	89,000	-10,000	79,000	

The reduction of $10 million in FY 1981 for the Inertial Upper Stage (IUS) will result in a one-year slip in the development schedule. The current schedule supports a 1983 launch of the International Solar Polar Mission. The program will be rephased to support the Galileo launches planned for 1984. This schedule extension will result in cost penalties since the revised development schedule will delay most of the NASA unique development activity until after completion of the DOD 2-stage IUS development effort, resulting in a less efficient overall development effort.

Advanced Programs

Advanced Programs.....	10,800	-2,000	8,800	RD 2-19

The reduction of $2 million in Advanced Programs activities in FY 1981 will limit the capability for definition study efforts on potential future space programs and systems. Some specific effects of the reduced FY 1981 funding level will be a reduction in engineering tasks associated with the definition

of the Power Extension Package (PEP) and 25-KW Power system; deferral of comprehensive system definition studies of an orbit transfer vehicle along with the deletion of definition of advanced propulsion concepts; a reduction in engineering tasks pertinent to near-orbiter and far-orbiter satellite services, related EVA and teleoperation activities; a significant reduction in geostationary platform definition efforts limiting activities to minimum definitions of an experimental platform only; and a deferral of some engineering tasks associated with large space structures. Activities associated with the definition of post FY 1982 future systems, particularly those related to geosynchronous operations have been drastically reduced. All long-range, new concept studies will be deferred.

The revised FY 1981 funding request will support only minimum definition efforts essential to support the highest priority potential FY 1982 new start candidates. The advanced studies activities supporting the opportunity to proceed with the Solar Electric Propulsion Systems (SEPS) and the Power Extension Package (PEP) in FY 1982 have been maintained.

Spacelab

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
		(Thousands of Dollars)		
Spacelab	151,700	-2,000	149,700	RD 2-21

The reduction of $2 million still provides a funding level sufficient to support progress toward readiness of approved flight missions. However, the Spacelab Simulator delivery will be delayed reducing the time available for crew training. Also, the processing of the flight unit after it arrives from Europe will be delayed. The impact of these delays increases schedule risk. In addition, outlay reduction will be accomplished by deferral of the planned payments to ESA for the second Spacelab.

Space Transportation Systems Operations

Shuttle operations	320,500	-24,500	296,000	RD 2-24
Spacelab operations	1,600	---	1,600	RD 2-24
Upper stages operations	32,900	-2,000	30,900	RD 2-24
Payload support operations	19,500	-1,500	18,000	RD 2-24
Total	374,500	-28,000	346,500	

These reductions are consistent with the rescheduling of the International Solar Polar Mission (ISPM) from 1983 to 1985. Rescheduling of this mission and delay in the planned increase in production of the external tank and solid rocket boosters will be necessary. The reduction in Upper Stage Operations is partially offset by increases in the Inertial Upper Stages for other approved missions.

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BUDGET AMENDMENT

FISCAL YEAR 1981 ESTIMATES

RESEARCH AND DEVELOPMENT BUDGET PLAN FOR SPACE SCIENCE PROGRAMS

Programs	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Request Pending	1981 Budget Amendment	1981 Revised Request
			(Thousands of Dollars)			
Physics and astronomy	282,900	337,500	337,100	438,700	-92,100	346,600
Planetary exploration	182,400	220,200	219,900	179,600	-4,300	175,300
Life sciences	40,100	43,900	43,800	49,700	-10,600	39,100
Total	505,400	601,600	600,800	668,000	-107,000	561,000

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BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE SCIENCE

PHYSICS AND ASTRONOMY PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS
(Thousands of Dollars)

	1979	1980		1981			
	Actual	Budget Estimate	Current Estimate	Request Pending	Budget Amendment	Revised Request	Page No. (Jan Subm)
High energy astronomy observatories (HEAO) development	10,647	4,800	2,100	---	---	---	RD 4-8
Solar maximum mission (SMM) development	16,700	600	3,100	---	---	---	RD 4-9
Space telescope (ST) development	79,200	112,700	112,700	119,300	---	119,300	RD 4-10
International solar polar mission (ISPM) development	12,500	50,000	47,900	82,600	-43,000	39,600	RD 4-12
Gamma ray observatory (GRO) development	---	---	---	19,100	---	19,100	RD 4-14
Shuttle/Spacelab payload development and mission management	34,900	41,300	40,900	72,100	-43,000	29,100	RD 4-16
Explorer development	31,288	30,400	32,300	33,000	---	33,000	RD 4-19
Mission operations and data analysis (MO&DA)	25,453	36,500	37,100	38,900	---	38,900	RD 4-21
Research and analysis (R&A)	44,005	34,300	34,100	42,800	-6,100	36,700	RD 4-24
Suborbital program	28,207	26,900	26,900	30,900	---	30,900	RD 4-29
Total	282,900	337,500	337,100	438,700	-92,100	346,600	

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Distribution of Program Amount by Installation:

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Request Pending	1981 Budget Amendment	1981 Revised Request
			(Thousands of Dollars)			
Kennedy Space Center.....	335	---	1,813	2,358	---	2,358
Johnson Space Center.....	346	216	1,713	6,181	-3,766	2,415
Marshall Space Flight Center...	124,275	158,112	155,226	177,583	-15,182	162,401
Goddard Space Flight Center....	83,299	76,963	79,908	117,828	-26,583	91,245
Jet Propulsion Laboratory.....	19,314	58,353	53,950	80,977	-41,685	39,292
Wallops Flight Center.....	7,028	5,219	5,678	6,874	---	6,874
Ames Research Center.....	20,401	4,157	12,817	8,901	-533	8,368
Langley Research Center.....	1,052	855	59	37	---	37
Lewis Research Center.....	185	---	---	---	---	---
Headquarters.....	26,665	33,625	25,936	37,961	-4,351	33,610
Total.....	282,900	337,500	337,100	438,700	-92,100	346,600

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BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT
FISCAL YEAR 1981 ESTIMATES

OFFICE OF SPACE SCIENCE

PHYSICS AND ASTRONOMY PROGRAM

EXPLANATION OF BUDGET AMENDMENT

International Solar Polar Mission (ISPM) Development

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
	(Thousands of Dollars)			
Spacecraft	62,600	-36,300	26,300	
Experiments	14,500	-2,500	12,000	
Ground operations	5,500	-4,200	1,300	
Total	82,600	-43,000	39,600	RD 4-12
Space transportation system operations	(15,700)	(-12,500)	(3,200)	

The launch of the International Solar Polar Mission (ISPM) is being delayed two years (from February 1983 to April 1985) in this budget amendment. The reduction of $43 million in FY 1981 will be accomplished through a directed slowdown in spacecraft system contractor development activities; a stretchout in experiment development; and a reduced level of ground operations activities. The stretchout of the ISPM project will require major program rebaselining and will result in an increased in the total project run out cost.

The ISPM consists of a pair of spacecraft, one provided by NASA and one by the European Space Agency (ESA). The mission profile requires that the two spacecraft make simultaneous observations over the northern and southern hemispheres of the Sun. Except for a delay in scientific results, the two-year delay in the launch will not significantly affect the scientific return of the mission provided that the simultaneity of the northern and southern hemisphere studies is maintained. Therefore, because both of the spacecraft should be launched during the same launch opportunity, the ESA spacecraft launch must also be slipped two years.

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Shuttle/Spacelab Science Payload Development and Mission Management

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
	(Thousands of Dollars)			
Science experiments	25,200	-20,900	4,300	
Mission management	46,900	-22,100	24,800	
Total	72,100	-43,000	29,100	RD 4-16

The Shuttle/Spacelab payload development and mission management project includes payload development funds for Physics and Astronomy experiments, and mission management funds for all NASA Shuttle/Spacelab flights.

The FY 1981 revised request allows for the continued development and integration of the Shuttle OFT payloads (OSTA-1 and OSS-1) to be launched in 1981; continued development and integration of payloads for the Spacelab 1 and 2 missions leading to launched in 1982 and continued mission management for the currently planned applications and technology missions including Spacelab 3. The Physics and Astronomy funding in FY 1981 will provide for mission management for subsequent Applications and Life Science Shuttle/Spacelab missions, but will severely curtail the Physics and Astronomy payload development in FY 1981. The immediate result of the reduced level of funding is a one to two-year delay in the early Physics and Astronomy Shuttle/Spacelab science activities, and a one-year delay in the mission management support to the Life Science missions.

Shuttle/Spacelab serves as a unique vehicle for Physics and Astronomy investigations and as such the impact of the budget amendment to the Physics and Astronomy program is substantial. The one to two-year delay is particularly severe in the solar physics discipline where experiments to be flown on Shuttle/Spacelab missions represent a key element of the research planned for the 1980's. The investigation of cool bodies in the universe is similarly impacted by the development delay of the Shuttle Infrared Telescope Facility (SIRTF). The new area of active experiments in space plasma physics will be adversely affected by the delay in flying experiments which complement those under development for OSS-1 and Spacelab 1.

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Research and Analysis

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
	(Thousands of Dollars)			
Supporting research and technology (SR&T)	24,900	-2,300	22,600	
Spacelab science payload definition	6,100	-1,800	4,300	
Advanced technological development	2,700	-200	2,500	
Data Analysis	9,100	-1,800	7,300	
Total	42,800	-6,100	36,700	RD 4-24

The funds previously requested in FY 1981 would have provided for a carefully designed program of new instrument development, laboratory measurement, supporting ground-based research, data analysis and theory specifically tailored to support and complement the past, current and future Physics and Astronomy Program of free flying observatories, explorers and Spacelab missions. Since this research and analysis program would have been at a minimum level in each of the discipline and supporting areas, the budget amendment requires the deletion or severe curtailment of specific research activities. Action required includes the following: (a) all work in relatively is deleted; (b) the number of active cosmic ray research groups have been halved; (c) ground-based supporting work for high energy missions will be eliminated; and (d) the definition of a number of important Solar Terrestrial Spacelab Payloads will be postponed, including the Pinhole/Coronograph and the tethered satellite system.

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BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE SCIENCE

PLANETARY EXPLORATION PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS
(Thousands of Dollars)

	1979	1980		1981			
	Actual	Budget Estimate	Current Estimate	Request Pending	Budget Amendment	Revised Request	Page No. (Jan Subm)
Galileo development	78,700	116,100	116,100	63,100	---	63,100	RD 5-5
Mission operations and data analysis	59,300	59,000	58,800	64,800	-4,300	60,500	RD 5-8
Research and analysis	44,400	45,100	45,000	51,700	---	51,700	RD 5-10
Total	182,400	220,200	219,900	179,600	-4,300	175,300	
Distribution of Program Amount by Installation:							
Johnson Space Center	4,115	6,380	6,012	5,990	---	5,990	
Marshall Space Flight Center	824	10	45	75	---	75	
Goddard Space Flight Center	3,749	3,830	3,757	3,780	-100	3,680	
Jet Propulsion Laboratory	107,899	136,330	140,067	101,877	---	101,877	
Ames Research Center	40,841	44,520	30,953	28,340	-4,200	24,140	
Langley Research Center	---	---	7	---	---	---	
Headquarters	24,972	29,130	39,059	39,538	---	39,538	
Total	182,400	220,200	219,900	179,600	-4,300	175,300	

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BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

OFFICE OF SPACE SCIENCE — PLANETARY EXPLORATION

EXPLANATION OF BUDGET AMENDMENT

Mission Operations and Data Analysis

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
Voyager basic mission	25,600	---	25,600	
Voyager extended mission	3,000	---	3,000	
Pioneer venus basic and extended mission	7,700	-2,700	5,000	
Pioneer 6-11 extended mission	2,500	-1,500	1,000	
Helios extended mission	100	-100	---	
Viking extended mission	---	---	---	
Planetary flight support	25,900	---	25,900	
Total	64,800	-4,300	60,500	RD 5-8

The continued successful operation of the Pioneer Venus mission, beyond the initially planned lifetime, is resulting in important new knowledge of the Venus atmosphere and surface structure. However, the existing Pioneer Venus mission computer system is becoming increasingly unreliable. It had, therefore, been our intent in FY 1981, to upgrade this system to reduce the potential of disruptions to the continuing mission operations and data analysis activities. However, the budget amendment would preclude upgrading of the Pioneer Venus computer. The impact of this decision will only be known when, and if, the existing computers cause operational problems or cause the loss of valuable scienfific data.

In addition, this reduction will require the elimination of the data analysis support for Pioneer 6-11 and Helios missions. We will continue the collection of this interplanetary data which will be analyzed later. This approach recognizes the importance of the scientific potential of the data acquired by these missions, but reflects the priority of interplanetary science compared with planetary science within the Planetary Exploration program.

BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE SCIENCE

LIFE SCIENCES PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS
(Thousands of Dollars)

	1979	1980		1981			
	Actual	Budget Estimate	Current Estimate	Request Pending	Budget Amendment	Revised Request	Page No. (Jan Subm)
Life sciences flight experiments..	15,700	12,900	16,600	19,200	-6,500	12,700	RD 6-3
Vestibular function research.....	---	3,700	---	---	---	---	
Research and analysis.....	24,400	27,300	27,200	30,500	-4,100	26,400	RD 6-5
Total.....	40,100	43,900	43,800	49,700	-10,600	39,100	
Distribution of Program Amount by Installation:							
Johnson Space Center.....	19,716	16,650	19,423	22,210	-5,560	16,650	
Kennedy Space Center.....	225	650	723	1,129	-100	1,029	
Jet Propulsion Laboratory.....	1,770	2,050	1,677	1,746	-580	1,166	
Ames Research Center.....	13,081	18,480	14,266	15,837	-3,340	12,497	
Dryden Flight Research Center.....	185	200	164	288	---	288	
Langley Research Center.....	---	---	40	40	---	40	
Headquarters.....	5,123	5,870	7,507	8,450	-1,020	7,430	
Total.....	40,100	43,900	43,800	49,700	-10,600	39,100	

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BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

OFFICE OF SPACE SCIENCE

LIFE SCIENCES PROGRAM

EXPLANATION OF BUDGET AMENDMENT

Life Sciences Flight Experiments

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
	(Thousands of Dollars)			
Life sciences flight experiments.....	19,200	-6,500	12,700	RD 6-3

The reduction in this program will result in (1) elimination of all efforts to develop a Vestibular Research Facility; and (2) a one-year slip in the launch of the first dedicated Life Sciences Spacelab flight from 1983 to 1984, with the second dedicated Life Sciences flight occurring 18 months later. Since the pool of investigations for possible flight on the first dedicated Spacelab was selected in November 1979, the currently anticipated interval between time of selection and actual flight has become excessively long; hence, a large portion of the investigations currently selected for definition will be eliminated from the program. The delay caused by the launch slip in gathering the medical data, particularly that relating to the vestibular problems, will impact our ability to investigate, understand and counteract some of the known physiological effects of space flight during the early years of our manned space activities.

Research and Analysis

Supporting research and technology.....	30,500	-4,100	26,400	RD 6-5

The Life Sciences research and analysis program is unique in that it has two distinct roles: the support of the United States manned space activities; and the conduct of basic research into the effects of space (specifically weightlessness) on living organisms. Like all other supporting research and analysis activities within Space Sciences, the program is at a minimum level and, hence, several major disciplines will be severely impacted. A decision has been made to accommodate the reduction in three areas: (1) all space vestibular

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research will be eliminated; (2) a major segment of the Life in the Universe program will be eliminated; and (3) most of the advanced life support activities will be eliminated.

The Nation is now entering a new era of manned space flight and it must be recognized that advanced life support systems will continue to be needed during the coming decade. Therefore, these definition and development activities must be resumed at a later date.

BUDGET AMENDMENT

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1981 ESTIMATES

RESEARCH AND DEVELOPMENT BUDGET PLAN FOR SPACE AND TERRESTRIAL APPLICATIONS

Programs	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Request Pending	1981 Budget Amendment	1981 Revised Request
			(Thousands of Dollars)			
Space Applications	274,800	332,300	331,800	381,700	-25,000	356,700
Technology Utilization	9,100	12,100	12,100	13,100	-1,000	12,100
Total	283,900	344,400	343,900	394,800	-26,000	368,800

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BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE AND TERRESTRIAL APPLICATIONS

SPACE APPLICATIONS PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS
(Thousands of Dollars)

	1979	1980		1981			
	Actual	Budget Estimate	Current Estimate	Request Pending	Budget Amendment	Revised Request	Page No. (Jan Subm)
Resource observations	139,400	141,400	145,203	162,300	+8,000	170,300	RD 7-9
Environmental observations	67,750	117,200	109,470	137,600	-28,000	109,600	RD 7-29
Applications systems	13,950	20,300	24,547	18,100	---	18,100	RD 7-49
Technology transfer	10,700	10,300	10,087	12,500	-5,000	7,500	RD 7-50
Materials processing in space	20,400	19,800	19,768	22,200	---	22,200	RD 7-53
Space communications	22,600	23,300	22,725	29,000	---	29,000	RD 7-58
Total	274,800	332,300	331,800	381,700	-25,000	356,700	RD 7-1
Distribution of Program Amount by Installation:							
Johnson Space Center	24,146	31,150	25,330	41,990	-900	41,090	
Kennedy Space Center	520	825	1,428	195	-15	180	
Marshall Space Flight Center	26,412	29,525	28,705	23,950	-2,150	21,800	
National Space Technology Laboratories	3,199	3,750	2,940	3,720	-1,545	2,175	
Goddard Space Flight Center	159,076	184,100	182,320	198,770	-2,670	196,100	
Jet Propulsion Laboratory	22,951	22,300	18,463	21,570	-1,700	19,870	
Wallops Flight Center	3,114	4,125	3,915	4,390	-50	4,340	
Ames Research Center	7,983	10,550	16,010	18,295	-1,045	17,250	
Langley Research Center	9,789	19,125	14,548	12,805	-1,515	11,290	
Lewis Research Center	5,294	5,125	10,368	17,000	-20	16,980	
Headquarters	12,316	21,725	27,773	39,015	-13,390	25,625	
Total	274,800	332,300	331,800	381,700	-25,000	356,700	RD 7-1

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BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

RESOURCE OBSERVATIONS PROGRAM

	1979	1980		1981			
	Actual	Budget Estimate	Current Estimate	Request Pending	Budget Amendment	Revised Request	Page No. (Jan Subm)
	(Thousands of Dollars)						
Landsat-D	97,500	89,800	98,663	64,300	+30,000	94,300	RD 7-12
Operational land observing system	---	---	---	16,000	-16,000	---	RD 7-14
Magnetic field satellite	3,900	1,600	1,600	500	---	500	RD 7-16
Shuttle/Spacelab payload development	6,200	1,600	1,850	2,000	---	2,000	RD 7-17
Extended mission operations	358	1,500	1,582	2,700	---	2,700	RD 7-19
Geodynamics	8,200	13,100	12,600	24,800	---	24,800	RD 7-20
Applied research and data analysis	22,242	17,800	12,908	18,800	-6,000	12,800	RD 7-23
AgRISTARS	---	16,000	16,000	33,200	---	33,200	RD 7-26
Landsat-3	700	---	---	---	---	---	
Heat capacity mapping mission	300	---	---	---	---	---	
Total	139,400	141,400	145,203	162,300	+8,000	170,300	RD 7-9

EXPLANATION OF BUDGET AMENDMENT

Earth Resources Technology Satellite (Landsat-D)

Spacecraft systems and sensors	44,300	+15,700	60,000
Ground system	14,100	+20,200	34,300
Ground operations	4,800	-4,800	---
Investigations	1,100	-1,100	---
Total	64,300	+30,000	94,300
Delta (Expendable Launch Vehicles Program)	(6,000)	(---)	(6,000)

RD 7-12

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The requirement for increased project funding is the result of unanticipated cost increases in the development of the Thematic Mapper at Hughes Aircraft Company and the space and ground segments at the General Electric Company. The total cost impact, exact spacecraft configuration, and resultant schedule are currently under intensive review within the administration. Although a revised launch date has not been determined, it is anticipated that Landsat-D will not be launched in 1981 as originally planned.

Increased funding in FY 1981 will permit completion and acceptance testing of the Multispectral Scanner for Landsat-D and D[1]. Fabrication and integration of the Landsat-D Thematic Mapper will also be completed during FY 1981 and integration of the Landsat-D[1] Thematic Mapper will be initiated. The fabrication and assembly of the mission-unique flight segment elements will be completed in FY 1981, and significant elements of the flight hardware (e.g., the multimission spacecraft) will be integrated and tested. The design and development of the Landsat-D ground system including the operations control center and data processing system will continue. Funding for ground operations and planned Landsat-D investigations will be deferred until FY 1982.

Operational Land Observing System

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
		(Thousands of Dollars)		
Ground data handling system modifications.....	10,000	-10,000	---	
Sensor parts procurement.....	6,000	-6,000	---	
Total.....	16,000	-16,000	---	RD 7-14

Deletion of these funds will defer hardware procurement and ground system modifications to support the operational land observing system. The Landsat-D ground system currently under development has been designed to meet the requirements of a research and development system, and lacks the reliability and timeliness provisions which are required of an operational system. Deferral of funds for initiation of these activities will prolong the operationally unsatisfactory status of the ground system, and will require modifications at higher cost. The delay in procurement of long lead-time MSS and Thematic Mapper parts for a follow-on Landsat-D spacecraft risks loss of continuity of coverage in the last half of the decade.

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Applied Research and Data Analysis

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
		(Thousands of Dollars)		
Renewable resources	7,800	-3,700	4,100	
Non-renewable resources	3,900	---	3,900	
Applications pilot tests	2,700	-1,300	1,400	
Operationally earth resources system (OERS) definition	2,800	-1,000	1,800	
Advanced studies	1,600	---	1,600	
Total	18,800	-6,000	12,800	RD 7-23

The revised FY 1981 Resource Observation AR&DA program will include continuation of activities at present or reduced levels:

Renewable Resources:	7,800	-3,700	4,100	RD 7-24

Principal efforts will be directed at continuation of ongoing remote sensing technique development with the Federal, university, and private research communities in the areas of fundamental research and sensor development. These efforts include theoretical modeling, ground-based studies, and aircraft and spacecraft data analysis. However, research in water and land resources disciplines will be terminated. This includes all research in snowpack properties, hydrologic modeling, watershed characteristics, land resources modeling, improved land cover classification, change detection, and bidirectional reflectance and atmospheric variation research. The remaining research will be concentrated in soil moisture, integration of visible-near IR and active microwave data, initiation of fundamental research in scene characterization and pattern recognition and multilinear array short wave infrared detector development.

Application Pilot Tests:	2,700	-1,300	1,400	RD 7-25

The revised estimate will support five ongoing Application Pilot Tests (APT's) with the California Department of Water Resources, Cotton, Inc., United States Geological Survey (USGS), Pennsylvania Department of Environmental Resources, and the Missouri Farm Association. However, the urban area information system APT with the Bureau of the Census which was originally scheduled for completion in FY 1982 will be terminated in FY 1980. No new APT's will be initiated in FY 1981.

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	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
		(Thousands of Dollars)		
Operational Earth Resources System Definition:	2,800	-1,000	1,800	RD 7-25

Support to the National Oceanic and Atmospheric Administration for definition of the OERS system, initiated in FY 1980, will be continued in FY 1981 at a reduced level. The definition tasks include an analysis of data acquisition requirements and the subsequent derivation of system engineering parameters, conceptual designs of space and ground segments and identification of implementation options for both segments.

ENVIRONMENTAL OBSERVATIONS PROGRAM

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	
			(Thousands of Dollars)				
Upper atmospheric research program	(14,500)*	13,000	12,500	13,500	---	13,500	RD 7-32
Applied research and data analysis	33,726	49,900	48,670	56,400	-6,500	49,900	RD 7-34
Shuttle/Spacelab payload development	7,750	9,600	9,600	8,200	-6,500	1,700	RD 7-39
Operational satellite improvement program	6,100	7,400	7,400	10,700	-1,500	9,200	RD 7-42
Earth radiation budget experiment	7,000	23,000	17,000	29,000	-12,000	17,000	RD 7-43
Halogen occulation experiment	3,600	8,000	8,000	6,000	-1,500	4,500	RD 7-44
Extended mission operations	1,250	5,800	5,800	8,000	---	8,000	RD 7-45
National oceanic satellite system	---	---	---	5,800	---	5,800	RD 7-46
Tiros-N	1,200	---	---	---	---	---	
Nimbus-7	3,624	500	500	---	---	---	
Seasat	3,500	---	---	---	---	---	
Total	67,750	117,200	109,470	137,600	-28,000	109,600	RD 7-29

*Program transferred from Space Science to Space Applications, January 1979; FY 1979 funding not included in total.

EXPLANATION OF BUDGET AMENDMENT

Applied Research and Data Analysis

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
		(Thousands of Dollars)		
Stratospheric air quality	5,800	-800	5,000	
Tropospheric air quality	5,400	-800	4,600	
Global weather (Including GARP)	11,600	-500	11,100	
Severe storms	6,600	-1,200	5,400	
Ocean processes	17,600	-2,400	15,200	
Climate	9,400	-800	8,600	
Total	56,400	-6,500	49,900	RD 7-34

The revised FY 1981 Environmental Observations AR&DA program will include the continuation of most of the ongoing activities. However, due to the reduction, several planned activities will be delayed.

Stratospheric air quality	5,800	-800	5,000	RD 7-36

The reduction in the FY 1981 budget estimate will require deferral of certain planned laboratory and modeling development efforts, and a reduction in the ground truth for analysis of Nimbus-7 and SAGE observations and for NOAA temperature soundings.

Tropospheric air quality	5,400	-800	4,600	RD 7-36

Due to the reduction in the revised budget, some planned sensor technology development will be delayed, and the tropospheric modeling effort will be decreased.

Global weather	11,600	-500	11,100	RD 7-36

Because of reductions in the FY 1981 revised budget, the development of advanced sounders will be delayed and the level of numerical model development reduced.

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
		(Thousands of Dollars)		
Severe storms	6,600	-1,200	5,400	RD 7-36

Lightning mapper research and technology transfer efforts will be delayed as a consequence of the reduction in the Amendment.

Ocean processes	17,600	-2,400	15,200	RD 7-37

The planned use of data from both Nimbus-7 and Seasat instruments to explore the limitations on deriving near-surface conditions of the ocean will be delayed because of the reduction in the revised FY 1981 budget. The preparation of a coordinated plan, including ocean and ice applications, for a SAR instrument to be flown on a future Shuttle mission will be delayed, and research efforts in water quality will be reduced. Other effects of the reduction in the budget plan include the deferral of a study using Seasat/SAR imagery to evaluate the performance of models to predict deformation of the ice field under the influence of the surface wind field, and delay in definition studies to explore options for flying improved scatterometers on future missions.

Climate	9,400	-800	8,600	RD 7-38

Definition studies and instrument development in support of a possible future climate observing system will be delayed because of reductions in the revised FY 1981 budget.

Shuttle/Spacelab Payload Development (Environmental Observations)

Measurement of air pollution from satellites (MAPS)	100	---	100	
Atmospheric trace molecules observed by spectroscopy (ATMOS)	600	---	600	
Atmospheric cloud physics laboratory (ACPL)	2,800	-2,100	700	
Principal investigator instrument development and reflight program	4,700	-4,400	300	
Total	8,200	-6,500	1,700	RD 7-39

	1981 Request Pending	1981 Budget Amendment	Revised Request	Page No. (Jan Subm)
		(Thousands of Dollars)		
Atmospheric Cloud Physics Laboratory (ACPL).....	2,800	-2,100	700	RD 7-41

The ACPL has been removed from Spacelab-3, but tests of developed hardware and ground-based experiments will be continued in FY 1981. The cloud physics program is being rescoped to ground-based research.

Principal Investigator Instrument Development/ Reflight Programs.....	4,700	-4,400	300	RD 7-41

Activities which have been delayed due to a reduction in the revised FY 1981 budget include instrument refurbishment and reflight of previously developed instruments, and development of new multiple-flight instruments for long-term research purposes.

Because of the reduction in the revised FY 1981 budget, development of a High Resolution Doppler Interoferometer (HRDI) for measuring upper tropospheric windfields will be delayed one year. The detailed design of the microwave limb sounder will be initiated, but "bread-boarding" of high technology subsystems for proof of concept determinations will be delayed. A definition study of solar irradiance measurements in the 168-365 nanometers spectral range will be delayed. These instruments were selected from the recent Announcement of Opportunity. Selections from another Announcement of Opportunity will be delayed because of the reduced FY 1981 budget.

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Operational Satellite Improvement Program

Research and development for improvement of operational satellite systems.....	10,700	-1,500	9,200	RD 7-42

Because of the reduction in the proposed FY 1981 budget, portions of the assessment of the atmospheric sounder experiment will be delayed one year. The reduced budget will require rephasing of the development of the Solar Backscatter Ultraviolet (SBUV) instrument scheduled for flight on NOAA-F. This NOAA-F/SBUV flight is an important milestone since it will be the first operational monitoring of stratospheric ozone from space. A further impact of the budget reduction will be a delay in the planned improvements in operational user terminals.

Earth Radiation Budget Experiment (ERBE)

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
	(Thousands of Dollars)			
Spacecraft	16,700	-12,000	4,700	
Sensors	11,800	---	11,800	
Mission operations and data analysis	500	---	500	
Total	29,000	-12,000	17,000	RD 7-43

Reduced funding provided by the amended budget request will delay completion of the NASA dedicated spacecraft fabrication and spacecraft-instrument integration. Launch readiness date will be delayed approximately one year, from 1983 to 1984.

Halogen Occultation Experiment (HALOE)

Sensor development	6,000	-1,500	4,500	RD 7-44

Fabrication of the engineering model unit to be flown on the Shuttle will continue, with delivery of the instrument for integration delayed slightly, until late 1981. Development of the unit to be flown on ERBS-A will be delayed commensurate with the new ERBE schedule.

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TECHNOLOGY TRANSFER PROGRAM

	1979 Actual	1980 Budget Estimate	1980 Current Estimate	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
	(Thousands of Dollars)						
Applications systems verification and transfer (ASVT)	900	1,700	1,700	1,800	-1,200	600	RD 7-52
Regional remote sensing applications	3,500	3,800	3,657	4,100	-2,300	1,800	RD 7-52
User requirements and supporting activities	4,500	4,800	4,730	6,600	-1,500	5,100	RD 7-52
Civil systems	1,800	---	---	---	---	---	
Total	10,700	10,300	10,087	12,500	-5,000	7,500	RD 7-50

EXPLANATION OF BUDGET AMENDMENT

Applications systems verification and transfer	1,800	-1,200	600	RD 7-52

Reduced funding will require termination of one ASVT project, the Pacific Northwest Land Resources Inventory, one year ahead of schedule. Five current ASVT projects will be continued at 50-60% of planned resource levels, requiring deferral of several activities planned for FY 1981. No new ASVT projects will be initiated in FY 1981, and program thrusts planned for FY 1981 will be delayed for consideration in FY 1982 or later. Only one ASVT, National Park Management with the National Park Service, will be completed in FY 1981.

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	1981 Request Pending	1981 Budget Amendment	Revised Request	Page No. (Jan Subm)
		(Thousands of Dollars)		
Regional remote sensing applications.....	4,100	-2,300	1,800	RD 7-52

Activities will concentrate on completing nine current joint projects with state governments and providing follow-up technical assistance to maintain momentum in states which are moving towards implementing operational Landsat data analysis systems. Completion of six projects scheduled for FY 1981 will be deferred to FY 1982. No new regional demonstration projects will be initiated in FY 1981. Activities associated with transfer of Landsat technology to state governments will continue at a reduced level of effort. A limited program of technology transfer to substate governments will be maintained in FY 1981 and will include an estimated 10-12 projects with county governments and regional government entities.

User requirements and supporting activities.....	6,600	-1,500	5,100	RD 7-52

Activities will focus on strategies to involve the private sector in NASA's technology transfer efforts both as a supplier of remote sensing services and as an independent end-user of remote sensing. Reduced funding will necessitate reduction of user outreach and communications tasks, such as NASA's involvement with the National Governors Association and National Conference of State Legislatures, to a minimum level to support the continued formal communications between NASA and the state governments. Opportunities for similar liaison programs with private sector user associations and public interest groups will be eliminated. In the University Applications activity, at least five university grants will be terminated and the opportunity to initiate two or three new grants in FY 1981 will be foregone, curtailing the rate of adoption of operational remote sensing services by potential users.

BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE AND TERRESTRIAL APPLICATIONS

TECHNOLOGY UTILIZATION PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS

	1979	1980		1981			
	Actual	Budget Estimate	Current Estimate	Request Pending	Budget Amendment	Revised Request	Page No. (Jan Subm)
	(Thousands of Dollars)						
Technology dissemination	3,200	3,800	3,800	4,100	---	4,100	RD 8-4
Technology applications	4,500	4,400	4,400	4,800	-1,000	3,800	RD 8-4
Program evaluation and support	1,400	1,500	1,500	1,600	---	1,600	RD 8-4
Civil systems*	(1,800)	2,400	2,400	2,600	---	2,600	RD 8-4
Total	9,100	12,100	12,100	13,100	-1,000	12,100	RD 8-1
Distribution of Program Amount by Installation:							
Johnson Space Center	145	200	100	150	---	150	
Kennedy Space Center	100	150	100	150	---	150	
Marshall Space Flight Center	562	500	550	540	-50	490	
National Space Technology Laboratories	---	50	100	75	---	75	
Goddard Space Flight Center	865	900	800	880	-330	550	
Jet Propulsion Laboratory	569	1,700	1,700	1,990	-400	1,590	
Wallops Flight Center	4	200	300	375	---	375	
Ames Research Center	733	1,000	920	1,250	-220	1,030	
Dryden Flight Research Center	54	60	37	50	---	50	
Langley Research Center	710	1,000	800	890	---	890	
Lewis Research Center	415	400	800	750	---	750	
Headquarters	4,943	5,940	5,893	6,000	---	6,000	
Total	9,100	12,100	12,100	13,100	-1,000	12,100	RD 8-1

*Prior to FY 1980, this effort was included in Space Applications.

BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981

TECHNOLOGY UTILIZATION PROGRAM

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
		(Thousands of Dollars)		
Technology dissemination	4,100	---	4,100	
Technology applications	4,800	-1,000	3,800	
Program evaluation and support	1,600	---	1,600	
Civil systems	2,600	---	2,600	
Total	13,100	-1,000	12,100	RD 8-1

EXPLANATION OF BUDGET AMENDMENT

Technology applications	4,800	-1,000	3,800	RD 8-4

The revised FY 1981 budget request will preclude the opportunity for any new start projects. At the revised level, NASA plans to continue the Biomedical Applications Teams as well as teams for Transportation, Public Safety, and Manufacturing to identify problems and to assist in development and evaluation of on-going projects. With the exception of one biomedical project, which will be delayed one year, on-going projects to develop prosthetic devices to aid the handicapped will be supported. Projects involving cooperative funding from other agencies and institutions will be continued. However, no new projects in any of the categories mentioned above can be undertaken.

BUDGET AMENDMENT

FISCAL YEAR 1981 ESTIMATES

RESEARCH AND DEVELOPMENT PLAN FOR AERONAUTICS AND SPACE TECHNOLOGY

	1979	1980		1981		
	Actual	Budget Estimate	Current Estimate	Request Pending	Budget Amendment	Revised Request
		(Thousands of Dollars)				
Aeronautical research and technology.....	264,100	300,300	308,300	290,300	-15,000	275,300
Space research and technology.....	107,300	116,400	115,800	115,200	-5,000	110,200
Energy technology.....	5,000	3,000	3,000	4,000	---	4,000
Total.....	376,400	419,700	427,100	409,500	-20,000	389,500

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BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY — AERONAUTICAL RESEARCH AND TECHNOLOGY PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS
(Thousands of Dollars)

	1979	1980		1981			
	Actual	Budget Estimate	Current Estimate	Request Pending	Budget Amendment	Revised Request	Page No. (Jan Subm)
Research and technology base.....	109,700	117,500	119,000	131,100	---	131,100	RD 9-4
Systems technology programs.....	154,400	182,800	189,300	159,200	-15,000	144,200	RD 9-20
Total.....	264,100	300,300	308,300	290,300	-15,000	275,300	
Distribution of Program Amount by Installation:							
Johnson Space Center.....	1,245	700	495	200	---	200	
Marshall Space Flight Center.....	1,113	900	725	800	---	800	
Jet Propulsion Laboratory.....	1,489	1,100	830	800	---	800	
Wallops Flight Center.....	614	700	600	500	---	500	
Ames Research Center.....	48,564	51,900	54,800	53,400	-500	52,900	
Dryden Flight Research Center.....	8,903	13,400	13,300	13,200	---	13,200	
Langley Research Center.....	92,171	115,300	115,800	109,900	-7,400	102,500	
Lewis Research Center.....	106,960	113,000	117,450	108,100	-7,000	101,100	
Headquarters.....	3,041	3,300	4,300	3,400	-100	3,300	
Total.....	264,100	300,300	308,300	290,300	-15,000	275,300	

(Page No. Jan Subm RD 9-1)

BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

AERONAUTICAL RESEARCH AND TECHNOLOGY

SYSTEMS TECHNOLOGY PROGRAMS

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
	(Thousands of Dollars)			
Materials and structures systems technology	9,600	---	9,600	RD 9-21
Propulsion systems technology	6,400	-1,500	4,900	RD 9-22
Avionics and flight control systems technology	1,550	---	1,550	RD 9-23
Aeronautical system studies	4,600	-1,000	3,600	RD 9-25
General aviation systems technology	100	---	100	RD 9-26
Low speed aircraft systems technology	23,450	---	23,450	RD 9-27
High speed aircraft systems technology	16,800	---	16,800	RD 9-29
Transport aircraft systems technology	40,500	-7,000	33,500	RD 9-31
Advanced propulsion system technology	56,200	-5,500	50,700	RD 9-33
Total	159,200	-15,000	144,200	RD 9-20

EXPLANATION OF BUDGET AMENDMENT

Systems Technology Programs

Propulsion systems technology	6,400	-1,500	4,900	RD 9-22

The reduction in FY 1981 will force a stretchout in advanced low-emission combustion work which will result in delayed availability of technologies for environmentally acceptable gas turbine aircraft engines and will limit the activity in areas of concern such as combustor durability and fuel flexibility.

There will be delays in the integration of fundamental design information into realistic combustor designs which are responsive to the needs for lower fuel consumption, the ability to use future fuels, and environmentally compatible aircraft engines.

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
	(Thousands of Dollars)			
Aeronautical systems studies.....	4,600	-1,000	3,600	RD 9-25

The budget amendment reduces the scope of systems studies which explore future technology needs and opportunities and evaluate the costs and benefits of projected technology advances. Areas impacted are studies of alternate (cryogenic) fuels, general aviation aircraft including potential propulsion systems and propeller advances, and short-haul transports.

Transport aircraft systems technology.....	40,500	-7,000	33,500	RD 9-31

Laminar Flow Control systems technology is being reoriented to proceed at a reduced pace while maintaining a continuing and focused attack on the critical issues of laminar flow control. These issues are manufacturing wing surfaces of sufficient smoothness and uniform suction, and maintaining the quality of the wing surface in normal operations in spite of the problems caused by cloud moisture, insects and dust. The successful completion of this work will represent a major step towards eliminating many of the concerns as to the feasibility of this technology. The impact of this reduced pace will be a delay in completing the leading edge system flight test and completing the wing surface panel development and ground tests.

Advanced propulsion systems systems technology.....	56,200	-5,500	50,700	RD 9-33

The funding plan for the Energy Efficient Engine effort has been rephased. The full-scale component tests of the fan, high-pressure compressor, full annular combustor, and high-pressure turbine will still be completed in FY 1981. The fabrication of the core system and integrated core and low spool system will be initiated essentially as planned in the original FY 1981 budget estimates. The FY 1981 reduction, however, will impact delivery of some core system long-lead hardware, thus resulting in delaying the initiation of tests of the complete core systems originally scheduled for the second quarter of FY 1982 under one contract and for the first quarter of FY 1983 under another contract effort.

BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY

SPACE RESEARCH AND TECHNOLOGY

SUMMARY OF RESOURCES REQUIREMENTS
(Thousands of Dollars)

	1979	1980		1981			
	Actual	Budget Estimate	Current Estimate	Request Pending	Budget Amendment	Revised Request	Page No. (Jan Subm)
Research and technology base...	86,277	99,300	99,785	103,400	-3,100	100,300	RD 10-3
Systems technology programs....	12,023	14,100	11,015	9,700	-1,900	7,800	RD 10-17
Standards and practices.....	9,000	3,000	5,000	2,100	---	2,100	RD 10-20
Total.....	107,300	116,400	115,800	115,200	-5,000	110,200	
Distribution of Program Amount by Installation:							
Johnson Space Center.....	5,284	9,440	10,045	8,200	-200	8,000	
Marshall Space Flight Center.	9,279	6,500	6,642	7,150	-100	7,050	
Goddard Space Flight Center..	9,656	9,300	8,848	9,400	-300	9,100	
Jet Propulsion Laboratory....	20,918	24,600	22,673	20,800	-1,500	19,300	
Ames Research Center.....	9,904	9,840	9,881	9,800	-300	9,500	
Langley Research Center.....	24,472	27,400	27,882	30,000	-1,900	28,100	
Lewis Research Center.....	22,866	25,420	23,694	25,900	-700	25,200	
Headquarters.....	4,921	3,900	6,135	3,950	---	3,950	
Total.....	107,300	116,400	115,800	115,200	-5,000	110,200	

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BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY — SPACE RESEARCH AND TECHNOLOGY

RESEARCH AND TECHNOLOGY BASE
(Thousands of Dollars)

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
Entry fluid physics research and technology	6,100	-200	5,900	
Chemical propulsion research and technology	9,300	-300	9,000	
Materials and structures research and technology	16,500	-500	16,000	
Electronics and automation research and technology	8,800	-300	8,500	
Space power and electric propulsion research and technology	20,300	-600	19,700	
Multidisciplinary research and technology	2,900	-100	2,800	
Information systems research and technology	22,600	-700	21,900	
Spacecraft systems research and technology	8,700	-200	8,500	
Transportation systems research and technology	8,200	-200	8,000	
Total	103,400	-3,100	100,300	RD 10-3

EXPLANATION OF BUDGET AMENDMENT
Research and Technology Base

Research and Technology Base	103,400	-3,100	100,300	RD 10-3

The reduction of $3.1 million has been applied to all Research and Technology Base program elements in an attempt to minimize the possible disruption to the ongoing research efforts. Each task which has been deferred would have contributed to the reservoir of technology which would be available for application in future space activities. In real terms, the resulting level of activity will be almost ten percent below the current level.

BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

OFFICE OF AERONAUTICS AND SPACE TECHNOLOGY — SPACE RESEARCH AND TECHNOLOGY

SYSTEMS TECHNOLOGY PROGRAMS
(Thousands of Dollars)

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
Space system studies	2,200	---	2,200	RD 10-17
Information systems technology	5,100	-900	4,200	RD 10-18
Spacecraft systems technology	2,400	-1,000	1,400	RD 10-19
Total	9,700	-1,900	7,800	

EXPLANATION OF BUDGET AMENDMENT
Systems Technology Program

Information Systems Technology	5,100	-900	4,200	RD 10-18

The $900 thousand reduction in the Satellite Communication Technology program at the Jet Propulsion Laboratory in FY 1981 will impact NASA's in-house 30/20 gigahertz and narrow band antenna design activities which are in support of the experimental communication satellite technology initiative. Suspension of this activity during FY 1981 will not critically change the major program objectives, but some changes in project phasing will be required. Technology effort will continue on critical, higher risk components, techniques and subsystems such as traveling wave tubes, amplifiers, filters, modulators and multiplexers.

Spacecraft Systems Technology	2,400	-1,000	1,400	RD 10-19

This reduction results in a delay of about one year to the launch schedule of the Long-Duration Explosure Facility. In addition, the total project costs will increase and there may be some difficulties related to program management continuity due to loss of project and experiment personnel who are needed to complete final checkout, integration, operations and data analysis.

BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

OFFICE OF SPACE TRACKING AND DATA SYSTEMS

TRACKING AND DATA ACQUISITION PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS
(Thousands of Dollars)

	1979	1980		1981			
	Actual	Budget Estimate	Current Estimate	Request Pending	Budget Amendment	Revised Request	Page No. (Jan Subm)
Operations	249,903	275,800	264,500	271,500	-1,500	270,000	RD 12-3
Systems implementation	40,497	46,400	57,300	76,200	-8,500	67,700	RD 12-12
Advanced systems	9,500	10,600	10,600	11,300	---	11,300	RD 12-21
Total	299,900	332,800	332,400	359,000	-10,000	349,000	
Distribution of Program Amounts by Installation:							
Goddard Space Flight Center	216,557	238,200	234,000	249,700	-6,600	243,100	
Jet Propulsion Laboratory	59,021	68,800	69,800	74,400	-400	74,000	
Wallops Flight Center	5,800	6,300	6,500	9,800	-3,000	6,800	
Dryden Flight Research Center	3,150	3,000	3,300	3,600	---	3,600	
Headquarters	15,372	16,500	18,800	21,500	---	21,500	
Total	299,900	332,800	332,400	359,000	-10,000	349,000	

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BUDGET AMENDMENT

RESEARCH AND DEVELOPMENT

FISCAL YEAR 1981 ESTIMATES

OFFICE OF SPACE TRACKING AND DATA SYSTEMS — TRACKING AND DATA ACQUISITION PROGRAM

SUMMARY OF RESOURCES REQUIREMENTS:

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
	(Thousands of Dollars)			
Operations	271,500	-1,500	270,000	RD 2-3
Systems implementation	76,200	-8,500	67,700	RD 12-12
Advanced systems	11,300	---	11,300	RD 12-21
Total	359,000	-10,000	349,000	

EXPLANATION OF BUDGET AMENDMENT

Operations

Operations	271,500	-1,500	270,000	RD 12-1

The FY 1981 request pending for operations was based on continuing the current, constrained level of support to flight missions. The impact of the reduction of $1.5 million is compounded by the fact that current rates of inflation are running higher than those anticipated at the time the pending budget request was developed. To minimize the impact on flight project support, reductions will be taken to the maximum extent possible in selected maintenance activity, reduced logistics inventories, and other support activities. Selected deferred maintenance is possible without predictable degration in network support; however, there will be increased risk to the NASA flight projects. There will also be additional loss of flexibility in responding to spacecraft emergency situations or unusual support opportunities.

Systems Implementation

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
	(Thousands of Dollars)			
Systems implementation.....	76,200	-8,500	67,700	RD 12-12

To minimize the impact on projects, this reduction will be accomplished by deferring the planned replacement of aging computer systems at the Goddard Space Flight Center and Wallops Flight Center. These computer systems are approximately fifteen years old with the attendant problems of increased downtime, increased maintenance costs, software inefficiencies, and decreasing reliability.

The system replacements affected by this reduction include the impact prediction system at Wallops and the Data Processing and Command Memory Management Systems at Goddard. Alternative plans are underway and where program priorities dictate, lease periods will be considered for the replacement systems in FY 1981. To the extent that the planned computer replacements cannot be implemented in FY 1981 there will be increased risk in providing reliable support to the projects. There will also be an increase in the total costs resulting from deferred purchase of the replacement systems due to additional lease costs that cannot be applied to the purchase price and continued operation of the existing systems.

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BUDGET AMENDMENT

RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 1981 ESTIMATES

BUDGET SUMMARY

SUMMARY OF RESOURCES REQUIREMENTS
(Thousands of Dollars)

	1979	1980		1981			
	Actual	Budget Estimate	Current Estimate	Request Pending	Budget Amendment	Revised Request	Page No. (Jan Subm)
Distribution of Budget Plan by Function:							
Personnel and related costs	709,055	727,176	768,462	779,991	-9,000	770,991	SUM 3
Travel	18,061	19,797	19,005	20,825	---	20,825	SUM 3
Facilities services	99,783	113,190	112,353	124,971	-2,537	122,434	SUM 3
Technical services	42,059	42,288	40,806	47,496	-964	46,532	SUM 3
Management and operations support	64,850	62,449	65,560	73,871	-1,499	72,372	SUM 3
Total	933,808	964,900	1,006,186	1,047,154	-14,000	1,033,154	
Distribution of Budget Plan by Installation:							
Johnson Space Center	152,930	156,466	162,881	170,688	-2,255	168,433	RPM 1-3
Kennedy Space Center	123,314	128,149	131,861	141,385	-2,153	139,232	RPM 2-2
Marshall Space Flight Center	149,007	148,884	157,599	160,377	-2,073	158,304	RPM 3-3
National Space Technology Laboratories	4,488	4,689	4,899	5,108	-66	5,042	RPM 4-2
Goddard Space Flight Center	127,910	131,197	135,805	139,335	-1,760	137,575	RPM 5-3
Wallops Flight Center	15,806	16,330	17,085	18,977	-280	18,697	RPM 6-2
Ames Research Center	62,712	65,839	69,801	71,469	-919	70,550	RPM 7-3
Dryden Flight Research Center	19,068	19,791	21,702	21,681	-295	21,386	RPM 8-3
Langley Research Center	106,643	110,258	116,040	119,145	-1,540	117,605	RPM 9-3
Lewis Research Center	87,457	95,800	97,825	101,360	-1,304	100,056	RPM 10-3
Headquarters	84,473	87,497	90,688	97,629	-1,355	96,274	RPM 11-4
Total	933,808	964,900	1,006,186	1,047,154	-14,000	1,033,154	

BUDGET AMENDMENT

RESEARCH AND PROGRAM MANAGEMENT

FISCAL YEAR 1981 ESTIMATES

SUMMARY OF RESOURCES REQUIREMENTS BY FUNCTION

	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
	(Thousands of Dollars)			
Personnel and related costs	779,991	-9,000	770,991	SUM 2
Travel	20,825	---	20,825	SUM 3
Facilities services	124,971	-2,537	122,434	SUM 3
Technical services	47,496	-964	46,532	SUM 3
Management and operations support	73,871	-1,499	72,372	SUM 3
Total	1,047,154	-14,000	1,033,154	

EXPLANATION OF BUDGET AMENDMENT

Personnel and related costs	779,991	-9,000	770,991	SUM 5

The 1981 estimate for personnel and related costs was based on a civil service work force of 22,713 permanent positions to support the activities at ten NASA installations and Headquarters, consistent with the research and development and construction of facilities program plans. The 22,713 permanent positions include an increase of 100 positions over 1980. This increase is the final increment of the build-up related to Space Shuttle (75) and the full staffing of the Office of the NASA Inspector General (25).

To minimize the impact of the $9 million reduction on the planned personnel program and on the NASA installations, it is planned to accomplish the reduction by delaying the filling of civil service vacancies as they occur during the fiscal year. The reduction will be distributed among all NASA installations and Headquarters.

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	1981 Request Pending	1981 Budget Amendment	1981 Revised Request	Page No. (Jan Subm)
	(Thousands of Dollars)			
Travel	20,825	---	20,825	SUM 5

The 1981 estimate for travel primarily covers the travel costs of civil service personnel to contractor plants, launch and tracking sites, and meetings for the accomplishment and coordination of technical matters required to successfully support NASA's research and development programs. Due to the difficulties NASA is currently experiencing as a result of the Government-wide travel reduction implemented for FY 1980, and the recent increased costs of air fares, no reduction is planned in the 1981 estimates.

Facilities services	124,971	-2,537	122,434	SUM 5

To minimize the impact on facilities services, this reduction will be accomplished by deferring maintenance and related activities at NASA installations, and by delaying the purchase of materials, hardware and equipment used in facility maintenance activities. This reduction has presently been distributed to all NASA installations until such time as the overall maintenance and related activities can be reassessed.

Technical services	47,496	-964	46,532	SUM 5

The 1981 estimate for technical services provides for administrative automatic data processing equipment and operations; scientific and technical information and educational programs, which includes public affairs activities; and shop support and services such as general fabrication shops, reliability and quality assurance activities, safety, photographic services, graphics, and audio visual material. By delaying the planned purchases of supplies, materials and equipment to support these activities, and by distributing the reduction to each NASA installation and Headquarters, this reduction of $964,000 will be accomplished.

Management and operations support	73,871	-1,499	72,372	SUM 5

The management and operations support requirements for 1981 include the cost of administrative communications; printing and reproduction; administrative supplies; general purpose materials and equipment; transportation of equipment and supplies; medical services and other support. The reduction will be accomplished by delaying the purchases of materials and supplies necessary to support these types of activities.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED APPROPRIATION LANGUAGE

BUDGET AMENDMENT

Federal Funds

General and special funds:

RESEARCH AND DEVELOPMENT

*See Part III for additional information.

For necessary expenses, not otherwise provided for, including research, development, operations, services, minor construction, maintenance, repair, rehabilitation and modification of real and personal property; tracking and data relay satellite services as authorized by law; and purchase, hire, maintenance, and operation of other than administrative aircraft, necessary for the conduct and support of aeronautical and space research and development activities of the National Aeronautics and Space Administration[; and including not to exceed $116,100,000 for Project Galileo and not to exceed $18,300,000 for space transportation system upper stages, without the approval of the Committees on Appropriations, $3,807,500,000] ~~$4,649,500,000~~ to remain available until September 30, [1981] *1982. (42 U.S.C. 2451, et seq.; Department of Housing and Urban Development—Independent Agencies Appropriation Act, 1980; additional authorizing legislation to be proposed.)*

$4,364,500,000

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

PROPOSED APPROPRIATION LANGUAGE

BUDGET AMENDMENT

RESEARCH AND PROGRAM MANAGEMENT

For necessary expenses of research in government laboratories, management of programs and other activities of the National Aeronautics and Space Administration, not otherwise provided for, including uniforms or allowances therefor, as authorized by law (5 U.S.C. 5901–5902); awards; *purchase (for replacement only, of one aircraft, for which partial payment may be made by exchange of at least one existing administrative aircraft and such other existing aircraft as may be considered appropriate)* hire, maintenance and operation of administrative aircraft; purchase (not to exceed [thirty-two] *thirty-six* for replacement only) and hire of passenger motor vehicles; and maintenance and repair of real and personal property, and not in excess of $75,000 per project for construction of new facilities and additions to existing facilities, repairs, and rehabilitation and modification of facilities; [$959,900,000] ~~*$1,017,154,000.*~~ *Provided*, That contracts may be entered into under this appropriation for maintenance and operation of facilities, and for other services, to be provided during the next fiscal year: *Provided further*, That not to exceed $25,000 of the foregoing amount shall be available for scientific consultations or extraordinary expense, to be expended upon the approval or authority of the Administrator and his determination shall be final and conclusive. *(42 U.S.C. 2451, et seq.; Department of Housing and Urban Development—Independent Agencies Appropriation Act, 1980; additional authorizing legislation to be proposed.)*

$1,033,154,000

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND DEVELOPMENT
Amendment to Program and Financing (in thousands of dollars)

OMB Cir A-11
Sec 39

Identification Code:	Budget Plan			Costs and Obligations		
80-0108-0-1-999	1981 Estimate	1981 Estimate	1981 Estimate	1981 Estimate	1981 Estimate	1981 Estimate
Program by activities:	Request Pending	Proposed Amendment	Revised Request	Request Pending	Proposed Amendment	Revised Request
Direct program:						
1. Space transportation systems:						
(a) Space shuttle	1,873,000	---	1,873,000	1,947,000	---	1,947,000
(b) Space flight operations	809,500	-42,000	767,500	688,000	-62,000	626,000
(c) Expendable launch vehicle development and support	50,400	---	50,400	65,700	---	65,700
2. Scientific investigations in space:						
(a) Physics and astronomy	438,700	-92,100	346,600	387,400	-82,600	304,800
(b) Planetary exploration	179,600	-4,300	175,300	204,800	-4,300	200,500
(c) Life sciences	49,700	-10,600	39,100	38,500	-10,100	28,400
3. Space and terrestrial applications:						
(a) Space applications	387,000	-25,000	362,000	366,100	-17,000	349,100
(b) Technology utilization	13,100	-1,000	12,100	9,800	-1,000	8,800
4. Space research and technology	115,200	-5,000	110,200	114,300	-4,000	110,300
5. Aeronautical research and technology	290,300	-15,000	275,300	302,800	-12,000	290,800
6. Energy technology	4,000	---	4,000	4,100	---	4,100
7. Supporting activity:						
(a) Tracking and data acquisition	359,000	-10,000	349,000	355,900	-10,000	345,900
Total, direct program	4,569,500	-205,000	4,364,500	4,484,400	-203,000	4,281,400
Total, reimbursable program	571,000	---	571,000	571,000	---	571,000
Total program costs, funded	5,140,500	-205,000	4,935,500	5,055,400	-203,000	4,852,400
Change in selected resources (undelivered orders and stores)	---	---	---	85,100	-2,000	83,100
10.00 Total	5,140,500	-205,000	4,935,500	5,140,500	-205,000	4,935,500

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND DEVELOPMENT

Amendment to Program and Financing (in thousands of dollars)

OMB Cir A-11
Sec 39

Identification Code: 80-0108-0-1-999	Budget Plan			Costs and Obligations		
	1981 Estimate Request Pending	1981 Estimate Proposed Amendment	1981 Estimate Revised Request	1981 Estimate Request Pending	1981 Estimate Proposed Amendment	1981 Estimate Revised Request
Financing:						
Offsetting collections from:						
11.00 Federal funds	-478,563	---	-478,563	-478,563	---	-478,563
14.00 Non-Federal sources	-92,437	---	-92,437	-92,437	---	-92,437
40.00 budget authority (appropriation)	4,569,500	-205,000	4,364,500	4,569,500	-205,000	4,364,500
Relation of obligations to outlays:						
71.00 Obligations incurred, net				4,569,500	-205,000	4,364,500
72.40 Obligated balance, start of year				1,464,303	9,000	1,473,303
74.40 Obligated balance, end of year				-1,799,603	-7,000	-1,806,603
90.00 Outlays				4,234,200	-203,000	4,031,200

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Amended Program and Financing (in thousands of dollars)

OMB Cir A-11
Sec 32

RESEARCH AND DEVELOPMENT

Identification Code: 80-0108-0-1-999	Budget Plan (amounts for research and development actions programmed)			Costs and Obligations		
	1979 Actual	1980 Estimate	1981 Estimate	1979 Actual	1980 Estimate	1981 Estimate
Program by activities:						
Direct program:						
1. Space transportation systems:						
(a) Space shuttle	1,638,300	1,886,000*	1,873,000	1,588,332	1,851,000	1,947,000
(b) Space flight operations	299,700	446,600	767,500	307,039	412,100	626,000
(c) Expendable launch vehicle development and support	38,700	36,100	50,400	68,797	41,490	65,700
2. Scientific investigations in space:						
(a) Physics and astronomy	296,400	339,200	346,600	266,450	331,400	304,800
(b) Planetary exploration	183,400	219,900	175,300	189,501	209,300	200,500
(c) Life sciences	40,100	43,800	39,100	29,959	46,500	28,400
3. Space and terrestrial applications:						
(a) Space applications	295,200	364,300	362,000	277,342	362,110	349,100
(b) Technology utilization	9,100	12,100	12,100	7,571	9,800	8,800
4. Space research and technology	107,300	115,800	110,200	94,922	117,100	110,300
5. Aeronautical research and technology	264,100	308,300	275,300	244,275	276,700	290,800
6. Energy technology	5,000	3,000	4,000	6,887	3,700	4,100
7. Supporting activity:						
(a) Tracking and data acquisition	299,900	332,400	349,000	292,653	323,200	345,900
Total direct program	3,477,200	4,107,500*	4,364,500	3,373,728	3,984,400	4,281,400

*Includes proposed supplemental of $300,000,000 for Space Shuttle.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Amended Program and Financing (in thousands of dollars)

OMB Cir A-11
Sec 32

RESEARCH AND DEVELOPMENT

Identification Code:	Budget Plan (amounts for research and development actions programmed)			Costs and Obligations		
80-0108-0-1-999	1979 Actual	1980 Estimate	1981 Estimate	1979 Actual	1980 Estimate	1981 Estimate
Reimbursable program:						
1. Space transportation systems:						
(a) Space shuttle	46,673	22,820	16,120	29,299	25,990	17,990
(b) Space flight operations	72,762	91,660	157,590	62,579	84,940	144,350
2. Scientific investigations in space:						
(a) Physics and astronomy	1,234	610	510	1,617	790	540
(b) Planetary exploration	10	---	---	6	4	---
(c) Life sciences	297	233	180	255	230	198
3. Space and terrestrial applications:						
(a) Space applications	137,567	162,330	93,440	114,074	168,340	111,480
(b) Technology utilization	16,132	13,460	13,220	12,235	17,800	13,490
4. Space research and technology	1,055	-20	2	1,460	719	2
5. Aeronautical research and technology	19,763	12,240	9,870	19,998	15,750	10,600
6. Energy technology	196,311	224,430	275,400	134,489	213,370	267,670
7. Supporting activity:						
(a) Tracking and data acquisition	4,300	4,410	4,668	4,354	4,240	4,680
Total, reimbursable program	496,104	532,173	571,000	380,366	532,173	571,000
Total program costs, funded	3,973,304	4,639,673	4,935,500	3,754,094	4,516,573	4,852,400
Change in selected resources (undelivered orders and stores)	---	---	---	115,133	547,991	83,100
10.00 Total	3,973,304	4,639,673	4,935,500	3,869,227	5,064,564	4,935,500

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
RESEARCH AND DEVELOPMENT
Program and Financing (in thousands of dollars)

	Identification code 80-0108-0-1-999	Budget plan (amounts for research and development actions programed)			Costs and obligations		
		1979 actual	1980 est.	1981 est.	1979 actual	1980 est.	1981 est.
	Financing:						
	Offsetting collections from:						
11.00	Federal funds	-380,871	-412,130	-478,563	-380,871	-412,130	-478,563
14.00	Non-Federal sources	-115,233	-120,043	-92,437	-115,233	-120,043	-92,437
	Reallocation of prior year unobligated reimbursable orders to current year:						
11.00	Federal funds	---	---	---	25,552	---	---
14.00	Non-Federal sources	---	---	---	10,021	---	---
21.40	Unobligated balance available, start of year: For completion of prior year budget plans:						
	Direct	---	---	---	-240,403	-239,006	---
	Reimbursable	---	---	---	-116,945	-185,885	---
23.40	Unobligated balance transferred to other accounts	---	---	---	680	---	---
24.40	Unobligated balance available, end of year: For completion of prior year budget plans:..						
	Direct	---	---	---	239,006	---	---
	Reimbursable	---	---	---	185,885	---	---
25.00	Unobligated balance lapsing	---	---	---	282	---	---
40.00	Budget authority (appropriation)	3,477,200	4,107,500	4,364,500	3,477,200	4,107,500	4,364,500
	Relation of obligations to outlays:						
71.00	Obligations incurred, net				3,408,696	4,532,391	4,364,500
72.40	Obligated balance, start of year				515,865	785,812	1,473,303
74.40	Obligated balance, end of year				-785,812	-1,473,303	-1,806,603
90.00	Outlays				3,138,749	3,844,900	4,031,200

Note--Reconciliation of budget plan to obligations:

	1979 actual	1980 estimate	1981 estimate
Total budget plan	3,973,304	4,639,673	4,935,500
Deduct portion of budget plan to be obligated in subsequent years	348,368	---	---
Add obligations of prior year budget plans	244,292	424,891	---
Total obligations	3,869,227	5,064,564	4,935,500

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

Amendment to Program and Financing (in thousands of dollars)

OMB Cir A-11
Sec 39

Identification Code: 80-0107-0-1-999	Budget Plan (amounts for construction of facilities actions programmed)			Costs and Obligations		
	1981 Estimate	1981 Estimate	1981 Estimate	1981 Estimate	1981 Estimate	1981 Estimate
Program by activities:	Request Pending	Proposed Amendment	Revised Request	Request Pending	Proposed Amendment	Revised Request
Direct program:						
5. Aeronautical research and technology	45,291	---	45,291	61,300	-2,400	58,900
7. Supporting activity	62,992	---	62,992	58,400	-6,200	52,200
All other activities	11,717	---	11,717	33,600	---	33,600
Total direct program	120,000	---	120,000	153,300	-8,600	144,700
Total reimbursable program	11,000	---	11,000	13,200	---	13,200
Total program costs, funded	131,000	---	131,000	166,500	-8,600	157,900
Change in selected resources (undelivered orders)	---	---	---	-10,600	8,600	-2,000
10.00 Total	131,000	---	131,000	155,900	---	155,900
Financing:						
11.00 Offsetting collections from Federal funds	-11,000	---	-11,000	-11,000	---	-11,000
21.40 Unobligated balance available, start of year: For completion of prior year budget plans:						
Direct				-88,601	---	88,601
Reimbursable				-4,276	---	-4,276
24.40 Unobligated balance available, end of year: For completion of prior year budget plans:						
Direct				65,201	---	65,201
Reimbursable				2,776	---	2,776
40.00 Budget authority (appropriation)	120,000	---	120,000	120,000	---	120,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

OMB Cir A-11
Sec 39

Amendment to Program and Financing (in thousands of dollars)

Identification Code:	Budget Plan (amounts for construction of facilities actions programmed)			Costs and Obligations		
80-0107-0-1-999	1981 Estimate	1981 Estimate	1981 Estimate	1981 Estimate	1981 Estimate	1981 Estimate
Financing:	Request Pending	Proposed Amendment	Revised Request	Request Pending	Proposed Amendment	Revised Request
Relation of obligations to outlays:						
71.00 Obligations incurred, net				144,900	---	144,900
72.40 Obligated balance, start of year				146,035	1,000	147,035
74.40 Obligated balance, end of year				-127,935	-8,000	-135,935
90.00 Outlays				163,000	-7,000	156,000

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Amended Program and Financing (in thousands of dollars)

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CONSTRUCTION OF FACILITIES

Identification Code: 80-0107-0-1-999	Budget Plan (amounts for construction of facilities actions programmed)			Costs and Obligations		
	1979 Actual	1980 Estimate	1981 Estimate	1979 Actual	1980 Estimate	1981 Estimate
Program by activities:						
Direct program:						
1. Space transportation systems	31,070	27,750	10,100	41,029	43,600	29,700
2. Scientific investigations in space.	---	4,250	1,617	5,215	2,800	3,400
3. Space and terrestrial applications.	---	---	---	2,225	800	500
4. Space research and technology	---	---	---	116	---	---
5. Aeronautical research and technology	76,530	62,500	45,291	43,047	69,300	58,900
7. Supporting activity	39,900	61,600	62,992	45,366	48,100	52,200
Total direct program	147,500	156,100	120,000	136,998	164,600	144,700
Reimbursable program:						
1. Space transportation systems	251	12,000	2,000	251	3,636	7,700
5. Aeronautical research and technology	1,550	1,600	4,000	5	2,030	2,000
7. Supporting activity	923	3,400	5,000	5,034	4,934	3,500
Total reimbursable program	2,724	17,000	11,000	5,290	10,600	13,200
Total program costs, funded	---	---	---	142,288	175,200	157,900
Change in selected resources (undelivered orders)	---	---	---	4,658	3,200	-2,000
10.00 Total	150,224	173,100	131,000	146,946	178,400	155,900
Financing:						
11.00 Offsetting collections from Federal funds	-2,724	-17,000	-11,000	-2,724	-17,000	-11,000
21.40 Unobligated balance available, start of year: For completion of prior year budget Plans:						
Direct	---	---	---	-93,356	-95,501	-88,601
Reimbursable	---	---	---	-823	-2,676	-4,276

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Amended Program and Financing (in thousands of dollars)

OMB Cir A-11
Sec 39

CONSTRUCTION OF FACILITIES

Identification Code: 80-0107-0-1-999	Budget Plan (amounts for construction of facilities actions programmed)			Costs and Obligations		
	1979 Actual	1980 Estimate	1981 Estimate	1979 Actual	1980 Estimate	1981 Estimate
Program by activities:						
Financing:						
22.40 Unobligated balance transferred from other accounts	---	---	---	-680	---	---
24.40 Unobligated balance available, end of year: For completion of prior year budget plans:						
Direct	---	---	---	95,501	88,601	65,201
Reimbursable	---	---	---	2,676	4,276	2,776
25.00 Unobligated balance lapsing	---	---	---	63	---	---
Unobligated balance restored	---	---	---	-103	---	---
40.00 Budget authority (appropriation)	147,500	156,100	120,000	147,500	156,100	120,000
Relation of obligations to outlays:						
71.00 Obligations incurred, net				144,222	161,400	144,900
72.40 Obligated balance, start of year				128,061	139,535	147,035
74.40 Obligated balance, end of year				-139,535	-147,035	-135,935
77.00 Adjustments in expired accounts				-32	---	---
90.00 Outlays				132,716	153,900	156,000

Note--Reconciliation of budget plan to obligations:

	1979 actual	1980 est.	1981 est.
Total budget plan	150,224	173,100	131,000
Deduct portion of budget plan to be obligated in subsequent years	62,885	54,200	32,600
Add obligations of prior year budget plans	59,607	59,500	57,500
Total obligations	146,946	178,400	155,900

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Amendment to Program and Financing (in thousands of dollars)
RESEARCH AND PROGRAM MANAGEMENT

OMB Cir A-11
Sec 39

Identification Code:	Budget Plan			Costs and Obligations		
80-0103-0-1-999	1981 Estimate	1981 Estimate	1981 Estimate	1981 Estimate	1981 Estimate	1981 Estimate
Program by activities: Direct program:	Request Pending	Proposed Amendment	Revised Request	Request Pending	Proposed Amendment	Revised Request
1. Space transportation systems	435,154	-5,800	429,354	435,154	-5,800	429,354
2. Scientific investigations in space	120,300	-1,600	118,700	120,300	-1,600	118,700
3. Space and terrestrial applications	133,000	-1,800	131,200	133,000	-1,800	131,200
4. Space research and technology	79,300	-1,100	78,200	79,300	-1,100	78,200
5. Aeronautical research and technology	207,700	-2,800	204,900	207,700	-2,800	204,900
6. Energy technology	30,400	-400	30,000	30,400	-400	30,000
7. Supporting activity	41,300	-500	40,800	41,300	-500	40,800
Total direct program	1,047,154	-14,000	1,033,154	1,047,154	-14,000	1,033,154
Total reimbursable program	32,000	---	32,000	32,000	---	32,000
10.00 Total	1,079,154	-14,000	1,065,154	1,079,154	-14,000	1,065,154
Financing: Offsetting collections from:						
11.00 Federal funds				-30,015	---	-30,015
14.00 Non-Federal sources				-1,985	---	-1,985
40.00 Budget authority (Appropriation)				1,047,154	-14,000	1,033,154
Relation of obligations to outlays:						
71.00 Obligations incurred, net				1,047,154	-14,000	1,033,154
72.40 Obligated balance, start of year				83,184	---	83,184
74.40 Obligated balance, end of year				-87,838	---	-87,838
90.00 Outlays, excluding pay raise supplemental				1,041,264	-14,000	1,027,264
91.20 Outlays, from civilian pay raise supplemental				1,236	---	1,236

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Amended Program and Financing (in thousands of dollars)
RESEARCH AND PROGRAM MANAGEMENT

OMB Cir A-11
Sec 32

Identification Code: 80-0103-0-1-999	Budget Plan			Costs and Obligations		
	1979 Actual	1980 Estimate	1981 Estimate	1979 Actual	1980 Estimate	1981 Estimate
Program by activities:						
Direct program:						
1. Space transportation systems	389,638	415,886	429,354	390,823	415,886	429,354
2. Scientific investigations in space.	120,113	115,900	118,700	120,014	115,900	118,700
3. Space and terrestrial applications.	110,451	128,700	131,200	107,252	128,700	131,200
4. Space research and technology	67,572	74,600	78,200	66,927	74,600	78,200
5. Aeronautical research and technology	178,474	199,500	204,900	176,615	199,500	204,900
6. Energy technology	24,439	28,300	30,000	24,409	28,300	30,000
7. Supporting activity	43,121	43,300	40,800	43,053	43,300	40,800
Total direct program	933,808	1,006,186	1,033,154	929,093	1,006,186	1,033,154
Reimbursable program:						
1. Space transportation systems	1,131	1,440	1,700	1,125	1,440	1,700
2. Scientific investigations in space.	105	50	50	105	50	50
3. Space and terrestrial applications.	5,008	7,780	4,180	4,980	7,780	4,180
5. Aeronautical research and technology	762	440	390	760	440	390
6. Energy technology	14,849	14,960	12,890	14,770	14,960	12,890
7. Supporting activity	11,818	11,330	12,790	11,749	11,330	12,790
Total reimbursable program	33,673	36,000	32,000	33,489	36,000	32,000
Total program costs, funded				962,582	1,042,186	1,065,154
Change in selected resources (undelivered orders)				4,899	---	---
10.00 Total	967,481	1,042,186	1,065,154	967,481	1,042,186	1,065,154

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
Amended Program and Financing (in thousands of dollars)
RESEARCH AND PROGRAM MANAGEMENT

OMB Cir A-11
Sec 32

Identification Code: 80-0103-0-1-999	Budget Plan			Costs and Obligations		
	1979 Actual	1980 Estimate	1981 Estimate	1979 Actual	1980 Estimate	1981 Estimate
Financing:						
Offsetting collections from:						
11.00 Federal funds				-27,887	-28,672	-30,015
14.00 Non-Federal sources				-5,786	-7,328	-1,985
25.00 Unobligated balance lapsing				261	---	---
Budget authority				934,069	1,006,186	1,033,154
Budget authority:						
40.00 Appropriation				936,469	959,900	1,033,154
40.01 Appropriation rescinded (Public Law 96-7, 92 Stat 798)				-2,400	---	---
43.00 Appropriation (adjusted)				934,069	959,900	1,033,154
44.20 Supplemental for civilian pay raises				---	46,286	---
Relation of obligations to outlays:						
71.00 Obligations incurred, net				933,808	1,006,186	1,033,154
72.40 Obligated balance, start of year				74,276	80,798	83,184
74.40 Obligated balance, end of year				-80,798	-83,184	-87,838
77.00 Adjustments in expired accounts				-2,279	---	---
90.00 Outlays, excluding pay raise supplemental				925,007	958,750	1,027,264
91.20 Outlays from civilian pay raise supplemental				---	45,050	1,236

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
RESEARCH AND DEVELOPMENT
AMENDED OBJECT CLASSIFICATION (in thousands of dollars)

OMB Cir. A-11
Sec. 39

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Identification code 80-0108-0-1-999	1981 estimate	1981 estimate	1981 estimate
	Request Pending	Proposed Amendment	Revised Request
Direct obligations:			
~~11.1 Permanent positions~~			
~~11.3 Positions other than permanent~~			
~~11.5 Other personnel compensation~~			
~~11.8 Special personal services payments~~			
~~Total personnel compensation~~			
Personnel benefits:			
~~12.1 Civilian~~			
~~13.0 Benefits for former personnel~~			
~~21.0 Travel and transportation of persons~~			
22.0 Transportation of things	11,860	-530	11,330
23.1 Standard level user charges	283	---	283
23.2 Communications, utilities, and other rent	59,917	-2,690	57,227
24.0 Printing and reproduction	2,870	-120	2,750
25.0 Other services	4,208,880	-188,930	4,019,950
26.0 Supplies and materials	177,580	-7,970	169,610
31.0 Equipment	105,760	-4,760	101,000
32.0 Lands and structures	1,150	---	1,150
~~33.0 Investments and loans~~			
41.0 Grants, subsidies, and contributions	1,200	---	1,200
~~42.0 Insurance claims and indemnities~~			
~~43.0 Interest and dividends~~			
~~44.0 Refunds~~			
99.0 Total obligations	4,569,500	-205,000	4,364,500

* U.S. GOVERNMENT PRINTING OFFICE : 1980 O—330-332

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
RESEARCH AND DEVELOPMENT
AMENDED OBJECT CLASSIFICATION (in thousands of dollars)

OMB Cir. A-11
Sec. 39

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Identification code 80-0108-0-1-999	1981 estimate Request Pending	1981 estimate Proposed Amendment	1981 estimate Revised Request
Reimbursable obligations:			
~~11.1 Permanent positions~~			
~~11.3 Positions other than permanent~~			
~~11.5 Other personnel compensation~~			
~~11.8 Special personal services payments~~			
~~Total personnel compensation~~			
Personnel benefits:			
~~12.1 Civilian~~			
~~13.0 Benefits for former personnel~~			
~~21.0 Travel and transportation of persons~~			
22.0 Transportation of things	720	---	720
~~23.1 Standard level user charges~~			
23.2 Communications, utilities, and other rent	1,850	---	1,850
24.0 Printing and reproduction	180	---	180
25.0 Other services	548,970	---	548,970
26.0 Supplies and materials	10,230	---	10,230
31.0 Equipment	8,470	---	8,470
32.0 Lands and structures	580	---	580
~~33.0 Investments and loans~~			
~~41.0 Grants, subsidies, and contributions~~			
~~42.0 Insurance claims and indemnities~~			
~~43.0 Interest and dividends~~			
~~44.0 Refunds~~			
Total reimbursable obligations	571,000	---	571,000
99.0 Total obligations	5,140,500	-205,000	4,935,500

* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—350-865

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304-103

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
RESEARCH AND DEVELOPMENT
AMENDED OBJECT CLASSIFICATION (in thousands of dollars)

OMB Cir. A-11
Sec. 34

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Identification code 80-0108-0-1-999	1979 actual	1980 estimate	1981 estimate
Direct obligations:			
11.1 Permanent positions			
11.3 Positions other than permanent			
11.5 Other personnel compensation			
11.8 Special personal services payments			
Total personnel compensation			
Personnel benefits:			
12.1 Civilian			
13.0 Benefits for former personnel			
21.0 Travel and transportation of persons			
22.0 Transportation of things	9,249	8,807	11,330
23.1 Standard level user charges	177	209	283
23.2 Communications, utilities, and other rent	46,747	58,430	57,227
24.0 Printing and reproduction	2,235	2,790	2,750
25.0 Other services	3,196,540	3,998,100	4,019,950
26.0 Supplies and materials	138,421	173,010	169,610
31.0 Equipment	82,438	103,030	101,000
32.0 Lands and structures	900	1,050	1,150
33.0 Investments and loans			
41.0 Grants, subsidies, and contributions	929	1,080	1,200
42.0 Insurance claims and indemnities			
43.0 Interest and dividends			
44.0 Refunds			
99.0 Total direct obligations	3,477,636	4,346,506	4,364,500

* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—338-933

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304-103

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
RESEARCH AND DEVELOPMENT
AMENDED OBJECT CLASSIFICATION (in thousands of dollars)

OMB Cir. A-11
Sec. 34

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Identification code 80-0108-0-1-999	1979 actual	1980 estimate	1981 estimate
Reimbursable obligations:			
11.1 Permanent positions			
11.3 Positions other than permanent			
11.5 Other personnel compensation			
11.8 Special personal services payments			
Total personnel compensation			
Personnel benefits:			
12.1 Civilian			
13.0 Benefits for former personnel			
21.0 Travel and transportation of persons			
22.0 Transportation of things	494	910	720
23.1 Standard level user charges			
23.2 Communications, utilities, and other rent	1,269	2,330	1,850
24.0 Printing and reproduction	125	230	180
25.0 Other services	376,476	690,338	548,970
26.0 Supplies and materials	7,016	12,860	10,230
31.0 Equipment	5,811	10,660	8,470
32.0 Lands and structures	400	730	580
33.0 Investments and loans			
41.0 Grants, subsidies, and contributions			
42.0 Insurance claims and indemnities			
43.0 Interest and dividends			
44.0 Refunds			
Total reimbursable obligations	391,591	718,058	571,000
99.0 Total obligations	3,869,227	5,064,564	4,935,500

* U.S. GOVERNMENT PRINTING OFFICE : 1980 O—330-692

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304-103

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
RESEARCH AND PROGRAM MANAGEMENT
AMENDED OBJECT CLASSIFICATION (in thousands of dollars)

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Sec 39

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Identification code 80-0103-0-1-999	1981 estimate	1981 estimate	1981 estimate
Direct obligations:			
Personnel compensation:	Request Pending	Proposed Amendment	Revised Request
11.1 Permanent positions	682,623	-8,189	674,434
11.3 Positions other than permanent	11,541	---	11,541
11.5 Other personnel compensation	8,918	---	8,918
11.8 Special personal services payments	2,958	---	2,958
Total personnel compensation	706,040	-8,189	697,851
12.1 Personnel benefits: Civilian	67,561	-811	66,750
13.0 Benefits for former personnel	46	---	46
21.0 Travel and transportation of persons	20,825	---	20,825
22.0 Transportation of things	2,592	---	2,592
23.1 Standard level user charges	5,927	---	5,927
23.2 Communications, utilities and other rent	75,541	---	75,541
24.0 Printing and reproduction	7,874	---	7,874
25.0 Other services	139,186	-4,334	134,852
26.0 Supplies and materials	16,468	-513	15,955
31.0 Equipment	4,920	-153	4,767
32.0 Lands and structures	70	---	70
~~33.0 Investments and loans~~			
41.0 Grants, subsidies, and contributions	99	---	99
42.0 Insurance claims and indemnities	5	---	5
~~43.0 Interest and dividends~~			
~~44.0 Refunds~~			
99.0 Total direct obligations	1,047,154	-14,000	1,033,154

* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—330-992

STANDARD FORM 304
May 1969, Bureau of the Budget
Circular No. A-11, Revised.
304-103

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
RESEARCH AND PROGRAM MANAGEMENT
AMENDED OBJECT CLASSIFICATION (in thousands of dollars)

OMB Cir A-11
Sec 39

71

Identification code 80-0103-0-1-999	1981 estimate Request Pending	1981 estimate Proposed Amendment	1981 estimate Revised Request
Reimbursable obligations: Personnel compensation:			
11.1 Permanent positions	15,312	---	15,312
~~11.3 Positions other than permanent~~			
11.5 Other personnel compensation	156	---	156
~~11.8 Special personal services payments~~			
Total personnel compensation	15,468	---	15,468
12.1 Personnel benefits: Civilian	1,805	---	1,805
~~13.0 Benefits for former personnel~~			
21.0 Travel and transportation of persons	2,849	---	2,849
~~22.0 Transportation of things~~			
~~23.1 Standard level user charges~~			
23.2 Communications, utilities and other rent	5 098	---	5,098
24.0 Printing and reproduction	33	---	33
25.0 Other services	5,962	---	5,962
26.0 Supplies and materials	561	---	561
31.0 Equipment	224	---	224
~~32.0 Lands and structures~~			
~~33.0 Investments and loans~~			
~~41.0 Grants, subsidies, and contributions~~			
~~42.0 Insurance claims and indemnities~~			
~~43.0 Interest and dividends~~			
~~44.0 Refunds~~			
Total reimbursable obligations	32,000	---	32,000
99.0 Total obligations	1,079,154	-14,000	1,065,154

* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—339-455

STANDARD FORM 304
May 1969, Bureau of the Budget
Circular No. A-11, Revised.
304-103

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
RESEARCH AND PROGRAM MANAGEMENT
AMENDED OBJECT CLASSIFICATION (in thousands of dollars)

OMB Cir A-11
Sec 34

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Identification code 80-0103-0-1-999		1979 actual	1980 estimate	1981 estimate
	Direct obligations:			
	Personnel compensation:			
11.1	Permanent positions	626,314	674,184	674,434
11.3	Positions other than permanent	8,577	11,125	11,541
11.5	Other personnel compensation	5,194	8,649	8,918
11.8	Special personal services payments	2,385	2,955	2,958
	Total personnel compensation	642,470	696,913	697,851
12.1	Personnel benefits: Civilian	62,303	66,044	66,750
13.0	Benefits for former personnel	100	106	46
21.0	Travel and transportation of persons	18,061	19,005	20,825
22.0	Transportation of things	2,887	2,427	2,592
23.1	Standard level user charges	5,067	5,511	5,927
23.2	Communications, utilities, and other rent	59,052	71,799	75,541
24.0	Printing and reproduction	5,800	5,754	7,874
25.0	Other services	115,133	119,606	134,852
26.0	Supplies and materials	16,062	16,474	15,955
31.0	Equipment	6,601	2,373	4,767
32.0	Lands and structures	182	70	70
~~33.0~~	~~Investments and loans~~			
41.0	Grants, subsidies, and contributions	74	99	99
42.0	Insurance claims and indemnities	16	5	5
~~43.0~~	~~Interest and dividends~~			
~~44.0~~	~~Refunds~~			
99.0	Total direct obligations	933,808	1,006,186	1,033,154

* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—339-662

STANDARD FORM 304
May 1969, Bureau of the Budget
Circular No. A-11, Revised. NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
304-103 RESEARCH AND PROGRAM MANAGEMENT OMB Cir A-11
AMENDED OBJECT CLASSIFICATION (in thousands of dollars) Sec 34 73

Identification code 80-0103-0-1-999	19 79 actual	19 80 estimate	19 81 estimate
Reimbursable obligations:			
Personnel compensation:			
11.1 Permanent positions	17,738	17,556	15,312
~~11.3 Positions other than permanent~~			
11.5 Other personnel compensation	312	183	156
~~11.8 Special personal services payments~~			
Total personnel compensation	18,050	17,739	15,468
12.1 Personnel benefits: Civilian	2,063	2,088	1,805
~~13.0 Benefits for former personnel~~			
21.0 Travel and transportation of persons	2,884	3,186	2,849
22.0 Transportation of things	96	---	---
~~23.1 Standard level user charges~~			
23.2 Communications, utilities, and other rent	4,532	4,744	5,098
24.0 Printing and reproduction	41	33	33
25.0 Other services	5,119	7,243	5,962
26.0 Supplies and materials	739	587	561
31.0 Equipment	140	380	224
~~32.0 Lands and structures~~			
~~33.0 Investments and loans~~			
~~41.0 Grants, subsidies, and contributions~~			
42.0 Insurance claims and indemnities	9	---	---
~~43.0 Interest and dividends~~			
~~44.0 Refunds~~			
Total reimbursable obligations	33,673	36,000	32,000
99.0 Total obligations	967,481	1,042,186	1,065,154

* U.S. GOVERNMENT PRINTING OFFICE : 1969 O—336-434

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND PROGRAM MANAGEMENT

AMENDMENT TO PERSONNEL SUMMARY

	1981 estimate Pending Request	1981 estimate Proposed Amendment	1981 estimate Revised Request
Total number of permanent positions	22,713	---	22,713
Total compensable workyears	24,061	-233	23,828
Full-time equivalent of other positions	(1,214)	---	(1,214)
Full-time equivalent of overtime and holiday hours	(135)	---	(135)
Average ES salary	$50,034	---	$50,034
Average GS grade	11.20	---	11.20
Average GS salary	$30,478	---	$30,478
Average salary, grades established by the Administrator, NASA	$45,626	---	$45,626
Average salary of ungraded positions	$23,561	---	$23,561

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND PROGRAM MANAGEMENT

AMENDED PERSONNEL SUMMARY

	1979 actual	1980 estimate	1981 estimate
Total number of permanent positions	22,831	22,613	22,713
Total compensable workyears	24,127	24,025	23,828
Full-time equivalent of other positions	(976)	(1,174)	(1,214)
Full-time equivalent of overtime and holiday hours	(135)	(135)	(135)
Average ES salary	$44,391	$50,034	$50,034
Average GS grade	11.18	11.20	11.20
Average GS salary	$28,213	$30,327	$30,478
Average salary, grades established by the Administrator, NASA	$42,801	$45,626	$45,626
Average salary of ungraded positions	$21,637	$23,335	$23,561

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND DEVELOPMENT

BUDGET AUTHORITY AND OUTLAYS BY SUBFUNCTION

Code			FY 1979	FY 1980	FY 1981 Request Pending	FY 1981 Proposed Amendment	FY 1981 Revised Request
			(Thousands of Dollars)				
253	Space Flight	BA	2,011,600	2,403,300*	2,738,200	-42,000	2,696,200
		O	1,789,055	2,287,000*	2,547,600	-62,000	2,485,600
254	Space Science, Applications and Technology	BA	901,600	1,063,500	1,182,000	-138,000	1,044,000
		O	825,330	965,400	1,068,400	-119,000	949,400
255	Supporting Space Activities	BA	299,900	332,400	359,000	-10,000	349,000
		O	292,841	325,100	340,400	-10,000	330,400
402	Air Transportation	BA	264,100	308,300	290,300	-15,000	275,300
		O	231,523	267,400	277,800	-12,000	265,800
	Total	BA	3,477,200	4,107,500*	4,569,500	-205,000	4,364,500
		O	3,138,749	3,844,900*	4,234,200	-203,000	4,031,200

*Includes proposed supplemental of $300,000,000 and outlays of $200,000,000 for Space Shuttle.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

CONSTRUCTION OF FACILITIES

BUDGET AUTHORITY AND OUTLAYS BY SUBFUNCTION

Code			FY 1979	FY 1980	FY 1981 Request Pending	FY 1981 Proposed Amendment	FY 1981 Revised Request
					(Thousands of Dollars)		
253	Space Flight	BA	31,070	27,750	10,100	---	10,100
		O	41,323	42,800	32,400	---	32,400
254	Space Science, Applications and Technology	BA	---	4,250	1,617	---	1,617
		O	8,677	3,800	4,100	---	4,100
255	Supporting Space Activities	BA	39,900	61,600	62,992	---	62,992
		O	47,745	44,900	56,700	-5,000	51,700
402	Air Transportation	BA	76,530	62,500	45,291	---	45,291
		O	34,971	62,400	69,800	-2,000	67,800
	Total	BA	147,500	156,100	120,000	---	120,000
		O	132,716	153,900	163,000	-7,000	156,000

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

RESEARCH AND PROGRAM MANAGEMENT

BUDGET AUTHORITY AND OUTLAYS BY SUBFUNCTION

Code			FY 1979	FY 1980	FY 1981 Request Pending	FY 1981 Proposed Amendment	FY 1981 Revised Request
					(Thousands of Dollars)		
253	Space Flight	BA	389,899	415,886	435,154	-5,800	429,354
		O	386,380	415,300	433,000	-5,800	427,200
254	Space Science, Applications and Technology	BA	322,575	347,500	363,000	-4,900	358,100
		O	319,083	346,600	361,300	-4,900	356,400
255	Supporting Space Activities	BA	43,121	43,300	41,300	-500	40,800
		O	42,702	43,400	41,500	-500	41,000
402	Air Transportation	BA	178,474	199,500	207,700	-2,800	204,900
		O	176,842	198,500	206,700	-2,800	203,900
	Total	BA	934,069	1,006,186*	1,047,154	-14,000	1,033,154
		O	925,007	1,003,800*	1,042,500	-14,000	1,028,500

*Includes proposed supplemental of $46,286,000 and outlays of $45,050,000 for October 1979 pay increase.

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