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1973 NASA AUTHORIZATION

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HEARINGS BEFORE THE COMMITTEE ON SCIENCE AND ASTRONAUTICS U.S. HOUSE OF REPRESENTATIVES NINETY-SECOND CONGRESS

SECOND SESSION

ON

H.R. 12824
(Superseded by H.R. 14070)

FEBRUARY 8; MARCH 17, 1972

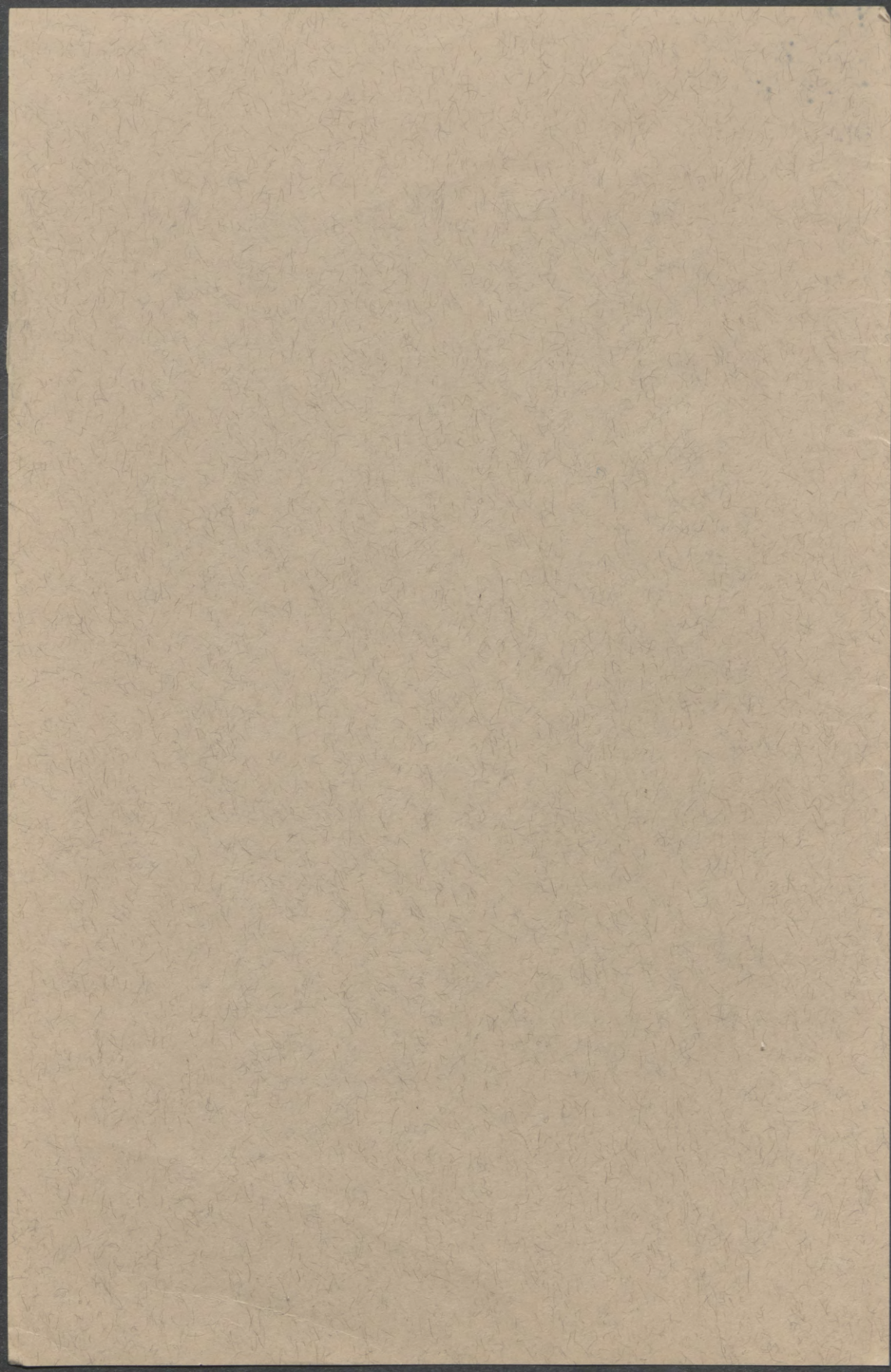
[No. 15]

PART 1

Printed for the use of the Committee on Science and Astronautics



1973 NASA AUTHORIZATION—PART 1



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BEFORE THE
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SCIENCE AND ASTRONAUTICS
U.S. HOUSE OF REPRESENTATIVES
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PART 1

Printed for the use of the Committee on Science and Astronautics



U.S. GOVERNMENT PRINTING OFFICE
WASHINGTON : 1972

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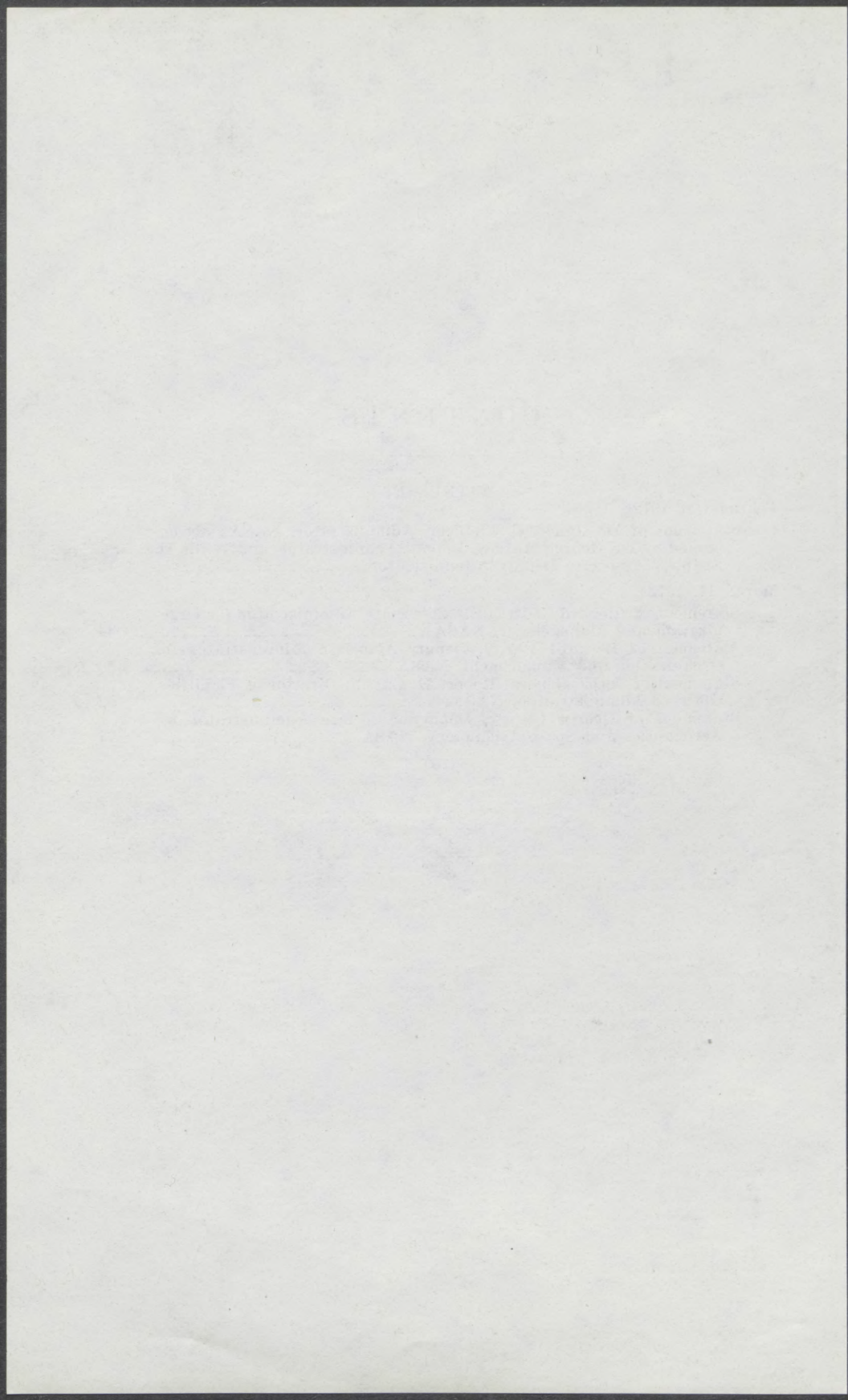
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1973 NASA AUTHORIZATION

TUESDAY, FEBRUARY 8, 1972

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

The committee met, pursuant to notice, in room 2318, Rayburn House Office Building, the Hon. George P. Miller (chairman of the committee) presiding.

The CHAIRMAN. Members of the committee, this is the first meeting of the full committee in this session, and we will now receive a briefing from Dr. Fletcher and his colleagues on the NASA budget for fiscal year 1973.

So the record may be complete, at this time I ask unanimous consent that there be inserted in the record at this point a copy of the authorization bill (H.R. 12824) now under consideration by the committee, and a copy of the NASA Administrator's letter transmitting the bill to the Congress.

(H.R. 12824 and NASA Administrator's letter are as follows:)

[H.R. 12824, 92d Cong., second sess.]

A BILL To authorize appropriations to the National Aeronautics and Space Administration for research and development, construction of facilities, and research and program management, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there is hereby authorized to be appropriated to the National Aeronautics and Space Administration:

- (a) For "Research and development," for the following programs:
 - (1) Apollo, \$128,700,000;
 - (2) Space flight operations, \$1,094,200,000;
 - (3) Advanced missions, \$1,500,000;
 - (4) Physics and astronomy, \$156,600,000;
 - (5) Lunar and planetary exploration, \$321,200,000;
 - (6) Launch vehicle procurement, \$191,600,000;
 - (7) Space applications, \$194,700,000;
 - (8) Aeronautical research and technology, \$163,440,000;
 - (9) Space research and technology, \$64,760,000;
 - (10) Nuclear power and propulsion, \$21,100,000;
 - (11) Tracking and data acquisition, \$259,100,000;
 - (12) Technology utilization, \$4,000,000.
- (b) For "Construction of facilities," including land acquisition, as follows:
 - (1) Rehabilitation and modification of aeronautical, airborne science, and support facilities, Ames Research Center, \$1,065,000;
 - (2) Rehabilitation of Unitary Plan wind tunnel model supports, control systems, and model preparation areas, Ames Research Center, \$760,000;
 - (2) Rehabilitation and modification of utility systems, Goddard Space Flight Center, \$590,000;
 - (4) Rehabilitation and modification of roadway system, Jet Propulsion Laboratory, \$610,000;

(5) Modifications of, and additions to, spacecraft assembly facilities, Kennedy Space Center, \$8,100,000;

(6) Modification of Titan Centaur, facilities, Kennedy Space Center, \$2,040,000;

(7) Rehabilitation of Full Scale Wind Tunnel, Langley Research Center, \$2,465,000;

(8) Modification of central air supply system, Langley Research Center, \$1,175,000;

(9) Environmental modifications for utility operations, Langley Research Center, \$650,000;

(10) Modification of high temperature and high pressure turbine and combustor research facility, Lewis Research Center, \$9,710,000;

(11) Modification of fire protection system, Manned Spacecraft Center, \$585,000;

(12) Warehouse replacement, Wallops Station, \$350,000;

(13) Space Shuttle facilities at various locations, \$27,900,000;

(14) Rehabilitation and modification of facilities at various locations, not in excess of \$500,000 per project, \$11,580,000;

(15) Minor construction of new facilities and additions to existing facilities at various locations, not in excess of \$250,000 per project, \$1,720,000;

(16) Facility planning and design not otherwise provided for, \$8,000,000

(c) For "Research and program management," \$700,800,000.

(d) Notwithstanding the provisions of subsection 1(g), appropriations for "Research and development" may be used (1) for any items of a capital nature (other than acquisition of land) which may be required at locations other than installations of the Administration for the performance of research and development contracts, and (2) for grants to nonprofit institutions of higher education, or to nonprofit organizations whose primary purpose is the conduct of scientific research, for purchase or construction of additional research facilities; and title to such facilities shall be vested in the United States unless the Administrator determines that the national program of aeronautical and space activities will best be served by vesting title in any such grantee institution or organization. Each such grant shall be made under such conditions as the Administrator shall determine to be required to insure that the United States will receive therefrom benefit adequate to justify the making of that grant. None of the funds appropriated for "Research and development" pursuant to this Act may be used in accordance with this subsection for the construction of any major facility, the estimated cost of which, including collateral equipment, exceeds \$250,000, unless the Administrator or his designee has notified the Speaker of the House of Representatives and the President of the Senate and the Committee on Science and Astronautics of the House of Representatives and the Committee on Aeronautical and Space Sciences of the Senate of the nature, location, and estimated cost of such facility.

(e) When so specified in an appropriation Act, (1) any amount appropriated for "Research and development" or for "Construction of facilities" may remain available without fiscal year limitation, and (2) maintenance and operation of facilities, and support services contracts may be entered into under the "Research and program management" appropriation for periods not in excess of twelve months beginning at any time during the fiscal year.

(f) Appropriations made pursuant to subsection 1(c) may be used, but not to exceed \$35,000, for scientific consultations or extraordinary expenses upon the approval or authority of the Administrator and his determination shall be final and conclusive upon the accounting officers of the Government.

(g) Of the funds appropriated pursuant to subsections 1(a) and 1(c), not in excess of \$10,000 for each project, including collateral equipment, may be used for construction of new facilities and additions to existing facilities, and not in excess of \$25,000 for each project, including collateral equipment, may be used for rehabilitation or modification of facilities: *Provided*, That of the funds appropriated pursuant to subsection 1(a), not in excess of \$250,000 for each project, including collateral equipment, may be used for any of the foregoing for unforeseen programmatic needs.

(h) No part of the funds appropriated pursuant to subsection (a) of this section may be used for grants to any nonprofit institution of higher learning unless the Administrator or his designee determines at the time of the grant that recruiting personnel of any of the Armed Forces of the United States are not being barred from the premises or property of such institution except that

this subsection shall not apply if the Administrator or his designee determines that the grant is a continuation or renewal of a previous grant to such institution which is likely to make a significant contribution to the aeronautical and space activities of the United States. The Secretary of Defense shall furnish to the Administrator or his designee within sixty days after the date of enactment of this Act and each January 30 and June 30 thereafter the names of any nonprofit institutions of higher learning which the Secretary of Defense determines on the date of each such report are barring such recruiting personnel from premises or property of any such institution.

SEC. 2. Authorization is hereby granted whereby any of the amounts prescribed in paragraphs (1) through (15), inclusive, of subsection 1(b) may, in the discretion of the Administrator of the National Aeronautics and Space Administration, be varied upward 5 per centum to meet unusual cost variations, but the total cost of all work authorized under such paragraphs shall not exceed the total of the amounts specified in such paragraphs.

SEC. 3. Not to exceed one-half of 1 per centum of the funds appropriated pursuant to subsection 1(a) hereof may be transferred to the "Construction of facilities" appropriation, and, when so transferred, together with \$10,000,000 of the funds appropriated pursuant to subsection 1(b) hereof (other than funds appropriated pursuant to paragraph (16) of such subsection) shall be available for expenditure to construct, expand, or modify laboratories and other installations at any location (including locations specified in subsection 1(b)), if (1) the Administrator determines such action to be necessary because of changes in the national program of aeronautical and space activities or new scientific or engineering developments, and (2) he determines that deferral of such action until the enactment of the next Authorization Act would be inconsistent with the interest of the Nation in aeronautical and space activities. The funds so made available may be expended to acquire, construct, convert, rehabilitate, or install permanent or temporary public works, including land acquisition, site preparation, appurtenances, utilities, and equipment. No portion of such sums may be obligated for expenditure or expended to construct, expand, or modify laboratories and other installations unless (A) a period of thirty days has passed after the Administrator or his designee has transmitted to the Speaker of the House of Representatives and to the President of the Senate and to the Committee on Science and Astronautics of the House of Representatives and to the Committee on Aeronautical and Space Sciences of the Senate a written report containing a full and complete statement concerning (1) the nature of such construction, expansion, or modification, (2) the cost thereof including the cost of any real estate action pertaining thereto, and (3) the reason why such construction, expansion, or modification is necessary in the national interest, or (B) each such committee before the expiration of such period has transmitted to the Administrator written notice to the effect that such committee has no objection to the proposed action.

SEC. 4. Notwithstanding any other provision of this Act—

(1) no amount appropriated pursuant to this Act may be used for any program deleted by the Congress from requests as originally made to either the House Committee on Science and Astronautics or the Senate Committee on Aeronautical and Space Sciences,

(2) no amount appropriated pursuant to this Act may be used for any program in excess of the amount actually authorized for that particular program by sections 1(a) and 1(c), and

(3) no amount appropriated pursuant to this Act may be used for any program which has not been presented to or requested of either such committee, unless (A) a period of thirty days has passed after the receipt by the Speaker of the House of Representatives and the President of the Senate and each such committee of notice given by the Administrator or his designee containing a full and complete statement of the action proposed to be taken and the facts and circumstances relied upon in support of such proposed action, or (B) each such committee before the expiration of such period has transmitted to the Administrator written notice to the effect that such committee has no objection to the proposed action.

SEC. 5. It is the sense of the Congress that it is in the national interest that consideration be given to geographical distribution of Federal research funds whenever feasible, and that the National Aeronautics and Space Administration should explore ways and means of distributing its research and development funds whenever feasible.

SEC. 6. (a) If an institution of higher education determines, after affording notice and opportunity for hearing to an individual attending, or employed by, such institution, that such individual has been convicted by any court of record of any crime which was committed after the date of enactment of this Act and which involved the use of (or assistance to others in the use of) force, disruption, or the seizure of property under control of any institution of higher education to prevent officials or students in such institution from engaging in their duties or pursuing their studies, and that such crime was of a serious nature and contributed to a substantial disruption of the administration of the institution with respect to which such crime was committed, then the institution which such individual attends, or is employed by, shall deny for a period of two years any further payment to, or for the direct benefit of, such individual under any of the programs authorized by the National Aeronautics and Space Act of 1958, the funds for which are authorized pursuant to this Act. If an institution denies an individual assistance under the authority of the preceding sentence of this subsection, then any institution which such individual subsequently attends shall deny for the remainder of the two-year period any further payment to, or for the direct benefit of, such individual under any of the programs authorized by the National Aeronautics and Space Act of 1958, the funds for which are authorized pursuant to this Act.

(b) If an institution of higher education determines, after affording notice and opportunity for hearing to an individual attending, or employed by, such institution, that such individual has willfully refused to obey a lawful regulation or order of such institution after the date of enactment of this Act, and that such refusal was of a serious nature and contributed to a substantial disruption of the administration of such institution, then such institution shall deny, for a period of two years, any further payment to, or for the direct benefit of, such individual under any of the programs authorized by the National Aeronautics and Space Act of 1958, the funds for which are authorized pursuant to this Act.

(c) (1) Nothing in this Act shall be construed to prohibit any institution of higher education from refusing to award, continue, or extend any financial assistance under any such Act to any individual because of any misconduct which in its judgment bears adversely on his fitness for such assistance.

(2) Nothing in this section shall be construed as limiting or prejudicing the rights and prerogatives of any institution of higher education to institute and carry out an independent, disciplinary proceeding pursuant to existing authority, practice, and law.

(3) Nothing in this section shall be construed to limit the freedom of any student to verbal expression of individual views or opinions.

SEC. 7. This Act may be cited as the "National Aeronautics and Space Administration Authorization Act, 1973."

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION,
OFFICE OF THE ADMINISTRATOR,
Washington, D.C., January 26, 1972.

Hon. CARL B. ALBERT,
Speaker of the House of Representatives,
Washington, DC.

DEAR MR. SPEAKER: Submitted herewith is a draft of a bill, "To authorize appropriations to the National Aeronautics and Space Administration for research and development, construction of facilities, and research and program management, and for other purposes," together with the section analysis thereof. It is submitted to the Speaker of the House of Representatives pursuant to Rule XL of the House.

Section 4 of the Act of June 15, 1959, 73 Stat. 73, 75 (42 U.S.C. 2460), provides that no appropriation may be made to the National Aeronautics and Space Administration unless previously authorized by legislation. It is the purpose of the enclosed bill to provide such requisite authorization in the amounts and for the purposes recommended by the President in the Budget of the United States Government for the fiscal year ending June 30, 1973. The bill would authorize appropriations totaling \$3,379,000,000 to be made to the National Aeronautics and Space Administration as follows:

(1) for "Research and development" amounts totaling \$2,600,900,000; (2) for "Construction of facilities" amounts totaling \$77,300,000 and (3) for "Research and program management," \$700,800,000.

The enclosed draft bill follows the format of the National Aeronautics and Space Administration Authorization Act, 1972 (Public Law 92-68), except for the omission of section 7 of that Act, which section is permanent law, having amended the National Aeronautics and Space Act of 1958. However, the bill does differ in substance from the prior Act in several respects. First, subsections 1(a), 1(b) and 1(c), which would provide the authorization to appropriate for the three NASA appropriations, differ in the dollar amounts and the "Construction of facilities" projects for which authorization to appropriate is requested.

Second, subsection 1(a) contains a numerical realignment of the program line items related to the activities of the former Office of Space Science and Applications, so that all of the program line items related to the new Office of Space Science are grouped together. To this end, the program line item "Launch vehicle procurement" precedes (rather than follows, as in the prior Act) the "Space applications" program line item. This later line item relates to the program activities of the new Office of Applications.

Third, subsection 1(b) contains two line items covering minor construction and rehabilitation and modification of facilities which relate to classes of activity (delimited as hereinafter discussed) to some extent covered within the authorizations for subsections 1(a) and 1(c) in prior years.

Fourth, subsection 1(c) omits the limitation contained in the prior year's Act on the amount available for personnel and related costs. Such limitation is deemed unnecessary for the fiscal year starting July 1, 1972.

Fifth, there are changes in statutory language related to the implementation of certain of the recommendations of the NASA Facilities Management Review Committee which I have approved. Copies of this Committee's report have previously been furnished to the respective Congressional Committees having cognizance over legislation and appropriations for NASA. The changes in statutory language consist of (1) the line items in subsection 1(b) covering limited construction and rehabilitation and modification activities, alluded to above; (2) the addition of language to subsection 1(d) clarifying that such provision relates to items of a capital nature, particularly facilities, at locations other than NASA installations; and (3) an overall revision to the language of subsection 1(g) which has the effect of restricting the use of "Research and development" and "Research and program management" funds for certain facilities purposes.

The report of the NASA Facilities Management Review Committee previously alluded to makes several recommendations of a fundamental nature, each of which I have approved. As indicated above, certain limited changes to the statutory language were required to implement them; however, their main impact is to be found in a revised approach to the management of NASA's facilities activities. The NASA budget, which would be implemented by the proposed bill, is structured in accordance with such approach, the principal points of which, as related to the changes in statutory language, are as follows:

One major area dealt with by the Committee involves the method of presenting for approval facilities projects (i.e., all projects involving the acquisition of new, or the enhancement of existing, facilities consisting of real property and equipment connected therewith). All such projects comprehended within the instant proposed bill have been presented—and any other such projects proposed after the date of enactment of the NASA Authorization Act, 1973 (without regard to the fiscal year during which the funds therefor became, or become, available), will be presented—for approval and ultimate funding under a full disclosure concept. That is, all elements required for the initial stated operational use of that facility, whether construction or equipment, will be fully disclosed to the extent that each of these elements has been or can be identified and quantified and estimates prepared therefor. (To the extent that elements can be identified but not quantified, and/or meaningful estimates cannot be prepared therefor, this also will be disclosed.) However, for purposes of funding under the applicable facilities authorities, only those elements constituting actual construction trades activity (i.e., "brick and mortar"), together with collateral equipment (i.e., equipment which is an inherent part of the structure, or is built in, or is large and substantially affixed to the structure) will be considered a part of the facility project. All other equipment, while it is to be disclosed as being related to the facilities project, will, nevertheless, be funded from sources otherwise available therefor. Also, greater emphasis than has been accorded in the past will be given to identifying the funding source for all equipment.

The above concept is not directly reflected in the enclosed draft bill other than by the term "collateral equipment" in subsections 1(d) and 1(g), which would take on the redefined meaning described above. However, the concept is followed in the NASA Budget which the enclosed draft bill would implement.

An additional recommendation of the Facilities Management Review Committee, which is also reflected in the enclosed draft bill, is that any facilities project (defined as above), the estimated cost of which at the time of approval is above a very minimal level (i.e., \$10,000 for construction of new, or additions to existing, facilities, and \$25,000 for rehabilitation or modification of facilities) will be funded from the "Construction of facilities" appropriation; provided, however, that a project required to satisfy unforeseen programmatic needs, the estimated cost of which project at the time of approval does not exceed \$250,000, will continue to be funded from the "Research and development" appropriation. Projects involving maintenance or repair of facilities will continue to be funded from the "Research and development" and "Research and program management" appropriations without a per project dollar limitation.

The implementation of this second major recommendation is evidenced (1) by subsection 1(g) of the enclosed draft bill; and (2) by the language of the three NASA appropriations as recommended by the President in the Appendix to the Budget of the United States Government, 1973. The enclosed draft bill would further provide for two line items under the "Construction of facilities" head covering (a) the construction of new, and additions to existing, facilities, the estimated cost of which (including collateral equipment) is not in excess of \$250,000 for each project at the time of approval; and (b) the rehabilitation and modification of facilities, the estimated cost of which (including collateral equipment) is not in excess of \$500,000 for each project at the time of approval. Any project for these purposes, the estimated cost of which exceeds the applicable project limitation, would be separately stated as a budget line item and justified as such.

It is noted that under subsection 1(g), revised in accordance with the above, "Research and development" funds would continue to be legally available for facility projects, required to satisfy unforeseen programmatic needs at NASA installations and other locations, the estimated cost of which projects, including collateral equipment, does not at the time of approval exceed \$250,000. Any unforeseen requirement, the estimated cost of which exceeds the stated amount, would be funded from the "Construction of facilities" appropriation using, where necessary and appropriate, one of the statutory flexibility provisions (unless, of course, it is fundable under the provisions of subsection 1(d)).

It will also be noted that subsection 1(d) has been revised so as to clarify that the use of "Research and development" funds thereunder for items of a capital nature is limited to locations other than NASA installations, and that the reporting requirement, which is a part of such subsection, relates only to construction of a major facility in accordance with the subsection.

It will be noted further that none of the specific flexibility provisions included in prior NASA Authorization Acts has been substantially affected by any of the foregoing. It is NASA's view that such flexibility provisions are essential to NASA's dynamic and evolving research and development activity.

Where required by section 102(2)(C) of the National Environmental Policy Act of 1969 (42 U.S.C. 4332(2)(C)), environmental impact statements covering NASA installations and the programs to be funded in fiscal year 1973 have been furnished to the Committee on Science and Astronautics.

The National Aeronautics and Space Administration recommends that the enclosed bill be enacted. The Office of Management and Budget advises that such enactment would be in accord with the program of the President.

Sincerely,

JAMES C. FLETCHER, *Administrator*.

2 Enclosures.

The CHAIRMAN. I also think it is appropriate that two other important communications from the Administrator be included in the record at this point.

One is his letter of January 14, 1972, outlining the history and status of the shuttle program, and, second, his letter of January 24, 1972, stating the background for the recent decisions on the NERVA program.

I also include biographical data on Dr. Fletcher.

The purpose of Dr. Fletcher's appearance this morning is to give us an overview of the NASA budget for the next fiscal year.

After this morning's meeting, the subcommittees will take up the budget in detail and meetings for this purpose will be scheduled by the subcommittee chairmen.

(Dr. Fletcher's letters of January 14, 1972, and January 24, 1972, together with biographical data on Dr. Fletcher are as follows:)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION,
OFFICE OF THE ADMINISTRATOR,
WASHINGTON, D.C., January 14, 1972.

HON. GEORGE P. MILLER,
*Chairman, Committee on Science and Astronautics,
House of Representatives, Washington, D.C.*

DEAR MR. CHAIRMAN: I am writing to inform you and the Committee in some detail of the developments in our studies and planning for the space shuttle which were the basis for the President's decision that we should proceed with the development of the space shuttle, and of the steps we now plan to take to get that work underway.

As you know, the FY 1972 budget for the space shuttle submitted to and approved by the Congress last year provided, in addition to engine development, for continuing studies or starting development of the shuttle itself, depending on the progress made in the studies. Our shuttle studies have now progressed to the point that we have been able to make a definite decision on the configuration concept and can now proceed to make the final trade-off decisions required for preparation and issuance of requests for proposals from prospective development contractors.

As reported in my letter of June 16, 1971, the results of our contractor Phase B studies then becoming available confirmed the technical feasibility of a reusable space shuttle. Since that time, as indicated in my subsequent letters on our space shuttle planning, the aim of our studies has been to identify alternative configuration concepts and program approaches which would substantially reduce development costs without sacrificing the principal objective sought in the program, i.e., a reusable system which, in addition to providing for future manned space flight missions, would provide a low cost flexible capability for launching and retrieving unmanned payloads from orbit.

The configuration concept we have now selected meets this objective. Its development cost will be half of what the fully reusable system originally conceived would have cost. We can develop this space shuttle within the framework of a total NASA program with annual budgets at approximately the present level.

It may be helpful if I review briefly how our thinking on the shuttle configuration concept has evolved during the past several months as the technical studies and evaluations have progressed. The lengthy process of study and successive iteration of alternatives we have followed is a necessary feature—and I believe a classic example—of the use of the systems engineering approach to balance complex technical and cost considerations to reach the proper decisions on a major new program.

1. The design concept to which the Phase B studies initiated in 1970 were originally addressed was a two-stage fully reusable system consisting of winged flyback booster and orbiter stages, with all fuel carried internally. We estimate that the development cost (excluding facilities) of such a system would have been about \$10 billion.

2. The Phase B study work indicated, however, that the size of the system and its development cost could be reduced through the use of an external expendable liquid-hydrogen tank for the orbiter, with a small increase in operating costs per launch. The resulting "baseline" configuration was the subject of detailed cost analyses which indicated that its development cost (excluding facilities) would have been about \$8.1 billion over about six years.

3. Further study showed that additional costs savings and technical advantages in the development program were feasible if *both* the liquid-oxygen and liquid-hydrogen for the orbiter were carried in an external tank that would be jettisoned in orbit. This change permitted the orbiter vehicle to be significantly smaller, thereby easing some development problems and reducing substantially orbiter development and procurement costs, with some additional increase in the recurring cost per flight. The orbiter and external hydrogen-oxygen tank

configuration established at this point has remained essentially the same in all the configurations subsequently studied.

4. In parallel with other studies, we also investigated alternatives which might reduce the peak annual funding required for developing the space shuttle by "phasing" the development over a longer period of years. We examined in some detail the approach discussed in my letter of June 16, 1971, in which the orbiter would first be tested on an interim unmanned expendable booster, with development of the manned reusable booster to be undertaken later. We found, however, that the advantages to be gained did not justify the high development cost of the interim booster and the increased total cost and longer development time for the entire program.

5. We then examined various other ways in which the introduction of advanced technology might be phased to reduce costs. Out of these studies came the Mark I/Mark II concept referred to in my letter of October 6, 1971. Under this concept a Mark I shuttle with reduced capability would first be developed using less advanced technology and subsystems. As new technology and subsystems were developed, they would be introduced some years later in a Mark II shuttle which would have the full planned capabilities. Estimated development costs (including facilities) for the Mark I/Mark II approach, with a flyback booster using F-1 engines, were \$6-\$7 billion.

6. Our studies of the Mark I/Mark II approach made it clear that any further substantial reduction in space shuttle development costs depended on the use of an unmanned ballistic booster. Accordingly, we focused intensive study efforts on a variety of possible types. In December these studies established the following points:

a. The recoverable/reusable pressure-fed liquid (PFL) and expendable solid rocket motor (SRM) are the best candidate unmanned ballistic booster concepts.

b. A space shuttle configuration concept consisting of the previously defined orbiter and an unmanned ballistic booster of either the PFL or SRM type is technically feasible.

c. Development costs (excluding facilities) would be about \$5.5 billion with a PFL booster and less with a SRM booster.

d. Operating costs per flight would be about \$7 to \$10 million with a PFL booster and somewhat higher for a SRM booster.

7. Based on all the information available, we concluded that sufficient studies were now in hand to show that:

The configuration concept described above, with either a PFL or SRM booster, has lower development costs than any other configuration concept meeting the technical performance requirements and the basic objective of the space shuttle program.

The expected operating costs per flight are in a range that is acceptable in view of the very large reduction in development costs. The large cost savings inherent in the capability to recover and repair a wide variety of payloads will be the same as for the fully reusable system originally envisaged.

The remaining open technical and cost questions on the PFL and SRM booster options can be resolved in about two months, permitting issuance of a request for proposals this spring and entering into the contract this summer.

These conclusions were the basis for NASA's recommendations and the President's approval for proceeding with development of the space shuttle.

We are now moving ahead with final studies and actions on the remaining open questions that must be resolved before the request for proposals can be issued. These include detailed studies to clarify certain technical aspects of both the SRM and PFL booster configurations and to provide a more precise forecast of the operating cost per launch that can be expected from these systems. In addition, we are making a study to revalidate earlier studies which indicated that the cost of the shuttle system would not be substantially less by reducing somewhat, but within acceptable limits, the precise payload size and weight requirements on which our planning is now based.

The results of all these studies are scheduled to be in hand in a few weeks and should put us in a position to make the final cost and technical trade-offs and the decisions required for issuing the request for proposals.

The decisions now reached on the configuration concept, and, as they become available, the results of the further studies described above, are being considered by the special board to evaluate launch sites for the space shuttle. As I have previously indicated, the final selection of sites for developmental and operational flights will be made after all pertinent technical, operational, cost, and environmental factors have been analyzed and evaluated. Pending a report

from the site evaluation board on the impact of the configuration concept decision, giving their assessment of the additional study and analyses required, I cannot at this time forecast when the site selection will be made.

I hope that this letter will give you and the Committee a useful summary of the basis for the decision on the space shuttle configuration concept and of the actions we now have underway. I am convinced that this decision will give the United States a space shuttle that

1. Is technically sound,
2. Meets the real future needs of the nation and the space program, and
3. Can be developed at the lowest possible cost consistent with meeting these objectives and within the framework of a balanced total NASA program with annual budgets at approximately the current level.

We look forward to discussing the program in further detail with you and the Committee during our hearings on the Fiscal Year 1973 budget request.

Sincerely,

JAMES C. FLETCHER, *Administrator.*

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION,
OFFICE OF THE ADMINISTRATOR,
Washington, D.C., January 24, 1972.

HON. GEORGE P. MILLER,
*Chairman, Committee on Science and Astronautics,
House of Representatives, Washington, D.C.*

DEAR MR. CHAIRMAN: I am writing to inform you in some detail of the decisions on the space nuclear propulsion program which have been made in connection with the President's FY 1973 Budget for NASA and AEC. As I advised you in my letter of September 29, 1971, we have been operating in this program during the first part of FY 1972 on the basis planned in the President's FY 1972 Budget, i.e., holding together a technical cadre of Government and contractor personnel so that development of the 75,000-lb. thrust NERVA engine could be resumed when it became timely to do so. I also advised you at that time that we anticipated that the decision on the future of the program would be made as a part of the FY 1973 budget decisions. This has now occurred.

As stated in the testimony on the FY 1972 budget, the reasons for suspending development of the NERVA engine in the FY 1972 budget were in part the fiscal constraints necessary in the budget for FY 1972 and succeeding years and in part the fact that the first missions using the NERVA engines would not take place before the middle or late 1980's. Therefore, the decision we presented in the FY 1972 budget was to suspend NERVA engine development and to endeavor to preserve the capability for resuming it at a later time when a development sequence—engine, stage, and payloads—leading to use of the nuclear engine in mission application requiring its capabilities could be begun with a reasonable expectation of being carried to completion.

In developing our FY 1973 budget we have given special attention to the problem of configuring the entire NASA program in such a way that it will not commit the nation to large increases in the total NASA budget in future years. This has meant some basic changes in our plans and another stretch-out of the period over which our continuing and long range objectives in space exploration and space science will be achieved. Two major examples have been our decisions on the space shuttle and on the Grand Tour. As outlined in my letter to you of January 14, 1972, we have selected a space shuttle configuration concept which will cost about half of what the configuration envisaged in our plans last year would have cost to develop; this decision serves to reduce substantially the peak funding required for shuttle development in any one year and thereby helps us avoid an increase in the total annual NASA budget. We have also decided to cancel plans for the Grand Tour mission which would have been possible only in the last half of the 1970's. This means that we will not be able to launch missions to explore the distant planets—Uranus, Neptune, and Pluto—until sometime in the 1980's, and that we will then have to depend on high efficiency propulsion stages to reach them.

By these and other actions we have been able to reconfigure our long range plans so that the total NASA program can be accomplished at an annual overall NASA budget at approximately the current level. The projections we will submit to Congress as required by the Legislative Reorganization Act will show that the

estimated run-out costs of the total program do not rise above the FY 1972-1973 level. (By contrast, the run-out projections submitted last year with the FY 1972 budget rose to \$4 billion.)

By properly phasing-in major new programs as we go along, we can maintain a viable and useful total NASA program in space and aeronautics at a total NASA annual budget level which (in 1971 dollars) can remain essentially at the FY 1972-1973 level for the indefinite future unless, of course, the President and Congress decide that the program should be expanded or accelerated. I strongly believe that this posture of a realistic long-term plan in which the nation's commitment is clearly limited to budgets of approximately the current size, is the proper one for NASA from the standpoint of responsible management and also is essential at this time to assure continued broad-based support for the NASA program.

As we took the actions in the FY 1973 budget needed to establish a realistic long range plan for NASA, we had to take another look, of course, at the nuclear propulsion program. From the standpoint of holding our total plan within an acceptable total, it was clear that we could not afford to reinstate development of the 75,000-lb. thrust NERVA engine. The costs in the 1970's would be too high, and with the stretchout in our future plans the missions requiring this capability would be even farther in the future than the forecast a year ago. Under these circumstances and constraints, reinstatement of the NERVA 75,000-lb. thrust engine development could not be justified.

On the other hand, the cancellation of the Grand Tour missions introduced the possibility of a new class of future missions for which a much smaller nuclear engine appears to be needed and particularly well suited, namely, the first missions to explore the distant planets—Uranus, Neptune, and Pluto. Our preliminary analyses show that a small nuclear engine, in the 15,000-20,000-lb. thrust class, may provide the most practical means for the first mission to these planets sometime in the 1980's, in lieu of the cancelled Grand Tour missions, as well as perhaps providing at a later time, by clustering or staging several small engines, many of the capabilities the large 75,000-lb. thrust engine would have given us.

If these conclusions are confirmed in the studies we are now initiating and are proposing to carry on in FY 1973, we will be able to establish a firm and significant specific mission goal for the nuclear propulsion development program. This would be most significant. With a focused effort on a specific mission objective, the program could then proceed without the uncertainties and controversy that has characterized it in the past.

For the reasons outlined above, the FY 1973 budget reflects a decision to reorient the nuclear propulsion program. NASA and AEC will define a small nuclear rocket system in the 15,000-20,000-lb. thrust class. This effort will be a part of a broader program to define and make trade-off studies of alternative types of advanced propulsion systems, including chemical, solar-electric, nuclear-electric, and nuclear-rocket systems for possible future missions to the distant planets Uranus, Neptune, and Pluto. Supporting research and component testing for nuclear systems will also be undertaken. Development of the NERVA 75,000-lb. thrust engine and the contractor effort directed at this goal are being terminated in favor of the program reoriented as above.

For the reoriented program, the FY 1973 budget includes a total of \$16.5 million in budget authority, \$8.5 million for NASA and \$8 million for AEC. This funding will support engine definition work at the Los Alamos Scientific Laboratory (LASL), component development and test at LASL and the Nuclear Rocket Test Site, and some work in supporting research and advanced technology work. The development contracts with Aerojet and Westinghouse will be terminated in FY 1972, with termination costs to be met out of funds available in FY 1972.

I hope that the foregoing will give you an understanding of the reasons which have led to the decisions on the nuclear propulsion program which are reflected in the FY 1973 budget and which we will begin to implement in the remainder of FY 1972. I will be available to discuss this further with you at your convenience.

Sincerely,

JAMES C. FLETCHER, *Administrator.*

BIOGRAPHICAL DATA

JAMES CHIPMAN FLETCHER, NASA ADMINISTRATOR

Dr. James C. Fletcher was sworn in as Administrator of the National Aeronautics and Space Administration in a White House ceremony in the President's office on April 27, 1971.

President Nixon announced Dr. Fletcher's nomination as NASA Administrator on Feb. 27, 1971 and the appointment was confirmed by the U.S. Senate on March 11, 1971.

Dr. Fletcher became President of the University of Utah in 1964 after two decades of leadership in industry, government and military activities.

He was born June 5, 1919 in Millburn, New Jersey, attended high school in New York City and received a B.A. degree in physics with a minor in mathematics from Columbia University in 1940.

After graduation, Dr. Fletcher served as a research physicist with the U.S. Navy Bureau of Ordnance, studying the problems of degaussing ships as protection against magnetic mines.

In 1941 he became a special research associate at the Cruft Laboratory of Harvard University. He went to Princeton University in 1942 as a teaching fellow and later was an instructor and research physicist.

At the end of World War II, he began work on a doctorate in physics at the California Institute of Technology under a teaching assistantship and an Eastman Kodak Fellowship. After receiving his Ph. D. degree in 1948, Dr. Fletcher joined Hughes Aircraft Co. as director of the Theory and Analysis Laboratory in the Electronics Division. Six years later this division—instrumental in developing the Falcon air-to-air missile and the F-102 all-weather interceptor—had grown from 120 to 25,600 employees.

In 1954, Dr. Fletcher joined the Ramo-Wooldridge Corp. as an Associate Director and soon became Director of Electronics in the Guided Missile Research Division. Later the Guided Missile Division became Space Technology Laboratories, a subsidiary of Ramo-Wooldridge, with technical responsibility for all United States intercontinental ballistic missiles (Atlas, Titan and Minuteman), as well as the Thor intermediate range ballistic missile. The laboratories also initiated Pioneer 4, the nation's first space probe.

In July 1958, Dr. Fletcher organized and was first president of the Space Electronics Corp. with his associate, Frank W. Lehan.

Space Electronics Corp. developed and produced the Able Star stage of the Thor-Able space carrier and had grown to 300 employees by 1960 when controlling interest was sold to Aerojet General Corp.

A year later, Space Electronics Corp. was merged with the spacecraft division of Aerojet to form the Space General Corp. Dr. Fletcher was responsible for the formation of this new corporation and was its first president. He later became Chairman of the Board of Space General and Systems Vice President of Aerojet General Corp. He served in this dual capacity until July 1, 1964 when he resigned to become the eighth president of the University of Utah.

In his career as a research scientist, Dr. Fletcher developed patents in areas as diverse as sonar devices and missile guidance systems. He continues his interest in science through national committee work, having served on more than 50 national committees and as chairman of 10.

In March 1967, Dr. Fletcher, after serving as a consultant since its inception in 1958, was appointed by President Johnson to membership on the President's Science Advisory Committee.

He was a member of the President's Committee on the National Medal of Science; and of several Presidential Task Forces, the most recent being the Task Force on Higher Education.

He is a Fellow of the Institute of Electrical and Electronics Engineers, an Associate Fellow of the American Institute of Aeronautics and Astronautics and a member of the Board of Trustees of the Theodore von Karman Memorial Foundation. He received the first Distinguished Alumni Award to be given by

California Institute of Technology. Dr. Fletcher served higher education as a member of the Executive Committee of the National Association of State Universities and Land Grant Colleges.

Dr. Fletcher is the fourth man to head the nation's civilian space agency which came into being Oct. 1, 1958. The first Administrator was Dr. T. Keith Glennan, president of Case Institute of Technology, Cleveland. He was succeeded in 1961 by Mr. James E. Webb, a former Director of the Bureau of the Budget and Under Secretary of State, who served until 1968. Dr. Fletcher's immediate predecessor was Dr. Thomas O. Paine, who resigned Sept. 15, 1970, to return to the General Electric Co. after heading NASA since 1968.

Dr. Fletcher is married to the former Fay Lee of Brigham City, Utah, and they are the parents of four children, three girls and a boy: Virginia Lee, Mary Susan, James Stephen and Barbara Jo.

DECEMBER 1971.

STATEMENT OF DR. JAMES C. FLETCHER, ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION; ACCOMPANIED BY DR. GEORGE M. LOW, DEPUTY ADMINISTRATOR, AND WILLIS H. SHAPLEY, ASSOCIATE DEPUTY ADMINISTRATOR

Dr. FLETCHER. Good morning, Mr. Chairman and members of the committee.

It is indeed an honor for me to be here today in my first appearance before the full committee to present NASA's fiscal year 1973 authorization request.

I am very much aware of how important the strong support and wise counsel of this committee has been over the years. I look forward to working with all of you as we move forward in aeronautics and space in the years ahead.

The fiscal year 1973 budget for NASA will indeed enable the U.S. aeronautics and space program to move forward, and to do so on a basis consistent with realistic budgetary constraints, both now and in the future.

It moves forward in that it fully supports President Nixon's decision to proceed with the development of the Space Shuttle, the keystone to the Nation's future in space; it continues our major ongoing space programs; and it provides a 50 percent set-up in our work in aeronautics.

It is realistic in that it supports these objectives within a fiscal year 1973 budget approximately equal to that of last year, and under a plan that does not commit the Nation to higher total NASA budget levels in future years.

I will review briefly the most significant elements of our fiscal year 1973 budget proposals and then touch briefly on some other matters of interest and concern to NASA and the committee at this time.

First, the Space Shuttle. As reported to the committee in detail in my letter to the chairman of January 14, 1972, we have made a definite decision on the configuration concept. The development cost of \$5.5 billion will be about one-half what the initial concept under study a year ago would have cost. This spring we will make the final decisions on the booster and some other technical details and issue a request for proposals to contractors. We will then be able to reach a decision on the

launch and landing site. The fiscal year 1973 budget, if approved by Congress, will provide the funds required in fiscal year 1973 to proceed with development and provide needed development facilities.

I am sure that this committee is fully aware of the reasons for the central importance we attach to the Space Shuttle for the future of the U.S. space program. In brief:

The Shuttle will provide the means for routine, quick reaction, and economical access to and return from space needed for scientific applications, and military uses of space in the 1980's and beyond.

The Shuttle will reduce the cost of space operations substantially. With space budgets at about current levels, the total savings to NASA, DOD, and other users are estimated to average a billion a year in the 1980's.

Finally, the Shuttle will assure that the United States will have a continuing effective presence in space. Without it there would be no U.S. manned space flights after the Apollo and Skylab missions are completed.

Mr. Chairman, to conserve time I will not dwell longer on the Shuttle. Instead, with your permission, I would like to place in the record the Space Shuttle fact sheet, attached to my statement, which summarizes what the Space Shuttle is, what it will do, what it will cost, and what it will save.

The CHAIRMAN. Without objection, the document referred to by Dr. Fletcher will be placed in the record.

(The referred to documents are as follows:)

THE SPACE SHUTTLE

The space shuttle is being developed by NASA as the key to the nation's future space program.

A bipartisan majority in Congress approved \$118.5 million for FY 1972—for studies and for starting development.

The President approved proceeding with development on January 5, 1972.

The FY 1973 budget includes \$228 million to carry the work forward in that fiscal year.

The space shuttle can be developed without an increase in the present NASA budget level.

WHAT IS THE SPACE SHUTTLE?

The space shuttle will be an entirely new way of getting to and from space:

It will be an airplane like vehicle that can be used over and over to take satellites to orbit and bring them back for repair and reuse.

It can perform manned missions in orbit but its principal use will be to conduct missions with unmanned satellites more efficiently and economically than we now do with launch vehicles that are destroyed on every launch.

WHAT WILL IT LOOK LIKE?

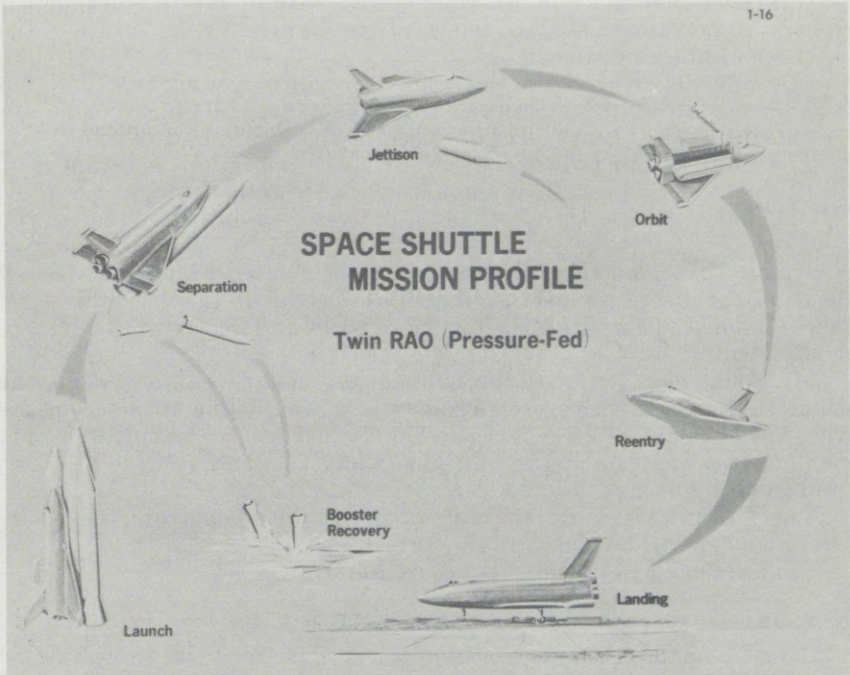
Each space shuttle consists of an orbiter and a booster:

The orbiter will look like an airplane and be about the size of one of the smaller jet airliners. It will be powered by three high pressure hydrogen-oxygen rocket engines. It will have a large cargo bay, 14 to 15 ft. in diameter and up to 60 ft. in length which carries up to 65,000 lbs. It will have a two-man crew and can carry 2-12 scientists and technicians.

The booster will be an unmanned ballistic-type vehicle, using either pressure-fed liquid or solid rocket engines. The final selection is to be made this spring.

HOW WILL IT WORK?

As shown in the "Space Shuttle Mission Profile":



The booster and orbiter stages will be joined for launch, with the orbiter in a "piggyback" position.

At altitude the orbiter will separate, fly in orbit like a spaceship.

In orbit the crew and the scientists and technicians on board will launch unmanned satellites and space probes, conduct observations and experiments, and retrieve satellites placed in orbit in previous missions.

When its mission is completed the orbiter will land like an airplane and be made ready for its next flight.

WHAT WILL THE SPACE SHUTTLE DO?

It will do more efficiently the same types of useful civilian and military space missions we are doing today by providing access to space and return to earth on a routine, quick reaction, and economical basis.

Specifically, it will be used by NASA, the Department of Defense, and other agencies to carry out unmanned, man-tended, and manned missions (non-astronauts can participate in manned missions) for:

Scientific exploration: instruments, observatories, and telescopes to study the earth, planets, sun, and universe;

Civilian applications: weather, communications, navigation, monitoring the environment, earth resources, and new ideas for the future; and

Military applications: these will take advantage of the shuttle's economical, routine, quick reaction capability.

WHAT WILL THE SPACE SHUTTLE COST?

Cost estimates based on pressure-fed reusable booster :

Development (spread over 6 years)-----	\$5.5 billion
Facilities -----	300.0 million
Additional investment (depends on future requirements) :	
Each additional orbiter-----	250.0 million
Each additional booster-----	50.0 million
Cost per flight-----	7.7 million

The cost of the space shuttle program can fit within a total annual NASA budget at approximately the current level (measured in 1971 dollars).

WHAT FUTURE SAVINGS WILL THERE BE?

After development, the space shuttle is far more economical to operate than conventional launch vehicles:

The cost per mission (\$7.7 million) is less than all existing launch vehicles except for the small Scout and Delta, even though the shuttle's 65,000 lb. capacity is far greater than any of them (except for the giant Saturn V).

The cost per pound in orbit when fully loaded is about \$120 compared to \$900 to \$5,600 per pound for conventional launch vehicles.

The savings from the shuttle's lower launch costs and from the reuse and design simplifications of payloads the shuttle makes possible are estimated at about \$13 billion over 12 years, an average of a little over \$1 billion per year, assuming a conservative combined NASA, DOD, and other user model with fewer than 50 missions per year over the period 1978-1990.

IN SUMMARY—WHY THE SPACE SHUTTLE?

The United States must continue to do useful things in space.

The cost of doing business in space must be reduced.

The space shuttle offers the most effective way :

 To maintain an advanced U.S. capability in space

 To improve the effectiveness while reducing the cost of our space operations—civilian and military

 To do this within a total NASA budget that can be held at approximately the present annual level.

APPENDIX TO SPACE SHUTTLE FACT SHEET

SPACE SHUTTLE ECONOMICS

1. JUSTIFICATION

The justification of the space shuttle is not based on the details of space shuttle economics alone. It is a fact that the shuttle is a good investment and will make possible significant savings in future space operations. But the fundamental reason for developing the space shuttle is the necessity to have a means for routine, quick reaction, and economical access to space and return to earth in order to achieve the benefits of the scientific, civil, and military uses of space that will be important in the decade of the 1980's and beyond. The space shuttle program is also the lowest cost approach for providing a continuing useful capability for manned space flight and for maintaining a clear U.S. presence in space.

2. FUNDING REQUIREMENTS

a. The development cost for the space shuttle is estimated to be \$5.5 billion.

b. The additional investment costs for procurement of production flight hardware and facilities is estimated at \$1.5 billion, on the reasonable assumption that the initial inventory will include: 3 production orbiters, 2 refurbished orbiters, and 4 production boosters (plus 2 development boosters if not expended during development).

c. The total investment, therefore, required to develop the shuttle and procure flight hardware and provide facilities will be approximately \$7 billion.

3. IMPLIED FUTURE COMMITMENTS

a. The full development of the shuttle, the initial investment required, and its subsequent operation, together with a continuing well-balanced program in science, applications, and aeronautics, can be supported at an essentially constant total NASA budget level, i.e., about \$3.4 billion in 1971 dollars.

b. The peak annual total funding level required for the shuttle during the development period is estimated at \$1.3 billion. As stated above, this will not require an increase over the current total NASA budget level.

4. RELATION OF SHUTTLE FUNDING TO OTHER SPACE PROGRAM FUNDING

a. There has been some confusion on funding levels required for the shuttle because some people have incorrectly counted the cost of future satellites and other payloads and mission support in future years as a part of the development or investment costs of the space shuttle system. In this way, figures of \$10 billion or more have been arrived at as the "true" cost of the shuttle system. This line of reasoning seems to assume that future satellites and payloads would be put in space only because we will have a shuttle, or would be put in space at a rate which is unreasonably high because we have the shuttle, thereby leading to annual budget levels far greater than current levels.

b. The facts are:

(1) The decision to develop the shuttle does not entail an increased level of future expenditures for the satellites and payloads it will carry or for conducting shuttle missions.

(2) The scientific and civil and military applications missions the shuttle will perform will be the same ones that would otherwise be launched by expendable boosters, although the additional capabilities of the shuttle will mean that many missions will be performed differently and more effectively.

(3) After development, the cost of performing these missions will be less with the shuttle than without, because the shuttle will be a more economical launch vehicle and because payload costs can be reduced by reuse and redesign.

(4) Economical use of the shuttle including mission costs is achievable with total annual budgets for space at substantially the current levels. Numbers of the order of \$10 billion or more, if correct at all, relate to expenditures that would be spread over a long period of time and which need not exceed the present annual levels.

5. ILLUSTRATION OF EXPECTED ECONOMIES THROUGH USE OF THE SHUTTLE

a. A conservative combined mission model for NASA, DOD, and other users that has been studied calls for some 500 missions over a 12-year period (1979-1990), a rate of less than 50 missions per year. This model is not a plan, but provides a realistic set of assumptions used to test the reasonableness of developing the space shuttle from an economic standpoint.

b. In this model, launch costs using existing conventional vehicles would be some \$11.0 billion over those 12 years. Using the shuttle, the total launch costs, including procurement of replacement boosters, drop to about \$5.8 billion, an economy of some \$5.2 billion.

c. The payload development and procurement costs for the 500 missions would, for conventional launches, run about \$29.8 billion over these 12 years divided between NASA, DOD, and other agencies. Because of payload reusability, design simplification, and lower risk factors, those same 500 missions using the shuttle would have payload costs of about \$22.6 billion. This is an economy of another \$7.2 billion.

d. Therefore, the assumed 12-year flight program can be carried out with the shuttle \$12.4 billion cheaper than without, an average saving of over \$1 billion per year.

e. The average total annual cost for launch and payloads in the assumed mission model is \$3.4 billion without the shuttle and slightly below \$2.4 billion with the shuttle. These levels are compatible with the current levels of the total space budgets for NASA, DOD, and other agencies.

6. SHUTTLE AMORTIZATION OVER 500 MISSIONS IN 12 YEARS

Billions

a. Investment in space shuttle, based on pressure-fed reusable booster, including initial inventory, as in item 2 above (details shown below) ----	\$7.0
(1) Development, test, and procurement of 2 orbiters and 2 boosters_	5.5
(2) Refurbish 2 orbiters and procure 3 more, including engines_-----	0.9
(3) Procurement of 4 boosters, including engines_-----	0.3
(4) Facilities for development, test, and launch capability_-----	0.3
b. Additional investments required to fly mission model assumed in item 5 above_-----	1.3
c. Total development and investment 1972-1990 (sum of items 6a and 6b) --	8.3
d. Net reduction in cost of 500 missions because of shuttle operations, as in item 5d above_-----	12.4
e. Twelve-year benefit saving realized from shuttle investment (item 6d minus 6c)_-----	4.1
f. Thus, even if the space programs of NASA, DOD, and other agencies terminated in 1990, the shuttle would have more than paid for itself by then.	

7. ADDITIONAL POINTS

a. The specific missions that justify the shuttle are those that could and would otherwise be justified on their own merits with conventional launch vehicles; the shuttle makes them more effective and less expensive.

b. The shuttle is self-sufficient; it does not require a space station in order to meet the good investment criterion, or to conduct useful manned missions in earth orbit.

c. Without the shuttle, the U.S. will have no program of manned space flight after 1973.

8. CONCLUSION

Even though the primary justification for the space shuttle is *not* economics, for mission models similar to those *now* in effect the shuttle investment will be returned with billions to spare. If, as is likely, new useful and economically beneficial mission possibilities open up during the 1980's because of the routine and quick access to space the shuttle provides, the investment will be returned many times over.

Dr. FLETCHER. My letter to you of January 14, 1972, which you have placed in the record, Mr. Chairman, describes in considerable detail how we arrived at the Shuttle configuration concept decision and how we are now proceeding with the final steps necessary before initiating developments.

I would like to emphasize that the steps we have taken and are taking are fully in accord with the plan and approach for the Space Shuttle presented to and approved by Congress in our fiscal year 1972 authorization and appropriations, namely, to proceed in fiscal year 1972 with engine development and to continue studies or initiate development of the Shuttle itself, depending on the progress in these studies. We will, of course, continue to keep the committee currently informed of significant developments and decision points as they occur.

The second very significant feature of NASA's fiscal year 1973 budget is that it supports the continuation of the major space flight projects NASA now has underway. We have only one new space project in fiscal year 1973, the important Tiros N weather satellite.

Our total fiscal year 1973 budget is constrained to approximately the fiscal year 1972 level. But the programs authorized in previous years are coming to fruition and the Nation will begin to realize the scientific and practical benefits of the efforts we have had underway for many years. For example:

Apollo 16, now scheduled for launch April 16, and Apollo 17, this December, will make the last Apollo scientific expeditions to the moon.

In terms of scientific information, Apollos 16 and 17 should surpass even the spectacular results of Apollo 15, which are adding entirely new dimensions to our understanding of the moon and its significance for a better understanding of the earth.

Skylab, our experimental space station, now in the crucial qualification phase of development, will be placed in orbit in 1973 for our astronauts to conduct the wide range of planned experiments in solar astronomy, earth resources, medical, and other fields.

Mariner 9 is now daily sending back exciting new information on the planet Mars. In a real sense we are discovering, with this information, a new planet, much different from what was known or expected from ground observations and the relatively brief glimpses from Mariners 4, 6, and 7.

Viking is on schedule to make our first landings on Mars in 1976 with scientific instruments that should make another giant leap in our understanding of this planet and its similarities and differences from the earth. The most recent information from Mariner 9 has greatly increased the possibility that some form of life may be found on Mars.

Pioneer F, man's first mission to Jupiter and the farthest penetration into space so far, is scheduled for launch at the end of this month. This will also be the highest velocity space launch to date: The high speed required to reach Jupiter will get Pioneer F out as far as the moon in only 11 hours. It will travel 900 million kilometers (600 million miles) to Jupiter in a little less than 2 years.

Going in the other direction, a Mariner spacecraft will swing by Venus to Mercury in 1973, and in 1974 and 1975 Helios, our cooperative program with the West Germans, will fly three-quarters of the way to the sun to make the closest solar observations ever made.

Orbiting observatories will continue to push back the frontiers of the cosmos with their observations of features of the universe that are invisible from the surface of the earth. OAO-2, launched more than 3 years ago, is still hard at work. OAO-C, with a different and more complex set of ultraviolet measuring instruments, will be launched this summer. Development of the new High Energy Astronomical Observatory (HEAO) to look systematically at the mysterious X- and gamma-ray sources deep in the universe will proceed, aimed at launches in 1975 and 1977. We will also proceed as planned with OSO-I, the advanced satellite to observe the sun, but have deferred, at least for now, work on further satellites in this series.

Last in order in my statement, but perhaps first in importance, are our applications satellites:

The launch, early this summer, of ERTS-A, the first experimental earth resources survey satellite, will be a major milestone in the development of practical uses of space. The more than 300 experiments with ERTS data planned by over a dozen agencies and 21 foreign

countries will represent the most massive effort to date to explore experimentally the direct uses and benefits of space for men on earth.

The practical uses of weather satellites will continue to be pushed with the launch of the first SMS stationary weather satellite, further sensor experimentation with Nimbus satellites, and of the initiation of the development of TIROS N to incorporate the advances of recent years into the Nation's operational weather satellite system.

In the communications field, advanced technology and user experiments will be conducted with ATS F, scheduled for launch in 1973, and ATS G, now scheduled for launch in 1975.

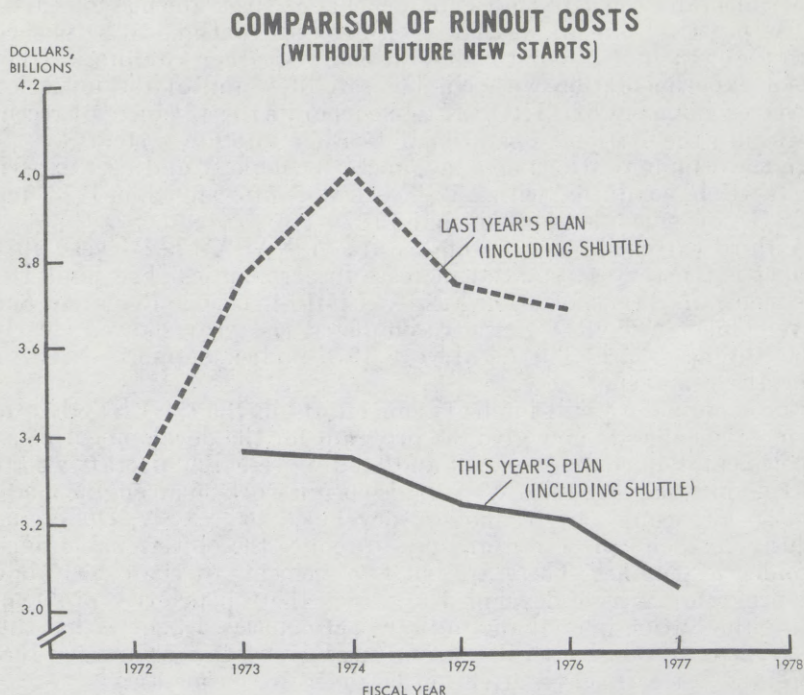
A third extremely significant feature of NASA's fiscal year 1973 budget is the very substantial increase in aeronautics. The joint Department of Transportation-NASA Civil Aviation Research and Development ("CARD") Study completed last year showed clearly what the needs are. The fiscal year 1973 budget supports NASA's efforts to meet them.

For example, we will intensify our efforts in the QUESTOL program—the name we now give the program for the development of an experimental quiet short takeoff and landing research aircraft we are starting in fiscal year 1972. We will also begin work on an engine modification kit, using new technology developed by NASA, DOT, and industry, which can permit airlines to reduce the objectionable noise of older jet engines. These are but two elements of the clearly laid out program we have developed to attack the top priority problems facing the Nation in civil and military aeronautics. I believe that this program is responsive to the strong urgings of this committee that more and better focused attention be given to aeronautics.

Let me now turn to the financial implications of our fiscal year 1973 budget. The NASA fiscal year 1973 authorization and appropriation request is \$3.379 billion. This budget was prepared under what I consider very tight constraints. The total has been held to approximately the same level as in fiscal year 1971 and fiscal year 1972. But we have applied this year yet another constraint of fundamental importance.

In developing the fiscal year 1973 budget, we have reconfigured NASA's programs and long-range plans in such a way that they will not commit the Nation to large increases in the NASA budget in future years. The projected total annual "runout" costs for continuing or completing the programs in our fiscal year 1973 budget do not rise above the level of the fiscal year 1973 budget. In contrast, the corresponding "runout" projections submitted last year rose to \$4 billion. Attached to my statement is a chart which graphically illustrates the difference in our planning, this year compared to last year.

(The chart referred to is as follows:)



Under our present plan, by properly time-phasing the start of future new programs, we can maintain a viable, useful, and balanced NASA program in space and aeronautics at a total annual budget level which, in 1971 dollars, can remain approximately at the fiscal year 1973 appropriation level for the indefinite future, unless of course, the President and Congress decide the program should be expanded or accelerated.

Mr. Chairman, I strongly believe that this posture of a realistic long-term plan in which the Nation's commitment is limited to budgets of approximately the current size is the proper posture for NASA from the standpoint of responsible management, and I believe it is also essential at this time to assure continued broad-based support for the NASA program.

To achieve this posture, we have had to make some basic changes in our planning and accept yet another stretchout of the period over which our continuing and long-term objectives in space exploration and space science will be achieved.

For example:

As I have mentioned, we selected a space shuttle concept with development costs about half of what the configuration envisaged last year would have cost, and whose peak annual funding requirements can fit within a balanced total NASA program at current total budget levels.

I should note, however, that those essential features of the Space Shuttle, for example, its ability to launch and refurbish satellites and return them to earth, are retained intact.

Next, we have reduced and redirected our program for exploration of the outer planets. The previously planned grand tour missions to the outer planets in the late seventies would have been costly and would have required heavy funding in the next few years to meet the unique launch opportunities. Partly for these reasons, the ground tour received less than wholehearted support from some of the scientific community. We have, therefore, replaced the grand tour missions with less complex missions in the same time period to Jupiter and perhaps to Saturn.

Finally, as reported in my letter of January 24, 1972, which has been placed in the record, we have decided to terminate the NERVA program for developing a 75,000-pound thrust nuclear rocket engine.

Under last year's budget we have been in a holding position in this program to see whether development of this engine should be resumed. The stretchout in our future plans necessary to avoid large overall NASA budget increases in future years served to push even farther into the future the earliest times we could hope to mount missions that would use the 75,000-pound NERVA engine. This fact, together with the need to hold down expenditures in the seventies, led us reluctantly to the conclusion that reinstatement of NERVA development could not be justified and that the existing development contracts should be terminated.

At the same time, cancellation of the grand tour missions has introduced the new class of future missions for which a much smaller nuclear rocket engine appears to be particularly well suited; the first missions to the distant planets—Uranus, Neptune, and Pluto—could be accomplished using this engine. Now that we will miss the opportunity for gravity-assisted grand tour missions, we will need a new high-energy propulsion system to reach these planets. A nuclear rocket engine in the 15,000–20,000-pound thrust class may well be the answer. In the fiscal year 1973 budget, therefore, NASA and AEC will proceed with definition of such an engine and the necessary trade-off studies to establish the preferred propulsion system for missions to these distant planets in the eighties.

Now I would like to mention a number of matters that will be of interest, I think, to the committee.

For NASA civil service personnel, the budget shows a reduction of 650 positions in fiscal year 1973, in addition to the fiscal year 1972 reduction of 850 made last year after our fiscal year 1972 budget had been approved by the Congress. These reductions, in effect, represent the application to NASA of the 5 percent across-the-board reduction in personnel ordered by the President last August. We had hoped to accomplish these reductions by attrition, but it now seems likely that some reduction-in-force actions will be necessary.

These most recent reductions, totaling 1,500, come on the heels of the 1,500 reduction previously planned in our fiscal year 1972 budget and yet another 1,500 reduction the year before. With our overall budget level and program not stabilized, I believe that our civil

service employment should likewise be stabilized at the 26,850 position level we will be reaching at the end of fiscal year 1973. Mr. McCurdy will discuss with the committee the results of his study of NASA's institutional base and personnel requirements later in these hearings. The proper and efficient management of NASA as an institution is one of our important continuing concerns.

Another matter of concern is the reliability of our two principal unmanned launch vehicles, the Delta and the Centaur. We are following up our reviews of recent failures with an intensive corrective program. The adjustments necessary in our fiscal year 1972 budget for this purpose will be the subject of an official reprogramming that will be sent to the Congress in the very near future.

In the area of facilities, I have approved the recent report of the Facilities Management Review Committee, appointed by Dr. Low last year, which was made available to the committee a short time ago. The authorization bill before you reflects its recommendations. I believe that by implementing this report, we can achieve substantial improvements in this area. I wish to express NASA's appreciation for the cooperation of this committee and its staff in developing improved methods for handling facilities matters.

Now, I would like to comment briefly on the status of our negotiations on space cooperation with the Soviet Union. As the committee has been advised, we have made what appears to be very good progress in several areas. We have set up three joint working groups in the fields of near-earth space, the moon, and the planets; satellite and rocket meteorology; and study of the natural environment. In the planetary field, we have arranged for direct teletype communications to exchange findings of special interest by the Soviet Mars 2 and 3 and the U.S. Mariner 9 missions. Lastly, we have had a series of detailed technical discussions on the design of compatible systems which would permit future United States and Soviet manned spacecraft to rendezvous and dock with each other for rescue or scientific or other purposes. There have been technical discussions of the possibility of an early experimental mission in which an Apollo spacecraft would rendezvous and dock with a Soviet Salyut-type space station. No decision has been made on conducting such a mission but we are taking the steps necessary to preserve the option for using surplus Apollo and Saturn IB hardware for this purpose.

Mr. Chairman, the committee will note that the format of our budget justifications book has been changed somewhat in an effort to present more clearly the need for and planned use of the funds requested. You will also be interested, I believe, to see that for the first time we have endeavored to present our technical justifications in metric units throughout, with conventional units indicated in parentheses where needed for clarity. This is the latest in the steps NASA has been taking in the converting to the use of metric units in our publications, in our thinking, and to the degree practical in our engineering and fabrication activities. This will take time, we realize, and there will have to be exceptions for some time to come. I note, however, that I referred a moment ago to the 75,000 pounds of the NERVA engine, not the 330,000 Newtons. That may be a little difficult to accept right away. But we share the committee's interest in moving steadily toward wider use of the metric system.

In conclusion, Mr. Chairman, I would like to say a very few words on the importance of the space program. Scientific knowledge, scientific exploration, and the practical applications of aeronautics and space are enormously important in their own right. But perhaps most important of all is the need for the United States to have a continuously advancing technology.

To meet the pressing social problems of our times requires above all a sound economy operating at a high level of employment to generate the tax revenues required at all levels of government. To maintain such an economy in a competitive world, we must increase our productivity year after year, decade after decade. The only way in the long term to keep increasing our productivity is through advancing our technology.

I know of no other activity which has done and can do as much to keep the United States strong in advanced technology as NASA's programs in space and aeronautics. Maintenance of technological leadership is a long-term matter. It takes many years for new technology to have its effects on the economy. But the problem is before us now. In 1971, the United States for the first time had an annual trade deficit, a net total deficit of over \$2 billion. But this deficit would have been three times that amount had it not been for the favorable balance of trade of almost \$4 billion the United States achieved in the aerospace field.

The economic necessity for advanced technology; the direct practical benefits of space applications and improved aircraft, including their significance for national defense; and—we should not forget—the human and future practical values of increased understanding of the earth, sun, moon, planets, and universe—these are the basic reasons for maintaining a strong national program in space and aeronautics. They are also the basic reasons why, in my opinion, Mr. Chairman, the Congress and the Nation should support the forward-moving and realistic program the President has recommended for NASA in his fiscal year 1973 budget.

Mr. Chairman, this concludes my statement.

The CHAIRMAN. Thank you very much, Dr. Fletcher. It was a very fine statement, and I want to congratulate you. The things you have said are an excellent kickoff for our hearings.

Mr. Mosher?

Mr. MOSHER. I join you, Mr. Chairman, in saying that this is an excellent kickoff for our hearings. It's a very insightful statement.

Dr. Fletcher, at the top of page 2, and again on page 10, you emphasize that you're proposing here a plan that does not commit the Nation to higher total NASA budget levels in future years.

I'm sure there's going to be some skeptics who think you must be using mirrors or sleight of hand, because at the same time you're proposing as a commitment for the Space Shuttle, the development cost of \$5.5 billion spread over a certain number of years; and I think this budget which you're proposing for 1973 contains only about \$200,000 for the Space Shuttle.

Dr. FLETCHER. \$200 million.

Mr. MOSHER. Yes, \$200 million for the Space Shuttle.

How would it be possible then to maintain a position of the same total budget while, I assume, in the next 2, 3, or 4 years you'll be rap-

idly expanding the amounts for the Space Shuttle? What will you be knocking out? What equivalents will you be knocking out of the budget in the next 3 or 4 years to make that possible?

Dr. FLETCHER. That question can perhaps best be answered by reference to our runout projections. In essence, as we phase out Apollo, and later the Skylab program, we will be phasing in the Shuttle, so that the total remains more or less constant. That still gives us room for new starts in fiscal year 1974 and in succeeding years.

Mr. MOSHER. What is the amount for the Apollo in this 1973 budget?

Dr. FLETCHER. In the 1973 budget, the amount is \$129 million.

Mr. MOSHER. That would be almost all gone after the next year?

Dr. FLETCHER. It will essentially all be gone in 1974.

Mr. MOSHER. Skylab amounts to how much?

Dr. FLETCHER. \$541 million in fiscal year 1973. We are estimating about half that amount for fiscal year 1974, and no request in 1975 or subsequent years.

Mr. MOSHER. So it isn't merely sleight of hand.

Dr. FLETCHER. We believe it is realistic fiscal management, Mr. Mosher.

The CHAIRMAN. This is based on today's dollar equivalents?

Dr. FLETCHER. Yes. I should have reemphasized that. This is all based on current dollars.

The CHAIRMAN. So, if the price of money goes down and things go up, it will mean more money in the future, but the effort will remain consistent?

Dr. FLETCHER. Yes, sir.

Mr. MOSHER. To repeat, you say these are not necessarily higher budget levels in the future. How many years do you contemplate this level may be maintained, unless the Congress approves substantial additional appropriations?

Dr. FLETCHER. Well, we tend to project our runout costs for 5 years, but to be sure that we were in good shape, we have made rough estimates throughout the end of the decade, and we see no reason why the budget should have to increase any time during this decade.

Mr. MOSHER. Mr. Chairman, just one more brief question.

The Tiros-N program, which would be the only new start, I think in your proposals for fiscal year 1973?

Dr. FLETCHER. Yes, sir.

Mr. MOSHER. Do I remember correctly that there are funds for Tiros-N proposed also in the NOAA budget being developed? Am I wrong about that?

Dr. FLETCHER. Somebody can correct me if I'm wrong, but I think the Tiros-N itself is our budget. Future Tiros' satellites that are operational would be in NOAA's budget.

Mr. MOSHER. I had some impression that there was some amount that would be in NOAA's budget this coming year for the development of Tiros-N.

Dr. Low. Mr. Mosher, as is always the case in developing a new satellite, it is agreed that we use NASA funds for the development of the first one and then funds are included in the NOAA budget for future satellites beyond the first one. I believe there are some funds requested in this year's NOAA budget for that purpose.

Mr. MOSHER. The point I want to make was that probably in Tiros-N and also in ERTS there are other agencies that will be appropriating certain funds to coordinate with NASA, and I think we should keep this in mind because it indicates that the funding and the emphasis on applications, looking at the total Federal budget is somewhat larger than would be indicated just in NASA's budget alone, and all of us on this committee are interested in the application for space science.

Dr. FLETCHER. Of course, ultimately the total in the other agencies' budgets will be much larger than it is now. But, as Dr. Low mentioned, we have an agreement with NOAA that we will develop the first prototype and then they will carry on with the operational systems. Of course, with this approach, the other agencies have to do planning, and that is true for ERTS, or Tiros, and any of the other applications programs.

Mr. MOSHER. But you would agree with me, in the total Federal budget there is an emphasis on applications of space science?

Dr. FLETCHER. Very much so.

Mr. MOSHER. It's actually larger than one might think just from the NASA budget.

Mr. SHAPLEY. Mr. Mosher, if I might supplement that, our information is that the total amount for space-related activities in the Department of Commerce, which is primarily NOAA, is \$44 million. I believe that illustrates your point.

Also, there are amounts ranging from \$3 million to about \$10 million in the budgets of other departments, such as Agriculture and Interior, I believe that this illustrates your point that the total effort in space applications is somewhat larger than appears in the NASA budget.

Mr. MOSHER. Thank you.

The CHAIRMAN. Mr. Teague.

Mr. TEAGUE. Doctor, one question. Is there a difference in this request as compared to the amount of money you requested of OMB?

Dr. FLETCHER. Yes. We have before you a \$3.379 billion program. Our minimum budget recommendation to OMB was \$3.385 billion, so the total is essentially the same. There were some changes, of course, in the content.

Mr. TEAGUE. Thank you, sir.

The CHAIRMAN. Mr. Hechler.

Mr. HECHLER. Dr. Fletcher, in your appearance before the Subcommittee on Space Technology several weeks ago, the committee stressed the necessity for a national offensive on the major problems in aeronautics: Noise, congestion, and safety, and I note in your statement of 18 pages there's less than one page devoted to aeronautics and there's very little indication in this statement of the kind of priority, which this committee has consistently urged in the field of aeronautics.

The second part of the question, I would like to observe that on page 17, in discussing a favorable balance of trade of almost \$4 billion, which you generally lump under aerospace, isn't it true that only a miniscule amount of that \$4 billion is keyed to exports of space and related vehicles?

A huge proportion of this \$4 billion is for the export of aircraft, aircraft engines, aircraft parts.

I wonder if, in making this statement, and devoting such a very small proportion of your statement to aeronautics and neglecting to

put the type of emphasis on aeronautics which this committee has consistently insisted on, whether you really intended to downgrade aeronautics to such an extent.

Dr. FLETCHER. Not at all, Mr. Hechler. We feel that the increase in funding of 50 percent in 1 year reflects the interest you have expressed in supporting aeronautics to the level that the country ultimately needs.

I would like to say a word of explanation concerning the statement I made this morning. I didn't want to make it too long. Our discussions and the statements we made during your recent subcommittee meetings, I hope, will convey what we really feel about aeronautics.

Mr. HECHLER. I was looking at this for a perspective. That's the reason I raised the question.

Dr. FLETCHER. There was no intent to slight aeronautics in any sense. In the final analysis, the increase in funding speaks for itself.

The CHAIRMAN. Mr. Wydler.

Mr. WYDLER. Thank you, Mr. Chairman.

Dr. Fletcher, I don't want to belabor the point, but just following up on what Mr. Hechler said, putting it in terms of a 50-percent increase sounds imposing, but I just want to point out that it's a percentage possibly of the total budget that is a more significant figure to be considered. If you would spend \$1 last year on aeronautics and you raised it to \$4 this year, you would say you had a 400-percent increase in your spending, but it really wouldn't make that much difference in the effect that it's going to have on the problems we face.

I want to say that I fully support and agree with a portion of your statement here today on our Nation's space program. I think you've made the right decisions and have the right priorities on what you're going ahead with and what you're trying to do, and I'll do my best as a member of this committee to help you achieve those, but I would be remiss if I didn't say that I think we are sadly lacking in the aeronautical part of the program, and I think nothing pointed this out more clearly than the very matters that you mentioned in your statement.

We've had committee hearings on this cost report which was made on the aeronautics program of the United States of America for a number of days, and the court report stated clearly that aeronautics is in trouble in our country, and that one of the major problems facing aeronautics is the problem of noise control, and during the course of those hearings, Dr. Fletcher, we were shown the schedule that NASA is following, that DOT is following, that the industry is following, on noise control of present aircraft, and that schedule showed us clearly that if they go along the way they're going now they're going to start retrofitting the fleet of air traffic that we now have creating the major noise problem about the end of the decade, which means that they will be retrofitting the planes at about the same time they're going to retire the planes from service, and it doesn't make any sense at all to follow that kind of a program. Something's wrong here somewhere, because what we're doing if that's so, is taking the public's money and spending it to do something that never will be done as a practical matter.

I think we need an urgent high priority, a push in this field of retrofitting, and if we don't get it we're just wasting the people's money on

this whole program; and I will tell you this: that I'm going to ask for this review at the highest level.

I realize that it's not necessarily within the control of NASA. I'm not criticizing the NASA efforts here today in this regard. But the present schedule and the present program is wholly inadequate, and I can see in your statement, for instance, where you're reprogramming money for work on the Centaur and Delta rocket, where you have a problem.

I applaud you for doing that, but I don't understand why we can't start thinking in terms of some sort of a crash program on this jet noise problem, and particularly on possibly reprogramming and putting additional money in this field where we could get quicker action, and which we really have to get if we're going to be practical at all with the people's tax dollars.

Dr. FLETCHER. I agree, Mr. Wydler, with most of the things that you've said, particularly with regard to the urgent need for the quiet engine.

As you point out, we don't have complete control of the retrofit program.

As far as the R. & D. is concerned, we are planning the R. & D. in such a way that we could make this retrofit by the middle of this decade.

You should know that, in large part because of your interest in the program and your encouragement, we are conducting a study in cooperation with the DOT to see if what you suggest is possible. I believe this study will be finished in about 45 days. It's just barely started. We'll have a lot more information at the end of this study.

Mr. WYDLER. You mean they're going to consider the schedule that we were told about during the course of the hearings, the present schedule of retrofitting?

Dr. FLETCHER. That is one of the things to be considered, yes.

Mr. WYDLER. Thank you.

Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Davis.

Mr. DAVIS. I have no questions, Mr. Chairman.

The CHAIRMAN. Mr. Winn.

Mr. Fuqua.

Mr. FUQUA. Dr. Fletcher, I have just two brief questions:

No. 1, you mentioned the configuration of the Shuttle. Is this the final configuration, or later in the year are we going to hear that has been modified, as we did last year?

Dr. FLETCHER. I'm quite sure that the orbiter is in the final configuration. We do have one more decision to make, and that is to decide whether or not the booster will have solid rocket engines or pressurized liquid engines. That decision will be made in a month or so, and then we'll go out with an RFP, and to the best of my knowledge, the configuration will not change after that.

Mr. FUQUA. The other question I'm very much concerned about is the termination of NERVA. You mention on page 13 of your statement that NASA and AEC are working together on the definition of an engine for missions in 1980.

Are you going to be able to utilize any of the NERVA technology, or is that going to be completely wasted?

Dr. FLETCHER. All of the technology that's been developed over the last several years in the large engine will be directly applicable to the smaller engine, so it will not be wasted effort.

Mr. FUQUA. Is there any percentage figure, not using the metric system, but some utilization that you might be able to calculate?

Dr. FLETCHER. It's hard to calculate in precise figures what percentage of the technology would be utilized, but I would say essentially all of the core technology, the reactor technology, the engine itself, the high temperature materials technology will be necessary for the development of small engines, and such a development wouldn't be possible if it hadn't been for the program carried out in past years.

Mr. FUQUA. So that money will not have been wasted?

Dr. FLETCHER. No.

Mr. FUQUA. Thank you, Mr. Chairman.

The CHAIRMAN. As a matter of fact, you can't say now that sometime in the future you may not need this, and that we have the technology from which to develop it.

Dr. FLETCHER. That's correct, Mr. Chairman. It is true that all the technology that we have developed will be useful for this small engine, but it's also true that some day we will probably build a larger engine, except that that is farther out into the future.

The CHAIRMAN. Thank you very much, Mr. Fuqua.

Mr. Frey.

Mr. FREY. Thank you, Mr. Chairman.

Doctor, let me ask you one basic question: What happens if we don't have the Shuttle?

Dr. FLETCHER. As we have stated, we regard the Space Shuttle as the key to this Nation's future space programs. If we did not have the Shuttle, it would mean that presumably we would have to use the 1960 technology of expendable boosters to attempt to carry out the programs of the eighties and beyond. The clear result would be that during that period we would be able to do much less for the same total budgets.

Mr. FREY. Isn't it true that after 1973, without the Shuttle, we won't be in manned space?

Dr. FLETCHER. That's correct. Without the Shuttle, there would be no U.S. manned space flights after the Apollo and Skylab missions are completed.

Mr. FREY. In your view is the Shuttle absolutely essential?

Dr. FLETCHER. We have to have the Shuttle to do the things the Nation ought to do in the years ahead. I can't say honestly that the space program will fall to pieces without the Shuttle, but certainly we won't be able to do the things we ought to be able to do.

Mr. FREY. I yield to the gentleman from New York.

Mr. WYDLER. I think Mr. Frey is asking for some reactions to this. If we didn't have the Shuttle in this year's program, if we eliminated it, what would the effect be, for instance, in the employment levels of NASA? Has anybody ever done any research on that?

Dr. FLETCHER. Yes. If for some reason we didn't develop the Shuttle, there would be 50,000 less jobs 3 or 4 years from now as the manned space program was phased out.

So it does mean 50,000 jobs.

Mr. FREY. One further question, Mr. Chairman.

You're talking about the booster and the definition of it. How do you make the decision that it's going to be a recoverable booster?

Dr. FLETCHER. That decision has not been made. Within the next month or so we hope to decide that.

There are two versions of the booster being considered, as you may recall, a pressure-fed liquid, which is recoverable, and a solid-rocket version, which may or may not be recoverable, but probably would not be.

Mr. FREY. But in either case they're going to be jettisoned or dropped?

Dr. FLETCHER. Yes, sir.

Mr. FREY. What percent of your planned launches are to the east?

Dr. FLETCHER. I don't recall the exact percentage. It's on the order of half. I would say 50 percent.

Mr. FREY. Thank you very much.

The CHAIRMAN. Mr. Symington.

Mr. SYMINGTON. Thank you, Mr. Chairman.

I would like to begin by complimenting you, Dr. Fletcher, on a very fine statement and one which I think will receive wide support, particularly with reference to your mention on page 10 that you are keeping within past budget limitations on future projections in order to assure broad-based support. I would therefore echo for another kind of broad-based support, the comments of Mr. Wydler and Mr. Hechler concerning the need to demonstrate that NASA is doing all it can to bring to this country a high level of aeronautic technology, not only in good working shape here, but competitive abroad.

With reference to that, you mentioned a \$4 billion saving to the balance of payments due to aerospace exports.

Could we get, or is there a breakdown, of the sources of that saving?

Dr. FLETCHER. I'm sure we can provide such a breakdown for the record.

Mr. FREY. Could that be submitted for the record?

The CHAIRMAN. I agree that it might be useful for the record to have a breakdown of the savings achieved in the aerospace industry. If you can furnish that, we would appreciate it.

Dr. FLETCHER. Yes, I can.

Mr. SYMINGTON. I think that would give us an opportunity to know the problem and bring it to its proper level of understanding if we could have that information.

(The information to be furnished by Dr. Fletcher is as follows:)

Question. Could we get a breakdown of the \$4 billion in savings to the Balance of Payments due to aerospace products?

Answer. Preliminary foreign trade figures from the Department of Commerce show the following 1971 results for the aerospace sector:

[In millions of dollars]

	Imports	Export
Civilian aircraft.....	39	1,893
Military aircraft.....	(1)	648
Aircraft engines and parts.....	37	467
Rockets, guided missiles, and parts.....	(2)	129
All other products.....	264	1,042
Total aerospace products.....	340	4,179
Balance of trade in aerospace products.....		+3,839

¹ Less than \$1,000,000.

² Not separately reported.

Mr. SYMINGTON. Again with respect to the shuttle, I think there were statements by AEC Chairman—Schlesinger—in an article in U.S. News and World Report with reference to new energy sources and what may have to be done with radioactive waste from nuclear plants. It indicated that it might be necessary to send some of it out into the universe, perhaps to the sun. Dr. James R. Schlesinger, Chairman of the Atomic Energy Commission, had testimony with respect to new sources of solar energy, which involved putting into orbit something of considerable size and weight, possibly in sections.

Would you care to comment on whether the Space Shuttle technology is relevant to either or both of those possible future needs?

Dr. FLETCHER. Of course the Space Shuttle is not only relevant, but probably necessary to those two programs that you mentioned. The decision as to what to do with the radioactive waste, however, is up to the AEC. But the only way you can transport them out into space or into the sun would be through a low cost transportation system.

With regard to the possible use of solar power being generated in outer space and being transmitted to the ground, that is a program which is under study now at NASA and at the National Science Foundation. The President has asked NASA and NSF to look at this possibility, and we are definitely considering it. For that also it would be absolutely necessary to have a low cost transportation system.

Mr. SYMINGTON. Thank you very much. Thank you, Mr. Chairman. The CHAIRMAN. Mr. Goldwater.

Mr. GOLDWATER. Thank you, Mr. Chairman.

I believe that we were all delighted to hear the President emphasize the need for increasing our efforts in research and technology, and I would like at this time, Dr. Fletcher, to commend you for the part that you have played in bringing this needed emphasis to the American people. I know you have worked very hard with the DOD and other members of the Presidential staff to bring recognition to the science community, and I think you are to be commended, you and your staff, for the part which you have played.

Dr. FLETCHER. Thank you.

Mr. GOLDWATER. I would also like to join with Mr. Wydler, Mr. Hechler, and Mr. Symington in their views with regard to aeronautics. I believe if we're going to proceed and provide the necessary vehicles for future transportation, then we've got to continue to a greater degree with the necessary research and development that will provide the breakthroughs necessary to meet the needs of the public in the future.

I would like to ask you one or two questions concerning the nuclear engine.

I would like to request, if you could tell us, exactly how much money has been spent to date on the development of the NERVA.

Dr. FLETCHER. You can get somewhat different answers, depending on what is included in the cost of NERVA. The official estimate, I believe, of NERVA itself is about \$614 million dollars. Some people add to that the cost of development of reactors and things of that sort that started before the NERVA program, which would make it come up to a somewhat higher figure.

Mr. GOLDWATER. Some have estimated close to a billion dollars.

Dr. FLETCHER. That is not a bad estimate if you include all the things that might be included as NERVA's program.

Mr. DAVIS. Will the gentleman yield?

Mr. GOLDWATER. Yes, sir.

Mr. DAVIS. Does that include the old programs, the reactors and so on?

Dr. FLETCHER. Yes, sir.

Mr. SHAPLEY. It also includes the AEC funding, as well as NASA.

Mr. GOLDWATER. How much of the total \$600 million, or close to a billion, is the Atomic Energy Commission and how much is NASA?

Mr. SHAPLEY. The AEC amount in that estimate, Mr. Goldwater, is \$321 million, and the NASA amount is \$293 million.

Mr. GOLDWATER. I assume that you've been in consultation with the AEC on this decision to terminate the high thrust engine. Are they in agreement?

Dr. FLETCHER. Yes; they're in agreement. In fact, the initiative for this small thrust engine came from one of the laboratories at AEC.

Mr. SYMINGTON. Would the gentleman yield?

Mr. GOLDWATER. Yes.

Mr. SYMINGTON. Dr. Fletcher, some of that \$600 million, or \$700 million would be relevant to the development of a smaller engine, and I think you should go ahead with that. I certainly wouldn't consider the technology wasted entirely. Could you assign some percentage of applicability?

Dr. FLETCHER. Essentially all of the technology developed over the years for the \$600 million is applicable to the small thrust engine.

Mr. SYMINGTON. Thank you.

Mr. GOLDWATER. I think that's significant. I'm sure that much of the knowledge that we have acquired will remain available, and perhaps even some of the equipment. But what about technical excellence in personnel? By cutting back or terminating NERVA are we not in a position of losing much of this expertise? Are we not in a position of losing many of the trained technicians who have come through this program and have developed to very high standards?

I remember this was a concern last year, that if we cut back—not terminate, but cut back—it would greatly hinder the whole program and there would be a tremendous loss of personnel and I'm wondering what will be the impact.

Dr. FLETCHER. As you know, Mr. Goldwater, last year there was a very large cutback in the NERVA program. The cutback this year will essentially keep intact a core of personnel, and some contractor effort will still be required.

Components will have to be purchased. It's very likely that some of the people who are involved in the Westinghouse program will find their way into other aspects of the program. The overall level is less than it was last year, and of course we will lose some of the people. We hope to keep the core of key personnel intact.

Mr. GOLDWATER. I think that would be important.

I'm wondering, what do you estimate to be the total development cost of the new AEC prototype NERVA?

Dr. FLETCHER. I think that any number that I gave you now would have to be taken with some degree of uncertainty, but we estimate that approximately \$200 million would be required to develop an operational prototype engine in the 15-20,000-pound thrust range. That's a very approximate figure.

Mr. GOLDWATER. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Hanna.

Mr. HANNA. Thank you, Mr. Chairman.

I was looking at the part of your statement that referred to the facilities, and I noted your reference to the study that was made by Dr. Low and is incorporated here, for the same facilities that were operated by NASA which you have closed, or are in the process of closing.

At this time do you still have all the facilities that you had when you went into the program?

Dr. FLETCHER. I'd like to turn to Dr. Low on that one.

Dr. Low. We have phased out a large number of facilities, Mr. Hanna, particularly in the industrial area. In many of our industrial plants, as the work on Apollo came down, portions of those facilities have been phased out.

Mr. HANNA. Then the situation is, I take it, that we haven't any ownership in the land or the facilities? Is that right? Were those turned over to GSA?

Dr. Low. The Government-owned facilities were disposed of through the GSA in the normal means.

Perhaps the best example of a NASA center being phased out—one that I should have mentioned earlier—is the electronics research center in Cambridge, Mass., which was turned over to the Department of Transportation in July of 1970, and is now doing extremely useful work as the Transportation Systems Center of DOT.

Mr. HANNA. Are there any facilities that you are now operating that you contemplate phasing out at a later date?

Dr. FLETCHER. We don't have any facilities, Mr. Hanna, that we are planning to phase out beyond those already phased out.

Mr. HANNA. I also notice that there is a wide power of transfer of funds in this bill, primarily for construction issues, and improvements in existing facilities. In other words, if all of the money, including that set up under 1.a and 1.c, aside from 1.b, which would be in the budget for construction, you have the power to transfer those funds with certain limitations.

Can you explain to me the necessity for all of that flexibility?

Mr. SHAPLEY. Mr. Hanna, the provisions in the bill as they are submitted to the Congress this year are slightly revised from those appearing in previous years. In broad outlines, however, the effects are essentially the same. This is the authority that the committee and the Congress have given NASA over the years.

The need for the flexibility stems from the fact that because of uncertainties which are inherent in the research and development process, occasions can arise, either from result of emergency or otherwise, where requirements for construction of facilities need to be met during the year, in the course of a year before the subsequent year's authorization. This is true at industrial contractors' plants, and at NASA installations.

The provisions of the bill require the reporting of these instances, and the facilities Review Committee, which you alluded to, recommended that in each instance the committees of Congress be notified, and these matters will be handled in that way under the bill before you.

Mr. HANNA. For those totaling \$250,000 per project or more. It just seems rather strange to me that with your past experience there would have to be that degree of flexibility.

I'm just trying to find out why that should be continued year after year. It seems like maybe you should have put more money in the facilities part of the budget in the first instance.

Mr. SHAPLEY. In the budget each year, Mr. Hanna, all the foreseen requirements for facilities are placed in the construction budget. Occasionally, in a new research and development program getting underway, the program has not reached that point in the planning, at the time the budget must be submitted to Congress, to be sure exactly what and where these facilities requirements are.

The CHAIRMAN. Would it be appropriate for the committee to ask NASA to provide a review of the extent to which these authorities have been exercised within the past year?

Mr. SHAPLEY. We'd be pleased to do that. Also, we plan to testify on this subject in more detail at a later hearing on the provisions of the bill.

Mr. HANNA. Thank you very much.

(The information to be provided is as follows:)

Section 3 of the annual NASA Authorization Act provides that:

"Not to exceed one-half of 1 per centum of the funds appropriated pursuant to subsection 1(a) hereof [For 'Research and Development'] may be transferred to the 'Construction of facilities' appropriation. . . ."

Section 3 sets forth the conditions under which this transfer may occur and the procedural and notification requirements which must be met.

The FY 1971 appropriations for NASA were as follows:

Research and development-----	\$2, 565, 000, 000
Construction and facilities-----	24, 950, 000
R. & PM-----	722, 669, 000
Total -----	3, 312, 619, 000

Thus, under Section 3 of the Authorization Act, 1971, \$12,825,000 was available for transfer to "Construction of facilities," and NASA has exercised that authority on four occasions. The total involved was \$3,805,000 for the following projects:

1. Ames Research Center, Moffett Field, Calif. Addition to Data Reduction Center for ILLIAC IV computer system. This is a single story addition to the data reduction building to house the computer system----- \$1, 200, 000
2. Manned Spacecraft Center, Houston, Tex. Lunar curatorial facility. Provides a facility for receiving, processing, and storing lunar samples returned from later Apollo missions----- 450, 000
3. Marshall Space Flight Center, Huntsville, Ala. Mission simulation structural test facility. Modifies the S-11 structural test facility to provide a large scale (104-inch diameter) test capability to support the Space Shuttle program----- 1, 500, 000
4. Lewis Research Center, Cleveland, Ohio. Vertical life engine test facility. Provides a facility for noise and ground effects testing of V/STOL and STOL engines at full scale----- 655, 000

In each of these instances, formal notifications to the Speaker of the House of Representatives and the Committee on Science and Astronautics were sent and the required 30-day waiting period was observed.

The authority in Section 3 of the 1972 Authorization Act to transfer funds from R&D to CofF has not been exercised.

The CHAIRMAN. Mr. Flowers.

Mr. FLOWERS. I must admit I viewed the announcement of the shuttle program with something less than enthusiasm, which some of the others have spoken of, because I think it represented something less than the program that some of us had hoped for in the way of a recoverable booster than what is offered.

Let me ask a couple of allied questions.

The proposed orbiter, Dr. Fletcher, as I understand it, the thinking now is basically more austere than it would have been with the airplane recoverable booster. Is that correct, sir?

Dr. FLETCHER. With one essential difference, and that is that we decided to put the fuel and oxygen tank, the gas tank so to speak, on the exterior of the orbiter.

Mr. FLOWERS. Exterior?

Dr. FLETCHER. Otherwise it's the same.

Mr. FLOWERS. They would be dropped at appropriate heights and disposed of in the atmosphere. Is that correct?

Dr. FLETCHER. They would be dropped from orbit.

Mr. FLOWERS. From orbit?

Dr. FLETCHER. At a place where it would be very sparsely populated probably.

Mr. FLOWERS. The Indian Ocean?

Dr. FLETCHER. Yes; the Indian Ocean, or something like that.

I should have mentioned that there was one other difference: although the payload compartment of the orbiter is essentially the same, the overall size orbiter, of course, is reduced.

Mr. FLOWERS. This resulted from putting the tanks on the outside, rather than on the inside?

Dr. FLETCHER. Yes, sir.

Mr. FLOWERS. The booster is where the major change has occurred.

Is there any consideration now under this concept of a manned booster?

Dr. FLETCHER. There is no money in the budget for development of a manned booster. Of course, this would always be possible, I suppose.

Mr. FLOWERS. Somewhere down the road?

Dr. FLETCHER. Later in the decade.

Mr. FLOWERS. What we're doing is we're trading off basically money saving now in the hope that this could be developed down the road at what would then be a much higher price probably too?

Dr. FLETCHER. I wouldn't want to say that we are deferring the essential features of the Shuttle until a later time. The Shuttle, with the ballistic booster, will be an extremely useful device, and has essentially all of the same capabilities that the flyback booster would have, except the cost per launch is slightly increased. But it does have the payload recovery capability. The orbiter is essentially the same, as mentioned, and all of the advantages that you get from recovery of payloads, refurbishments, and so forth, are still there.

So the booster that we're talking about, plus the orbiter, is a very useful device.

Mr. FLOWERS. My own personal judgment is that I think perhaps the recoverable total package could have been sold better than we're giving ourselves credit for, because part of their appeal is the total recoverability, or would be the total recoverability of the entire package; and now, under this concept, we're recovering the lead on the pencil, but very little else. So you don't have that as part of your sales pitch to the Congress or to the American people.

Mr. FREY. Would the gentleman yield?

Mr. FLOWERS. Yes.

Mr. FREY. Dr. Fletcher, would you give us the difference in cost between the unmanned booster and the manned recoverable booster? Perhaps that's the original thought in what we're talking about today.

Dr. FLETCHER. The difference in cost of the booster alone, if we kept exactly the same orbiter, would be something like \$1.5 to \$2 billion. We don't know exactly how much. There are so many uncertainties involved in this type of recoverable booster that the cost difference might have been larger than that. We decided that this was not a risk that we should take at this time.

Mr. FREY. Of course, one of our sales pitches on the recoverable craft was the reduction in cost per pound, but now that you're going back to this concept, it seems to me you're increasing the cost per pound, and it almost in a sense destroys the sales pitch that we originally conceived for the craft.

Dr. FLETCHER. I think the cost per pound over the craft that was originally conceived a year, or a year and one-half ago, is up somewhat, maybe 50 percent, but the savings are still enormous. For example, it might have been 10 to 1, 2 years ago, and now it's only 6 or 7 to 1.

Mr. FLOWERS. Those are the front-end savings on development costs that you're talking about, and so on.

Before my time runs out, let me ask you:

Under the present concept you say it's a question of the high-pressure liquid fuel or the solid fuel.

Does Saturn I-B enter into the picture, and if it does, how?

Dr. FLETCHER. I don't think the Saturn I-B per se as a booster enters into the picture. Of course, components from this Saturn I-B and Saturn V will be used to a very large extent. Also, and maybe more importantly, the technology developed under the Saturn program will be directly applied to the booster development.

Mr. FLOWERS. In the ballistic-type vehicle is there any possibility of an unmanned recoverable booster? Is that in the thinking?

Dr. FLETCHER. Yes. The pressure-fed liquid booster would be unmanned and recoverable.

Mr. FLOWERS. It would land in water, but it would be unmanned?

Dr. FLETCHER. It would land in water, but it would be water recoverable.

Mr. FLOWERS. Water recoverable only?

Dr. FLETCHER. Water recoverable only.

The CHAIRMAN. Mr. Winn.

Mr. WINN. Thank you, Mr. Chairman.

Along the same line, Dr. Fletcher—and I think you just answered part of my question in your reply to Mr. Flowers—in the modified design of the space shuttle, is the inland design out, or is it still feasible for landing and launching?

Dr. FLETCHER. At the present time we haven't finished our studies, so I can only guess how it might come out. I think that it would be pretty difficult to recover the pressure-fed liquid booster inland, and I would guess that would not be a likely possibility.

On the solid booster, inland launch is certainly possible, and studies are underway now to see what that entails. That's a quick estimate of my own personal feelings as to how it would come out. The real

answer must come out of the Site Selection Committee, which is very intensely working on this problem.

Mr. WINN. I understand that. But my concern is, as I understand it now, the decision is to be made in April. Originally we heard the decision was to be made in October.

Can we count on an April decision as a final decision? We've got 35 States and 45 sites that are all up in the air, and a lot of them are spending a lot of money trying to sell the committee members and sell NASA on the project.

I just wondered if we can really depend on April as the final decision, or is that too close?

Dr. FLETCHER. Your point about doing it as soon as possible is absolutely well taken.

We find it somewhat difficult to make a decision on the site without making a decision on the particular booster. We probably could make the decision, but it might not be the right decision, and so we are going along that dual path until that decision on the booster is made, and as soon as possible thereafter we will make the site selection.

Mr. WINN. Is it subject to additional changes, other than the modified changes? Do we have a lot more possible changes in midstream like we had before?

Dr. FLETCHER. No, sir. Not that I know of. We plan to freeze the configuration in time for the request for proposals, which is expected this spring.

Mr. WINN. Thank you. Thank you, Mr. Chairman.

The CHAIRMAN. Mr. Cotter isn't here. Mr. Roe isn't here, or Mr. Camp. Mr. Seiberling.

Mr. SEIBERLING. Thank you, Mr. Chairman.

Dr. Fletcher, I want to commend you for the very hard decisions that you've made with respect to priorities, and I too think that you've come up with some very, very sound decisions.

Such things as the grand tour were very, very thrilling and exciting prospects, but I guess NASA, like individuals, has to forgo some of the frills in order to cope with the necessities of life.

The presentation you've made on the Space Shuttle I think has been very good, as has the appendices that you presented.

I guess we all know that there's going to be a major battle over the Space Shuttle, and I think that it behooves NASA, as well as this committee, to do an effective job of demonstrating, as soon as it can be demonstrated, that this is a desirable thing from the standpoint of overall aeronautic priorities.

I am a little bothered by the reference in your presentation to the military uses of the Space Shuttle, and I just wonder if Congress' approval of the Space Shuttle, in your opinion, implies some commitment to any particular uses in space, bearing in mind that there are international treaties limiting military activities in space, and hopefully we will succeed in keeping any major nuclear, and possibly other military activities, out of space.

Does the NASA budget include any military programs for the use of the Space Shuttle?

Dr. FLETCHER. The NASA budget does not include any military programs for the Space Shuttle. We have tried to tailor our specifications for the Shuttle so that the military could use the Shuttle if they

so desired, but any plans that the military would have would be their own. They now use the same kinds of boosters that we do. We borrow from them, and they borrow from us, and it would certainly be wise for the Shuttle to be compatible for both programs.

Mr. SEIBERLING. Is there any way of estimating how much the cost of the Space Shuttle development is the result of purely military considerations?

Dr. FLETCHER. Since I've been at NASA I have been intensely involved in all of the cost studies and design changes, and so forth, and I can't find any cost that is there solely because of military requirements.

Mr. SEIBERLING. Thank you.

I have one other question with respect to the aeronautical aspect of your budget.

Does this include any aeronautical research with respect to SST's?

Dr. FLETCHER. No research with respect to SST's per se. A good bit of the technology that is being developed in our science and technology programs, of course, could be applicable to an advanced transport, either supersonic or otherwise.

Mr. SEIBERLING. Apparently other countries are continuing to go ahead with SST's, and one of the serious issues that was raised and conveyed on the SST's in the Garvan report, which was subsequently published, was the environmental implications of a fleet of 500 SST's, particularly the effect of nitrogen oxide on the ozone and the stratosphere.

Since other countries are going ahead with these programs, I wondered whether NASA is doing anything about taking a look into the environmental effects, or is that something that is properly under EPA, or some other department of the Government?

Dr. FLETCHER. NASA is involved in looking at the environmental effects of advanced supersonic transports. We have a research program.

George, would you like to add to that?

Dr. Low. I think you've covered it, Dr. Fletcher. The Office of Aeronautics and Space Technology, and the Office of Applications, are jointly looking at the environmental effects of supersonic flight of the type that you mentioned, Mr. Seiberling.

The purpose of the program is to be prepared to answer environmental questions with more accuracy should questions be raised again in the future.

Mr. SEIBERLING. Do you have any prospective timetable as to which you expect to have any results from this study?

Dr. Low. This is a continuing program, and there are no timetables for completion.

Mr. SEIBERLING. Thank you very much. I thought it was an excellent presentation.

Dr. FLETCHER. Thank you.

The CHAIRMAN. Mr. Coughlin. Mr. Murphy. Mr. McCormack.

Mr. MCCORMACK. Thank you, Mr. Chairman.

Dr. Fletcher, I also want to congratulate you and your staff on your fine presentation today.

I have one area of questions that has to do with the discontinuance of the NERVA project. I am troubled by one aspect of the discussions

so far, which seems to be omitting any reference to the ability to lift payloads from lower orbit to synchronous orbit. I'm particularly concerned because it seems to me that one of the things we're going to need in the 1980's is this ability, not only for research in solar and sonar energy, but for many other applications.

I'm sure you are more aware of the many applications of this orbit than I am, but I think we're all aware that there are many. Some of these may be, of course, very large payloads.

The NERVA was always presented to us as a vehicle, or an engine, that would provide the energy to go to low orbit or to synchronous orbit in its substantial payload. It's one of its objectives, one of its jobs.

What will we have, Dr. Fletcher, in the 1980's to take large payloads from lower levels to synchronous orbit?

Dr. FLETCHER. The Shuttle will accommodate, at least two existing transfer stages: the Agena and the Centaur; not that either of these will be the principal transfer stages, but certainly we could use them almost as is for transfer to synchronous orbits.

The point I think you are making about the NERVA is that it would have the potential for putting much larger payloads into synchronous orbits.

Mr. McCORMACK. And using the same vehicle over and over as the power system?

Dr. FLETCHER. Yes. I think that is a good point. Even with the small NERVA, if you like, the 15-20,000-pound engine, very large payloads could be put into synchronous orbit and returned, and that is, of course, one of the things that we will look at during this year, to see if we can use the small nuclear engine for that application.

Mr. McCORMACK. One of the disadvantages of using the small nuclear engine, of course, will be a substantially longer time requirement for lifting from lower to synchronous orbit, will it not?

Dr. FLETCHER. It will take a relatively long time, but it's of the order of hours, not days.

Mr. McCORMACK. I see.

Dr. FLETCHER. With chemical rockets the time would be shortened somewhat, but I think the main advantage of using the nuclear engine would be to put larger payloads, less expensively, into synchronous orbits.

Mr. McCORMACK. You have funded research, or at least the economic evaluation, of satellite solar energy, I understand.

Dr. FLETCHER. Yes, sir.

Mr. McCORMACK. Will this evaluation take into consideration lifting the vehicles from low orbits to synchronous orbits, the various costs and times involved?

Dr. FLETCHER. The study going on now is not exclusively a NASA study. It's a joint NASA and NSF study. George, will that be one of the requirements?

Dr. Low. We have not yet funded an evaluation in this area, but a number of industrial firms have done so. We do plan to go forward with a more intensive study, and certainly the cost of transportation to synchronous orbit will be one of the parameters that will be considered in that study, and also the kind of stage that would be used will be considered in that study.

Mr. McCORMACK. Thank you.

May I then suggest, just in closing my comments for today, that a realistic attempt should be made to estimate the gross amount of payloads, the number of payloads that will be required if satellite solar energy is economically feasible by the year 2000.

There is every reason to believe there will be a large number, a very large number, of satellites with station keeping crews and maintenance facilities, perhaps even fabrication facilities, for solar cells in synchronous orbit.

This has a very significant impact, let's say, on any economic feasibility studies, or any lifting from low orbit to synchronous orbit.

Dr. Low. You're quite right, and we agree.

Mr. McCORMACK. Thank you.

The CHAIRMAN. Mr. DAVIS.

Mr. DAVIS. Dr. Fletcher, I also congratulate you on a fine presentation this morning.

In your reply to Mr. Frey's question about the Shuttle you made the statement that we would have to do without several future projects that we will need in the United States unless we have the Shuttle.

Is there a list of priorities on this yet?

Dr. FLETCHER. My comment was that unless we have the Space Shuttle the cost for payloads and for getting the payloads back and forth into orbit would be much larger in the eighties, and so the things that we could do would be correspondingly less for the same total budget. We just would have to cut back generally on the space program in the eighties if we did not have the Shuttle. We haven't singled out any particular project that we could not do if we didn't have the Shuttle.

I think, in addition to that, it should be pointed out that there are a number of things that only the Shuttle can do, for example, you mentioned solar power, and somebody else mentioned the disposal of nuclear waste. There's also the potential for quick reaction, with the possibility that experiments will take 6 months instead of 6 years to get out into space. This would be true also in meeting military requirements. All of these you would give up, because there is no other way to do them except with the Shuttle.

Mr. DAVIS. Thank you, Mr. Chairman.

The CHAIRMAN. I want to welcome Mr. Bergland. He is a new member of our committee.

Do you have any questions?

Mr. BERGLAND. Thank you very much, Mr. Chairman.

I have no questions this morning. I'm delighted to be assigned to this committee.

I've been impressed by your statement, Dr. Fletcher, and was further impressed with the fact that I have an enormous amount of homework to accomplish before I can contribute much to this committee.

Thank you, Mr. Chairman.

The CHAIRMAN. I overlooked one man, my good friend, Congressman Camp.

Mr. CAMP. Thank you, Mr. Chairman.

I would like to say that we do welcome you and your colleagues here, Dr. Fletcher.

I have just one question:

What is NASA doing to inform the general public of its activities, and what funds will it need to accomplish this?

Dr. FLETCHER. As you know, this committee has encouraged us a great deal in this regard, and we have made a very large effort to try to do this within the budget limitations that we have on our public affairs activities.

We have a series of programs through the news media, through television programs, through visits of astronauts, and supplying materials to this committee, that are designed to inform the public on what NASA is doing.

We also have an intensified effort at the various visitor centers, particularly at Cape Kennedy. Last year we had 21½ million visitors at our visitor centers, where we have educational programs.

I should also mention the lunar samples that are on tour and on exhibit in various parts of the United States.

All of these together represent intensified efforts to try to inform the people of NASA's programs.

I don't think we're as far along as we would like to be. We've got a lot more work to do, but I think we've made great strides in the last year or so in this regard.

Mr. CAMP. Do you have any knowledge of what industry is doing in this area?

Dr. FLETCHER. No direct knowledge, but they send me copies of a lot of things that they do, and I must say that I'm impressed.

The industrial people are doing a large amount, particularly in terms of television programs—I learned of one 15-minute program last week, for example, that was put together by one of the aerospace companies—and also by brochures which describe particularly the benefits of the space program. I don't mean psychological benefits. I mean the direct down-to-earth benefits of the space program.

These are just some of the things that I have noticed. But we don't have any direct control, of course, over what the industry does. We watch it happening and, of course, are interested.

Mr. CAMP. Mr. Chairman, may I just comment that I believe that the report of the committee, made to Congress here, within the last month or 6 weeks has been one of the best public relations jobs I think that has been done and given to the general public.

I must suggest, not only to the members of the committee, but to Members of the Congress, that they use this information in their visits back home with their people, and the remarks that they make to them, showing all the beneficial spinoffs of NASA work, which I think is a tremendous effort, what the committee has done, and I think it's good information for the people.

I think we should have had SST, and I think we would have had the Shuttle program probably earlier, if they'd had this report a little bit earlier.

Thank you.

The CHAIRMAN. Thank you, Mr. Winn.

Mr. WINN. I would just like to add to what Happy Camp had to say.

I want to congratulate NASA and also private industry on the strides they have made in the last 2 years. This is my sixth year on the committee, and I've seen remarkable strides in the area of public relations and telling the story.

NASA has led the way, even with the constant tight budget that they have had. Private industry, as you say, has done a very fine job. I've seen a lot of radio and TV shows, and those brochures. I've used those on my radio programs that I carry at home. Some of us on the committee have added to the number of people who have been visitors down at the Cape, and I intend to continue to do so. I have a hundred people waiting to find out when you're going to shoot Apollo 16—from my State.

I think the members of the committee should be made more aware, particularly the newer members, of the strides that have been made, and I think that we can do a bigger and better job of selling the programs by the use of our radio and television time, as given to us as Members of the Congress. We have the materials right there and I report, Mr. Chairman, I think we could sort of lead the way too.

The CHAIRMAN. Thank you. I want to call to the attention of the members present the fact that tomorrow morning we will meet here again to receive from the National Science Foundation a basic presentation of their program, the same as we have received from the National Aeronautics and Space Administration today.

Dr. Fletcher, I want to thank you, and congratulate you on a very fine job.

The meeting is adjourned.

(Whereupon, at 11:55 a.m., the committee adjourned.)

1973 NASA AUTHORIZATION

FRIDAY, MARCH 17, 1972

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

The committee met, pursuant to adjournment, at 10 a.m., in room 2318, Rayburn House Office Building (Hon. John W. Davis) presiding.

Mr. DAVIS. Gentlemen, the committee will be in order.

We are convened today to receive final testimony on the fiscal year 1973 NASA authorization bill to assist us in our deliberations on the markup of the bill scheduled for next week.

I wish to announce at this time that the committee will meet at 10 a.m. on Wednesday, March 22 and Thursday, March 23 to receive the subcommittee reports on both the NASA and NSF bills as well as other pending legislation.

The committee will receive subcommittee reports next week in the following order:

Subcommittee on Aeronautics and Space Technology.

Subcommittee on Science, Research, and Development.

Subcommittee on Manned Space Flight.

Subcommittee on Space Science and Applications.

After receiving the subcommittee reports, the committee shall proceed with the final markup of pending legislation.

This morning we are privileged to have as witnesses, Dr. George M. Low, Deputy Administrator, NASA, who is accompanied by Mr. Richard C. McCurdy, Associate Administrator for Organization and Management; Mr. Bernard Moritz, Deputy Associate for Organization and Management; Maj. Gen. Robert H. Curtin, Director of Facilities, Office of Administration, and Mr. George Cherry, Deputy Associate Administrator for Aeronautics and Space Technology.

The committee will receive first, a report on the institutional base study announced by Dr. Low last year. This will be followed by testimony on the general provisions of the NASA bill and those items included in the bill which are not assigned to any of the subcommittees.

Dr. Low is here especially to answer any additional questions the members of the committee may have on the overall NASA authorization request preparatory to our final deliberations on the bill.

After receiving this testimony, the committee will view the jet engine noise abatement demonstration previously presented before the Subcommittee on Aeronautics and Space Technology.

I would suggest that the witnesses present their statements in order, and that members hold their questions until all statements have been presented after which we will have a question and answer period.

At this time we are very pleased to have the statement of Mr. Richard C. McCurdy.

Mr. McCURDY. Thank you, Mr. Chairman.

My statement deals with the institutional base you mentioned and also with the R. & M. appropriations in general.

I will take the institutional base first.

STATEMENT OF RICHARD C. McCURDY, ASSOCIATE ADMINISTRATOR FOR ORGANIZATION AND MANAGEMENT, NASA

Mr. McCURDY. Mr. Chairman and members of the committee, in our testimony at last year's hearings, Dr. Low and I spoke of the need for a priority review of the proper size and composition of the NASA operating base. This need was evident based on the problems involved in making significant work force adjustments, together with the evolving changeover of NASA programs from those of the sixties to the others coming along in the seventies. The first phase of this study has been completed and we now have a substantial body of data which is useful in appraising and utilizing more effectively, NASA's human resources.

The operating base, as used here, is made up of essentially the civil service complement, the various support and research contractors doing related work, and the specialized facilities they require at NASA installations. NASA is technical/scientific in orientation and possesses the Nation's principal reservoir of space flight know-how. Its activities fall into three major areas:

1. Generating programs for space exploration and for obtaining and utilizing space and aeronautical data of scientific and practical utility. This may be done internally or by constructive interaction with qualified elements in government, universities, or industry.

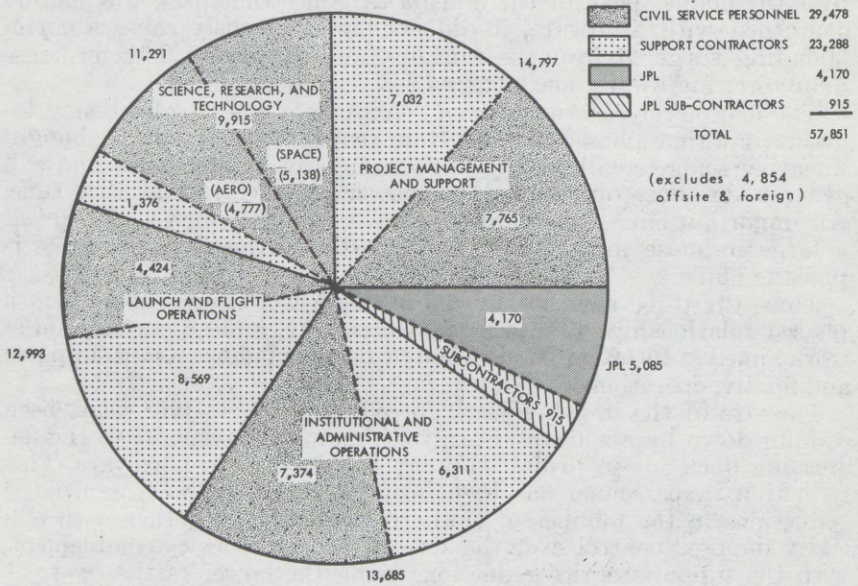
2. Managing and technically supporting these programs and specific projects.

3. Conducting launch, control, data management, communications, and similar operations.

In fiscal year 1971, the break of the three main functions outlined above showed that launch and flight operations occupied about one-third of the in-house manpower effort; science, research, and technology occupied somewhat less than one-third and was divided, roughly, half in aeronautics and half in space; while project management and support occupied somewhat more than one-third. Mr. Chairman, on the page following this there is a pie cut diagram which shows these various distributions of the civil service and the contract people in the categories that I am discussing. In the latter category, technical project support accounted for six-sevenths of the effort, and project management proper only about one-seventh of it—see chart. Although the work force will be further reduced in 1972 and 1973, it is expected that the distribution will remain about the same.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

NASA FY 1971 IN-HOUSE MANPOWER



The strong technical orientation of this effort is reflected in the following occupational table on the NASA civil service work force, which is about 45 percent professional scientists and engineers. The table gives the breakdown of these.

COMPOSITION OF THE PERMANENT CIVIL SERVICE WORK FORCE

	1971		1972		1973	
	Number	Percent	Number	Percent	Number	Percent
Professional scientists and engineers.....	13,370	44.8	12,558	45.7	12,305	45.8
Technicians.....	5,588	18.7	5,154	18.7	5,037	18.8
Wage board.....	2,429	8.1	2,082	7.6	2,033	7.6
Professional administrative.....	4,183	14.1	3,873	14.1	3,772	14.0
Clerical.....	4,280	14.3	3,833	13.9	3,703	13.8
Total.....	29,850	100.0	27,500	100.0	26,850	100.0

The size of the NASA budget, overall, obviously influences the workload carried by the institutional base, and consequently its manpower needs, but the relationship is by no means a direct one. This is because a budget dollar spent for one purpose may generate an entirely different in-house workload than would be a dollar spent for another purpose. For example, a budget dollar spent for hardware is mainly a generator of out-of-house contractor workload rather than NASA workload, while a budget dollar spent on tracking and data acquisition, in-house research, or operations, directly generates NASA in-house workload. Thus, the in-house manpower implications of a NASA

budget will vary importantly with the nature of the work underway, particularly with the relative expenditures for hardware as against nonhardware items. This fact is the key to an understanding of the relationship between NASA budgets and NASA manpower, since both have undergone significant changes in moving toward and passing over the budget peak of the sixties. Since that peak was mainly concerned with hardware, it did not simultaneously cause a corresponding surge of in-house workload or manpower. This in-house manpower high water mark lagged 2-3 years behind.

The manpower consequences of NASA funding are also bound together in a time-phased manner from year to year. Hardware bought in earlier budgets will usually be flown in later budget years, and will generate in-house operational manpower requirements at that time. An important current example of this is Apollo, which still requires a large in-house work force although the contractor work force is phasing out.

Thus, the three elements of the in-house work force operate in a phased relationship: first, science, technology, and advanced studies work aimed at future missions; then project management and support; and finally, operations.

The size of the in-house work force has, since its 1968 peak, been coming down by about 4,000 per year, mainly in response to the decreasing demands in project support for the Apollo hardware. This reduction in personnel has been brought about by NASA-initiated reductions in the number of support contractors, together with officially imposed control over the size of the civil service complement, with the support service reductions being the larger of the two.

Considering now the R. & P.M.-supported civil service component of the force, a 1973 ceiling of 26,850 is proposed, which is 1,500 lower than the original 1972 ceiling, and which will bring the total reduction since the peak to about 8,300 positions, or 25 percent. The further reduction will cause a loss in capability of the civil service work force. We shall, as in the past, strive to avoid personnel actions resulting in an irreversible loss in national capabilities.

The avoidance of such specific actions, however, even if wholly successful, will not insure against the erosive and cumulative effects of a series of reductions upon the vitality of the organization, and upon the ultimate ability of NASA to bring in younger blood. This is because the civil service reduction-in-force procedures, operating on a basis of seniority, serve to push out younger people and to retain older ones, often in new positions for which they are not as well suited. When several reductions are made serially, as they have been in NASA over the past several years, the effects compound, and the healing processes, such as the resumption of hiring of younger people, the filling of vacancies via merit promotion and so on, do not have an opportunity to function. The NASA organization currently is feeling these disadvantageous effects severely. Intake of young people from the schools has substantially dried up, and the grades GS-7 and GS-9 in science and engineering have essentially been emptied. Since 1967, NASA has replaced less than one out of every two personnel separations, on the average. These forced restrictions in hiring have had an adverse effect on the number of new college graduates being brought into the work force. Then, Mr. Chairman, the table shows that in

1966 we had some 900 to a thousand graduates hired and that now we have come down to the 200 level, which, in an organization on our size, I might interject, is not sufficient to keep its young blood going.

This dwindling of the supply of new blood is most worrying, and it is obvious that the trend cannot continue without the health and vigor of the organization being undermined.

NASA civil service must soon enter a period in which there can be a reasonable intake of young people. To accomplish this, we shall need to embark upon a period of stability in the civil service work force, so that it can, through a return to normal personnel development practices, heal the damage of the past several years, and be prepared to meet the challenges of the 1970's. With the prospect of a period of relative stability in the general level of spending, and a clearer view of the NASA forward mission, such a policy is indicated from all aspects.

To sum up our work force situation, we have made the major part of the critical appraisal we spoke of last year, in a thoughtful and careful manner, and from it we have drawn budgetary workload relationships which have increased our ability to assess the manpower needs corresponding to various kinds of programs. We have found that the NASA total work force, the size of which is basically determined by the contractor population, has responded appropriately to the reduction in budgetary levels since the peak, and can continue to do so. The civil service component of the work force, absent some programmatic change that alters what this force is supposed to do, should be left at roughly the same size so as to repair the serious damage that has been done to its makeup since the late sixties.

Before I finish, I would like to make a few comments about the overall size of the R. & P.M. request. The program directors have presented the detailed budget for each of our field installations, and I do not wish to retread ground already covered. In the total request, over 70 percent of the R. & P.M. money is used to pay salaries and related benefits for civil service employees who carry out the functions discussed previously; the balance is needed to provide for travel, essential institutional expenses like facilities services, technical services, and administrative support at all NASA installations. The important point to remember is that the R. & P.M. appropriation is not an "overhead" account. As I said earlier, it pays for the NASA in-house people in direct and indirect support and for the test and operational facilities which allow for the efficient conduct of NASA's work as required for the currently planned program levels.

For 1973, NASA is requesting \$700,800,000, a decrease of \$25.6 million from 1972. The following table indicates the distribution of obligations by functional area. And the table shows that all areas are reduced.

[In millions]

Functional area	1971	1972	1973
Personnel and related costs.....	\$544.2	\$554.9	\$543.6
Travel.....	16.2	16.2	15.7
Facilities services.....	76.3	76.4	67.7
Technical services.....	41.0	34.9	32.0
Administrative support.....	44.4	44.0	51.8
Total.....	722.1	726.4	700.8

The reduction of \$11.3 million in our personnel and related costs represents overall reductions in all categories of this function. These costs include compensation of permanent and temporary civil service employees and military and civilian personnel detailed to NASA, overtime and night differential pay costs, personnel benefits, personnel training, and transfer of personnel. Decreases in costs because of the lower number of permanent employees have greatly exceeded minor pay increases resulting from longevity and career development promotions. Temporary personnel costs have remained constant, although we have been able to provide for a larger number of disadvantaged trainees within the total. Overtime costs are less than 1 percent of permanent compensation, which continues to be the lowest rate of any major Government agency.

Before I go on, I should like to comment briefly on the plans for achieving the 1972 and 1973 personnel ceiling reductions. When NASA was first apprised of the further reduction of 850 in 1972 employment levels, we developed a plan for achieving the lower ceiling, largely through normal attrition. When the 1973 reduction of 650 was assigned, we planned to achieve the new 26,850 ceiling through normal attrition also. The 1973 budget is based on this expectation.

When we prepared the plan for 1972 last October, we realized that our ability to predict attrition levels was not exact, and that some involuntary separations might be required to achieve the June 1972 employment ceiling. After 5 months of actual attrition experience, we find that the rate of attrition is running about 22 percent lower than required to meet the end year ceilings. We have faced the problem by directing our installation directors to use reduction-in-force procedures, as required, to achieve their employment ceilings.

Because the situation is not the same for each installation, we cannot tell you at this time precisely the proportion of involuntary separations that will be required. In addition, each installation must assess, in detail, the cumulative work force imbalance problems which have been created by virtually no hiring this fiscal year. The solution of such problems will, of course, impact the size and character of any RIF's planned.

In regard to 1973, we are still basing our plans on achieving the required ceiling reductions through normal attrition. Because we cannot clearly foresee the character of problems which will arise in achieving the 650 reduction in 1973, we are not able at this time to accurately predict whether further RIF's may be necessary next year. If RIF's will be required next year, however, we understand that the added costs of terminal leave and severance pay will be borne within the personnel and related costs funds requested at this time.

I will now discuss the changes in other arts of the R. & P.M. budget, beginning with the requirements for travel. NASA has continued to reduce costs of travel, although costs of transportation and per diem have been increasing perceptibly. The estimate of \$15.7 million is equivalent to a reduction of one-third from the 1967 peak in travel cost when the 1967 cost is adjusted for increases in per diem, travel costs, and tax since that time.

The cost of facilities services is reduced by \$8.7 million in 1973. This reduction is the net result of several actions, the largest of which,

\$8.1 million, is related to the Mississippi Test Facility. If you recall, in 1971, \$10 million was appropriated to provide on a nonreimbursable basis, basic institutional and technical support to Federal agencies resident at MTF who are engaged in space and environmental missions. Because of the time required to implement this directive and because R. & P.M. is an annual appropriation, Congress continued the availability of these funds into 1972. The \$8.1 million reduction in 1973 results from completion of work contemplated in the MTF provision. The 1973 budget has no provision for this support, which will be reimbursed fully by benefiting agencies.

The balance of the reduction is accounted for by the transfer of minor construction costs, \$1 million, to the construction of facilities appropriation, partially offset by small increases for higher utility rates, \$400,000.

Costs in the technical services area will be \$2.9 million lower in 1973 than in 1972. The greatest portion of the reduction will be related to ADP where equipment and operating costs will be \$2.1 million lower. This reduction is possible because of past purchases of equipment and many small economies in operations. The balance of the reduction will be achieved in the informational programs area, where the cost reductions begun in 1971 and 1972 will be continued into 1973.

In the last functional area, administrative services, each subcategory will be reduced, except for printing which shows a small increase related to recent legislation requiring greater use of non-NASA printing facilities. The reductions in other categories reflect decreases in the numbers of people supported because of recent civil service employment reductions.

It should be understood that our 1973 budget request contains no provision to cover the cost of the January 1972, civil service increases. It is our understanding that funds to cover these costs will be requested by the President in a later transmittal.

In addition to having overall responsibility for the total agency R. & P.M. budget, I also act as the Institutional Director for headquarters. The headquarters R. & P.M. budget will be \$1,703,000 less in 1973 than in 1972. The chief reason for this decline is the reduction in civil service personnel. The number of headquarters permanent positions will be reduced by 192 from June 1971 to June 1973, with 41 of that reduction occurring in 1973. This reduction in staff will reduce personnel and related costs at NASA Headquarters by \$1,421,000 below the 1972 expenditure.

Other than personnel costs will be reduced by \$282,000 in 1973. This amount represents overall savings of \$523,000 which are partially offset by two uncontrollable cost increases: To wit, \$154,000 for an increase in anticipated reimbursements to the Postal Service; and \$87,000 for partition changes, telephone changes, and general building maintenance. The latter cost increase results because in 1972 much of the work was performed in conjunction with the moving of HEW offices into the Reporters Building and the relocation of NASA offices to other buildings. In 1973, NASA must pay for all such changes itself. Because of our continued attention in the area, the 1973 amount is significantly less than the 1971 amount.

In conclusion, we feel that NASA has taken the steps necessary to size its institutional base to the kind and level of program and mission assigned to us. The R. & P.M. request of \$700.8 million reflects these efforts. It is a minimum budget which places tight constraints on us, but does allow us to operate and to have the financial resources in this area to carry out our programs.

That is the conclusion of my statement, Mr. Chairman.

Mr. DAVIS. Thank you so much, Mr. McCurdy, for an enlightening and helpful statement.

We will now proceed to the statement of Mr. Bernard Moritz.

Mr. Moritz, would you proceed?

STATEMENT OF BERNARD MORITZ, DEPUTY ASSOCIATE ADMINISTRATOR FOR ORGANIZATION AND MANAGEMENT, NASA

Mr. MORITZ. Mr. Chairman and members of the committee:

My purpose in appearing today is to discuss with you those provisions of H.R. 12824, the NASA Authorization Act, 1973, other than those which relate to the authorization of appropriations for specific purposes in specified amounts.

H.R. 12824 follows the format of prior NASA authorization acts. I shall not address myself to those provisions which have appeared in prior acts. However, I will discuss differences between H.R. 12824 and its predecessors.

The most significant differences between the provisions of this bill and last year's act relate to the implementation of certain of the recommendations of the NASA Facilities Management Review Committee chaired by me. Such report has been furnished to the committee and has been printed as appendix C to the report of the Subcommittee on NASA Oversight, "Acquisition of Capital Plant—NASA." We have noted that the recommendations of the NSA report are substantially the same as the recommendations of your subcommittee.

The NASA report makes several recommendations of a fundamental nature, each of which has been approved by Dr. Fletcher, as he has already testified. Only limited changes to the statutory language were required to implement such recommendations. Their main impact is to be found in a revised approach to the management of NASA's facilities activities.

One major area dealt with by the Facilities Management Review Committee involves the method of presenting facility projects for approval. By the term "facility project" I refer to projects involving the acquisition of new, or the enhancement of existing, facilities, meaning land, structures, and equipment connected therewith.

Under the approach implemented in H.R. 12824, the NASA Authorization Act, 1973, all NASA facility projects will be presented for approval and ultimate funding under a full disclosure concept. That is, all elements required for the initial stated operational use of that facility, whether construction or equipment, will be fully disclosed to the extent that each of these elements has been or can be identified and quantified and estimates prepared therefor. To the extent that elements can be identified but not quantified, and/or meaningful estimates cannot be prepared therefor, this also will be disclosed. However,

for purposes of funding under the applicable facility authority, only those elements constituting actual construction trades activity, that is, "brick and mortar," together with collateral equipment, by which I mean, equipment which is an inherent part of the structure, or is built in, or is large and substantially affixed to the structure, will be considered a part of the facility project. All other equipment, while it is to be disclosed as being related to the facility project, will, nevertheless, be funded from sources otherwise available therefor. Also, greater emphasis than has been accorded in the past will be given to identifying the funding source for all equipment.

The above change in approach is not directly reflected in H.R. 12824 other than by the term "collateral equipment" in subsections 1(d) and 1(g), which would take on the redefined meaning I have described. As previously stated, the change in approach has been followed in the NASA budget which the bill would implement.

An additional recommendation of the Facilities Management Review Committee, which is also reflected in the bill, is that any facility project, defined as I have stated, the estimated cost of which at the time of approval is above a very minimal level, that is, \$10,000 for construction of new, or additions to existing, facilities, and \$25,000 for rehabilitation or modification of facilities, will be funded from the "Construction of facilities" appropriation. The only exception is that a project required to satisfy unforeseen programmatic needs, the estimated cost of which at the time of approval does not exceed \$250,000, will continue to be funded from the "Research and development" appropriation.

The implementation of this second major recommendation is evidenced first, by subsection 1(g) of H.R. 12824; and second, by the language of the NASA appropriations as recommended by the President. The bill further provides for two line items under the "Construction of facilities" head covering (a) the construction of new, and additions to existing, facilities, the estimated cost of which including collateral equipment is not in excess of \$250,000 for each project at the time of approval; and (b) the rehabilitation and modification of facilities, the estimated cost of which including collateral equipment is not in excess of \$500,000 for each project at the time of approval. Any project for these purposes, the estimated cost of which exceeds the applicable project limitation, would be separately stated as a budget line item and justified as such.

Under subsection 1(g) of H.R. 12824, which has been revised to accord with the above, "Research and development" funds would continued to be legally available for facility projects required to satisfy unforeseen programmatic needs at NASA installations and other locations, the estimated cost of which projects, including collateral equipment, does not at the time of approval exceed \$250,000. Any unforeseen requirement, the estimated cost of which exceeds the stated amount, will be funded from the "Construction of facilities" appropriation using, where necessary and appropriate, one of the statutory flexibility provisions, unless, of course, it would be fundable under the provisions of subsection 1(d).

This last mentioned provision, subsection 1(d), has been revised so as to clarify that the use of "Research and development" funds there-

under for items of a capital nature is limited to locations other than NASA installations, and that the reporting requirement, which is a part of such subsection, relates only to construction of a major facility in accordance with the subsection.

It will be noted further that none of the specific flexibility provisions included in prior NASA Authorization Acts has been significantly affected by any of the foregoing. It is NASA's view that such flexibility provisions are essential to NASA's dynamic and evolving research and development activity.

In addition to the changes related to implementation of the recommendations of the Facilities Management Review Committee, H.R. 12824 also reflects several minor technical changes from the language of prior acts. Section 7 of last year's act is omitted from H.R. 12824 because it is permanent law having amended the National Aeronautics and Space Act of 1958. Also there have been some minor numerical realignments of the program line items in the "Research and development" account related to the activities of the former Office of Space Science and Applications, so that all of the program line items related to the new Office of Space Sciences could be grouped together. To this end, the program line item "Launch vehicle procurement" precedes rather than follows, as in the prior act, the "Space applications" program line item. This latter line item relates to the program activities of the new Office of Applications. Lastly, subsection 1(c) omits the limitation contained in the prior year's act on the amount available for personnel and related costs. Such limitation is deemed unnecessary for the fiscal year starting July 1, 1972.

That concludes my statement, Mr. Chairman.

Mr. DAVIS. Thank you very much, Mr. Moritz, for a helpful statement.

At this time we would like to hear from General Curtin.

STATEMENT OF MAJOR GENERAL ROBERT H. CURTIN, DIRECTOR OF FACILITIES, OFFICE OF ADMINISTRATION, NASA

General CURTIN. Mr. Chairman, I have a very comprehensive statement. I understand that previously this committee and its subcommittees have reviewed essentially all of the items in the "Construction of facility" request for authorization this year with the exception of the item for facility planning and design. With your permission, Mr. Chairman, I would ask that my statement be placed in the record and that I direct my remarks to facility planning and design.

Mr. DAVIS. Without objection, it is so ordered.

(The statement referred to is as follows:)

PREPARED STATEMENT OF MAJ. R. H. CURTIN, USAF (RET) DIRECTOR OF FACILITIES

Mr. Chairman and members of the committee, You have already heard Dr. Fletcher, Dr. Low and other NASA witnesses describe the programs which are being recommended and the details of the FY 1973 budget request which relate to the implementation of these programs. As in past years, our FY 1973 request for Construction of Facilities is, in large measure, a direct reflection of these programs. In the facilities management area, we are continuing our efforts to provide the balanced facility support necessary to the total needs of our missions and programs. We are continuing to improve our programs to maintain and update the basic facilities capabilities which are essential ingredients of our research and development plant. Concurrently, we are moving to enhance the safe and more efficient use of these existing facilities and we are actively improving our advance facility planning and design work.

The FY 1973 request for Construction of Facilities totals \$77.3 million. This compares to \$52.7 million appropriated in FY 1972 for this purpose. This program evolves from a stringent review of a large list of potential programmatic and institutional requirements submitted by the field installations for Program Office and Headquarters consideration.

This FY 1973 construction program, as included in this request, supports four major budget activities as follows:

Manned Space Flight, \$27,900,000

All of this amount is associated with space shuttle facilities.

Scientific Investigations in Space, \$11,205,000

This amount involves proposed rehabilitation and modification of hangar and shop facilities at Ames Research Center, and additional facilities for Titan Centaur and related Viking operations at Kennedy Space Center.

Aeronautical Research and Technology, \$12,935,000

This includes the rehabilitation work on wind tunnels at Ames and Langley Research Centers, and the modification of turbine and combustor research facilities at Lewis Research Center.

Supporting Activities, \$25,260,000

This amount involves several smaller proposed projects as well as our rehabilitation and modification, minor construction, and facility planning and design programs.

This program is composed of four major elements. These are: (1) the specifically delineated major facilities projects which are not space shuttle-related (\$28,100,000); (2) comparable major facilities projects in support of the space shuttle program (\$27,900,000); (3) rehabilitation and modification, and minor construction programs (\$13,300,000); and (4) the facilities planning and design program (\$8,000,000). Twenty-one major facilities projects account for \$56,000,000, or over 70% of this total request. These projects, for the most part, relate to specific requirements to achieve a necessary capability by a given date. The need for all of these projects is set out in the detailed descriptions and justifications of each as provided in the estimates which you are considering.

These projects are as follows:

Ames Research Center, California, \$1,825,000

This provides for the rehabilitation and modification of a hangar and shop complex that was built in 1945. This project will provide improved laboratories, offices and shops in support of the airborne science activities carried out here. It will replace temporary and improvised facilities, will modernize inadequate and obsolete electrical and other systems, provide for fire protection, and rearrange available space to permit effective utilization. Major emphasis on research to be undertaken in this facility will include astronomy, earth observations, and geophysics.

This request also provides for the rehabilitation of the model support systems, associated control and drive systems, and model preparation areas of the "Unitary Plan" wind tunnel. This work will strengthen the model support systems and enhance the reliability and accuracy of the control systems. At the same time, the central shop area will be rehabilitated to provide permanent laboratory and model preparation space in support of activities at this wind tunnel, which was initially placed in operation in 1955. The use of this tunnel will be in high demand for many years in support of major aircraft programs.

Goddard Space Flight Center, Maryland, \$590,000

This provides for the major rehabilitation and modification of the electrical, steam and chilled water systems at this Center. It includes the replacement of an old and deteriorated steam generator, the restoration of corroded chilled water and steam distribution lines, and the upgrading of the electrical distribution system to improve the reliability and increase its capacity to better meet current needs.

Jet Propulsion Laboratory, California, \$610,000

The JPL installation in Pasadena, California, is located on approximately 176 acres bounded on the north by hills and to the east by an arroyo. It is a somewhat congested but very active site. We have been upgrading the on-site road network to improve circulation of traffic and pedestrians. This request continues that work by providing for the rehabilitation of the main east-west arterial

road, completing a major traffic artery along the central and south-easterly portion of the Laboratory, and refurbishing and improving several other existing road sections. This work is necessary to relieve congestion, improve safety and reduce future maintenance costs.

Kennedy Space Center, Florida, \$10,140,000

In FY 1972 the NASA construction program provided \$10.7 million for modifications to the Air Force Titan III launch area to permit the final assembly, checkout and launch of the Titan Centaur vehicle combination and its associated spacecraft. This work was directed toward achieving capability for the scheduled 1975 Viking launches. This year's request includes \$8,100,000 for the modification of and additions to three existing facilities at Kennedy in order to make these facilities suitable for the assembly, encapsulation and sterilization of Viking spacecraft. The preparation of a sterilized spacecraft for its planned landing on the surface of Mars is a very complex matter and requires a "clean room" environment for assembly, and the associated capabilities for sterilization and encapsulation. The proposed modifications and additions provide this environment and involve necessary lighting, cranes, sterilization ovens, and other related equipment.

The remainder of the proposed work for Kennedy Space Center involves further modification of the Titan Centaur facilities proper. This would expand the existing launch control and monitoring capability through the addition of common instrumentation equipment to support Launch Complex 40 as well as 41, and the test cells of the Vertical Integration Building. This work will permit the concurrent testing and checkout of two launch vehicles and minimize potential "high risk" interference during the pre-launch preparations and count-down, and during the launch of missions from each complex.

Langley Research Center, Virginia, \$4,290,000

There are three separate projects involved in the proposed work at Langley. The first of these is the rehabilitation of the full scale wind tunnel. This wind tunnel, which has a 30x60-foot test section, is now over 40 years old and has been subjected to heavy and constant usage. It now requires rehabilitation and some modifications in order to improve its reliability and permit it to meet current and future research needs. The major work involved consists of improving the drive motors, reducing fan vibrations, increasing the air supply, improving the test chamber, and expanding the model shop. It is anticipated that there will continue to be a heavy requirement for large and full scale aerodynamic research and testing for which this wind tunnel is most suited.

At Langley Research Center, a central air plant provides high pressure air to many of the Center's research facilities. As needs have grown, the system has been expanded so that today it is attempting to meet the needs of some 25 dispersed research facilities. Growing requirements for compressed air dictate that this facility be modified to provide additional air pumping and drying capacity and permit more effective storage and utilization of this air. Air supply has become an increasing limitation on research capabilities involved with noise studies, V/STOL studies, combustion and heat transfer studies. The limitation on air supply has reached a point where the ability to carry on efficient research projects is increasingly compromised. The third project at Langley involves several actions necessary to reduce or eliminate the discharge of potential air and water pollutants. This is a continuation of our efforts begun last year to fully comply with Executive Order 11514, "Protection and Enhancement of Environmental Quality".

Lewis Research Center, Cleveland, Ohio, \$9,710,000

This proposed project provides for the modification of the high temperature and high pressure turbine and combustor research facility at Lewis. Research has been proceeding for some time at this Center on advanced turbines and combustors required in air breathing engine aeronautics propulsion. The compressor pressure ratios and turbine inlet temperatures of gas turbine engines have been steadily increasing. The trend in such engines is toward turbofans having a compact, high temperature gas generator. To effectively continue this research work on advanced turbines and combustors requires a facility which can supply large amounts of air at higher temperatures and pressures than are now available. This involves a significant increase in the present capability. This project will provide two test stations in the existing Engine Research

Building with the additional compression and heating capabilities needed to achieve flow rates up to 240 pounds of air per second at 660 pounds per square inch absolute, and with turbine inlet temperatures of 3000-4000° F. This work will then provide the necessary upgrading of these capabilities to permit effective progress in this research area.

Manned Spacecraft Center, Houston, Texas, \$585,000

This work provides essential fire detection and suppression systems in some 29 buildings. There are about 250,000 square feet of high density electronic equipment areas involved which are located in various buildings. This is an element of our continuing program to provide or modernize fire detection and protection systems at all of our field locations. Much of the equipment to be protected by this project is mission essential and the scientific, flight, medical and other data involved here are extremely valuable and in some cases not replaceable.

Wallops Station, Virginia, \$350,000

This project provides for the construction of a warehouse to replace the present main warehouse which is now about 25 years old. The existing light metal structure has deteriorated well beyond economical repair and there are no other facilities in which this activity can be relocated.

This brief review covered the major non-space shuttle facilities projects included in our FY 1963 request. These 12 projects total \$28.1 million. The next segment of major projects involves those in direct support of the space shuttle program. As you will recall, \$18.5 million was appropriated in FY 1972 for space shuttle facilities, including \$13.0 million for main engine test facilities and \$5.5 million for facilities modifications required for the development of thermal protection systems now associated only with the orbiter vehicle. Work has proceeded with regard to the facilities needed for thermal protection systems research and development. With the January 1972 decision regarding the use of high pressure LOX/LH₂ engines in the orbiter, work previously held in abeyance is now moving ahead on the engine test facilities at the Mississippi Test Facility.

Our FY 1973 request for space shuttle facilities has been structured in such a way as to permit it to accommodate a subsequent decision regarding the specific type of booster to be used. We have initially outlined our facility requirements for the space shuttle based on the use of a liquid-fueled (LOX/RP-1 or LOX/propane) booster and have indicated the adjustments required should the subsequent decision indicate that a solid-fueled booster will be utilized.

There are 10 individual projects involved in this total requirement regardless of the choice of booster which may finally be made. If the pressure-fed booster configuration is selected, these include the modification of pressure-fed engine test facilities at a location to be selected. Within the \$27.9 million total for this fiscal year, the first phase of this work would be provided for mainly by the deferral of the Systems Integration and Mockup Laboratory planned for the Manned Spacecraft Center, as well as the second phase of planned modifications to the Structures and Mechanics Laboratory at Marshall Space Flight Center. At the same time, with a pressure-fed booster the first phase of booster-peculiar work must be included and this is accommodated mainly by the deferral of most of the instrumentation work planned for the Altitude Test Facility at the Arnold Engineering Development Center, Tennessee. A tabulation showing these possible adjustments, as well as listing all projects involved, is attached to this statement. We will now review this submittal in further detail. For the purpose of this review, we have placed the required facilities into groups of related items.

The first group is: Engine Test Facilities.

This work is required to provide engine test capability for a new booster pressure-fed engine and for work associated with the testing of the orbiter high pressure engine. For the pressure-fed booster, the amount required to accomplish this work is \$11,435,000; and for a solid-fueled booster, the amount would be \$7,960,000. The projects involved are detailed as follows:

Modifications of Pressure-Fed Engine Test Facilities, Various Locations, \$4,795,000

This project provides for the modification of two existing test stands at a government-owned location which is to be determined. This work is required for the developmental and acceptance testing for space flight of the pressure-fed engine and its thrust chamber. One of the test stands will be used for engine testing and

the other for the thrust chamber development work. A key element in the development of a recoverable booster for the shuttle is a new liquid oxygen/RP-1 or liquid oxygen/propane engine with a thrust level of approximately 1.2 million pounds. To meet the developmental test program requirements of this engine, provision for an engine test stand in this timeframe is necessary. The single most critical component of this engine, requiring early development, is the thrust chamber. Developmental testing to evaluate and resolve issues relating to the chamber's combustion dynamics, heat transfer and material selection will be required. To meet these needs, modification for a thrust chamber stand will be necessary. A second engine test stand will also be required and it is planned that this will be provided by modifying another existing stand at the same location. This requirement will be programmed in a subsequent fiscal year.

Modification of Altitude Test Facilities, Arnold Engineering Development Center, Tennessee, \$5,480,000

This project provides for the modification of the existing J-4 test cell at Arnold Engineering Development Center for simulated altitude testing of the orbiter's high pressure main engine. This testing is required for research, development and qualification of the engine for flight in outer space. Fiscal Year 1972 provided \$2.0 million for procurement of long-lead items. This request will provide the necessary resources to substantially complete the work, with the exception of the installation and checkout of the instrumentation and control system. A change in the type of space shuttle booster from pressure-fed to solid fuel, as previously indicated, would permit the completion of this project within our FY 1973 estimates at a level of \$6.8 million.

Rehabilitation of Propellant and High Pressure Gaseous Systems, Mississippi Test Facility, \$1,160,000

This project is required to provide for major rehabilitation, repair, and replacement of deteriorated segments of the pressure reducing stations and the cryogenic propellant systems at the Mississippi Test Facility. The age of these systems, the heavy past usage and the last two years of inactivity have generated the need for this work. The work is necessary to support the space shuttle's orbiter main engine developmental test program.

The second group is: Research and Development Facilities.

This work is required for modification, rehabilitation, and additions to existing research and development facilities to provide capability for research, testing, evaluation and qualification of each key element of the shuttle's total system. Included are facilities for: acoustic model engine test for early solutions to problems associated with induced vibrations; acoustic and sonic fatigue tests of vehicle components, structures and mechanical systems; electrical systems development; vibration and structural testing of component and vehicle assemblies; and systems integration. The amount required to accomplish this work for a pressure-fed booster configuration is \$9,575,000, and the amount for a solid-fueled booster would be \$14,400,000. Included in this work are the following projects:

Modification of the Entry Structures Facility, Langley Research Center, Virginia, \$1,635,000

This project is necessary to modify an existing facility at Langley Research Center to provide the capability for research and development on the shuttle's heat shield materials and components under simulated reentry conditions. The existing Entry Structures Facility will be modified and upgraded by the addition of three multi-parameter simulators and the installation of an arc-heated aerothermal apparatus. Samples of both non-metallic and metallic candidate thermal protection systems materials will be subjected to repeated tests in this facility, and data on characteristics of each will be collected and analyzed. This facility will augment and supplement the facility items authorized in FY 1972 for research and development of thermal protection systems.

Modifications for Systems Integration and Mockup Laboratory, Manned Spacecraft Center, Texas, \$2,545,000

This project involves a large addition to the Technical Service Facility which is necessary to provide the capability for conducting engineering experiments, using mockups of the hardware, in support of the development and integration of the shuttle systems. This is a firm and definitive requirement, and while it should be accomplished in FY 1973, within the resources available, it would be

necessary to defer it to a subsequent year program if the pressure-fed booster is selected. This action would be necessary to provide for the higher priority pressure-fed engine testing. Should the solid booster be selected, sufficient resources would then be available within FY 1973 for this project.

Modification of the Vibration and Acoustic Test Facility, Manned Spacecraft Center, Texas, \$2,770,000

This project provides for modifications to the existing Vibration and Acoustic Test Facility at Manned Spacecraft Center. It is required to adapt this facility for the conduct of acoustic fatigue tests on full-size segments of the shuttle hardware. The work includes expanding the size of the acoustic chamber at its full height of about 105 feet, and extending the east side to house a sonic fatigue test cell. Associated horn and sound generators will also be added. These modified facilities will be used to simulate the sound and vibration levels to be encountered in actual flight, and subject critical components, such as the crew compartment and the cargo bay, to these simulated acoustic flight conditions. This testing capability is vital in developing and qualifying space shuttle hardware.

Modification of the Structures and Mechanics Laboratory, Marshall Space Flight Center, Alabama, \$2,420,000

This project provides for major modification and rehabilitation of some 2400 channels of the existing data acquisition and control systems located in the Structures and Mechanics Laboratory at the Marshall Space Flight Center. The need for the modification stems from the basis that the system is ten years old, has been deteriorating as indicated by the excessive maintenance, and has become obsolete as evidenced by the fact that many replacement parts are no longer "off-the-shelf" items and, for some components, the initial manufacturer is no longer in business. The work is essential to support the structural test program required for the shuttle development. FY 1973 funding level for this project will be affected by the ultimate decision on the type of booster to be used. Under the pressure-fed option, a project in the amount of \$2,420,000 is required to provide the first operable increment in support of program requirements. Should a solid-fueled booster be the choice, the total project requirement, estimated at \$4.7 million and involving some 5200-6000 channels of instrumentation, can and should be accomplished in fiscal year 1973 as indicated in the budget request.

Addition for the Electrical Power Laboratory, Marshall Space Flight Center, Alabama, \$320,000

This project provides for an addition to the Hazardous Operation Laboratory. This addition is required to augment and expand the capability for research and development in advanced electrical power generation systems such as fuel cells, batteries and other power sources. The present research effort in these areas has been greatly limited due to the lack of adequate facilities.

Modification of Acoustic Model Engine Test Facility, Marshall Space Flight Center, Alabama, \$2,430,000

This project includes the modification of the existing Acoustic Model Engine Test Facility and related augmentation of the gaseous supply area. This will provide the capability for accommodating space shuttle model engine test requirements. This testing capability, using up to 1/10th-scaled model engines of the basic propulsion system, will provide an invaluable research tool for the better definition and understanding of the acoustic field related to the shuttle propulsion system. It will also provide the data necessary for early solutions to the problems associated with induced vibrations, noise effects during lift-off and flight, and the design of launch facilities.

The final group of space shuttle facilities is: *Manufacturing and Final Assembly Facilities.*

This work is required for modification to an existing government-owned plant, at a site to be determined, in order to adapt that plant for the manufacture of selected components of the total system and for the final assembly of flight booster and orbiter vehicles and associated external tanks. Included are assembly stations for the orbiter and subassembly work stations for the orbiter's external tanks, and the booster. The remaining work relative to the final assembly and checkout of the booster and orbiter's external propellant tanks will be requested in subsequent programs.

This project is also affected by the booster selection decision. The \$6,890,000 amount requested is related to the pressure-fed booster. Should a solid-fueled

booster be selected, then the modifications related to the booster assembly would not be required and the request would be reduced to \$5,540,000.

From the outline of space shuttle facilities just concluded, it is clear that the dual programs presented in our FY 1973 estimates were both evolved within a \$27.9 million total. The projects, as identified above, can ultimately be associated with the specific type of booster finally selected without revision to the total amount involved for space shuttle facilities.

The next two items, Rehabilitation and Modifications and Minor Construction of Facilities, involve significant changes in the composition of the Construction of Facilities program for FY 1973 when compared to prior year submittals. The major revision is the inclusion in these programs, beginning this year, of minor facilities projects previously accomplished under the R&PM and R&D appropriations. Excluded, and still to be accomplished with the R&D appropriation, are those unforeseen programmatic projects estimated to cost \$250,000 or less, which may arise during the year. These projects will emerge as a reflection of the "unknowns" inherent in research/development and test type programs. In this request, there is included a total of \$13,300,000 for these two programs and we will now further detail each of these.

Rehabilitation and Modification of Facilities, Various Locations, \$11,580,000

This is the fourth year of this comprehensive program within the Construction of Facilities estimates to provide central management of and direction to our priority facility rehabilitation and modification work. We embarked on this program in FY 1970 and it has been of such value and merit to soundly justify its continuation. In this fiscal year, however, there have been certain changes made in the content of this program. In prior years this program has focused on work packages estimated to cost between \$250,000 and \$1,000,000, and those which were basically non-programmatic in nature. Beginning this year: (1) the upper limit has been reduced to \$500,000, (2) we have included the smaller projects under \$250,000 previously accomplished from the R&PM and R&D appropriations, and (3) the scope has been extended to include foreseeable programmatic needs. As a reflection of these changes, again beginning this year, rehabilitation and modification projects estimated to cost in excess of \$500,000 are shown as individual line items and were discussed earlier. As recast, these revised requirements include essentially a series of specific projects, each estimated to cost less than \$500,000. The proposed work has been selected from listings submitted by the field Centers totalling about \$40,000,000.

As a reflection of the current and continuing importance of this program, NASA has recently completed a survey of its Aeronautics and Space Technology Centers. These installations are:

- Ames Research Center, California;
- Flight Research Center, California;
- Langley Research Center, Virginia; as well as
- Lewis Research Center and Plum Brook Station, both in Ohio

The preliminary findings of this survey indicate that there are rather extensive pending requirements of this type which we must adequately cope with in future years. This survey is now being refined and extended to other NASA centers. We would hope, over the next year, to evolve a very comprehensive rehabilitation and modification listing as the basis for our future consideration of projects of these types.

As in the past, this year's submittal for rehabilitation and modification work is geared to the continued preservation and protection of our physical plant, and the enhancement of its utilization. The thrust of this program is to overcome the cumulative effects of wear and deterioration on our physical plant as well as those of obsolescence.

Minor Construction of New Facilities and Additions to Existing Facilities, Various Locations, \$1,720,000

As indicated earlier, this program is initiated, within the Construction of Facilities, in this fiscal year. The purpose is to provide for the continuation of the type of minor facility project work previously accomplished under the R&PM and R&D appropriations. For inclusion in this program, the projects involved are estimated to cost less than \$250,000. The minor construction of new facilities as well as additions to existing facilities are necessary to improve the usefulness of our physical plant by making it possible for us to make needed minor adjustments in utilization and minor augmentations of our plant capabilities. Our exist-

ing physical plant is necessarily impacted by changing utilization and adaptations made necessary as a consequence of changing technology and mission needs. In addition, new minor facility requirements are constantly generated by research, development, test and like activities. This requirement is supported by a list of candidate projects selected on the basis of relative urgency and the expected returns from their accomplishment in relation to the investment involved.

Facility Planning and Design, \$8,000,000

This request is to support the continuation, into FY 1973, of our efforts relating to field installation master planning, special engineering studies, preliminary engineering reports, final facility design and related efforts. This year's planning and design request is composed of two elements: (1) regular requirements which relate to our continuing and more general needs, and (2) other or special requirements which are generated by pending exceptionally large and complex projects. The \$3.5 million requested for regular planning requirements is in keeping with our recent experience. This involves the necessary planning and related work associated with our recurrent needs and is at the same level as provided in FY 1973 for these purposes.

As is evident, the accomplishment of comparable planning work for facilities in support of the emerging space shuttle program is of such a magnitude and nature as to justify special consideration. For this reason these requirements are specifically identified in the amount of \$3,750,000. Of this amount, \$1,000,000 is estimated to be required for the preparation of preliminary engineering reports, and investigations and studies related to the proposed space shuttle facilities projects which must be considered for inclusion in our subsequent FY 1975 program. In a like manner, it is estimated that \$2,750,000 is required to permit the early and timely development of final designs, drawings and specifications necessary for the accomplishment of shuttle facilities included in the FY 1974 request. Also included in this year's estimates is \$750,000 to conduct studies and component design for a proposed "full scale subsonic wind tunnel". This facility is currently considered as a potential large aeronautical research facility under study by the Aeronautics and Astronautics Coordinating Board as being required in future years.

It is only prudent that all of these planning efforts go forward so that alternate solutions and approaches can be more fully explored and better overall facility solutions adopted.

Mr. Chairman, this completes a review of the FY 1973 Construction of Facilities requests. We have outlined the projects which are covered in more detail in Volume III of the NASA FY 1973 Budget Estimates. For each applicable project, this volume includes project justification, description, and cost data as well as site plans, layouts, and sketches where applicable. The emerging space shuttle facility needs plus the inclusion of work previously funded in the R&PM and R&D appropriations make this a most prudent and modest request. We urge that it be approved in its entirety.

	Booster configuration	
	Pressure fed	Solid fueled
Main engine test facilities.....	\$11,435,000	\$7,960,000
Modifications of pressure-fed engine test facilities, various.....	4,795,000	
Modification of altitude test facilities, Arnold Engineering Development Center.....	5,480,000	6,800,000
Rehabilitation of propellant and high pressure gaseous systems, Mississippi Test Facility.....	1,160,000	1,160,000
Research and development facilities.....	9,575,000	14,400,000
Modification of the entry structures facility, Langley Research Center.....	1,635,000	1,635,000
Addition for systems integration and mockup laboratory, Manned Spacecraft Center.....		2,545,000
Modification of the vibration and acoustic test facility, Manned Spacecraft Center.....	2,770,000	2,770,000
Modification of the structures and mechanics laboratory, Marshall Space Flight Center.....	2,420,000	4,700,000
Addition for electrical power laboratory, Marshall Space Flight Center.....	320,000	320,000
Modification of acoustic model engine test facility, Marshall Space Flight Center.....	2,430,000	2,430,000
Manufacturing and final assembly facilities.....	6,890,000	5,540,000
Modification of manufacturing and final assembly facilities, various.....	6,890,000	5,540,000
Total.....	27,900,000	27,900,000

Mr. DAVIS. I think it also appropriate, since we are considering Construction of facilities, to insert in the record at this point two communications received from NASA concerning the status of all previously authorized construction not completed as of December 31, 1971, and a report on the extent to which NASA has exercised the statutory authority for minor new construction.

(The inserts for the record are as follows:)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION,
Washington, D.C., February 25, 1972.

HON. GEORGE P. MILLER,
Chairman, Committee on Science and Astronautics, House of Representatives,
Washington, D.C.

DEAR MR. CHAIRMAN: Enclosed for your information, is a report on all NASA Construction of Facilities projects for FY 1972 and prior years which were not completed as of December 31, 1971.

This is a copy of a report which we have sent to the Senate Committee on Aeronautical and Space Sciences in accordance with the request appearing on Page 87 of Senate Report No. 91-282 on the FY 1970 NASA Authorization Act.

Sincerely,

H. DALE GRUBB,
Assistant Administrator for Legislative Affairs.

Enclosure.

MATERIAL REQUESTED BY THE COMMITTEE ON AERONAUTICAL AND SPACE SCIENCES
(SENATE) ON H.R. 11271 NASA AUTHORIZATION FOR FISCAL YEAR 1970 DATED
JUNE 26, 1969, PAGE 87

Below is information concerning status of all NASA Construction of Facilities projects for FY 1972 and prior years which were not completed as of December 31, 1971. For report purposes, those projects which have been completed during the past year have been so noted. Not included are those projects which have claims or minor deferred work outstanding but are in operational use.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION CONSTRUCTION PROJECTS IN PROGRESS

[Dollar amounts in thousands]

Line No. (a)	Project No. (b)	Prog. No. (c)	Field center (d)	Project title (e)	Current funds released			Design status		Construction progress			Remarks (o)
					Initial program est. (f)	Current est. (g)	Design (h)	Const. (i)	Per- cent (j)	Est. comp. date (mo/yr) (k)	Start date (mo/yr) (l)	Percent comp. (m)	Est. comp. date (mo/yr) (n)
1	2144/72	ART	ARC	Modernization of 40' x 80' wind tunnel.	\$6,500	\$6,500	\$294	\$6,500	60	Apr. 1972	Jan. 1972	0	June 1973
2	7702/72	SSA	KSC	Centaur modification to Titan III launch area LC-41.	10,700	10,700	255	10,700	100	-----	Oct. 1971	10	Nov. 1974
3	7686/72	SSA	KSC	Alterations to launch complex 17.	4,500	4,500	212	0	15	Apr. 1972	May 1972	0	May 1973
4	9314/72	TDA	VAR	Relocate applications technology satellite ground station (western Europe).	500	500	50	0	40	Mar. 1972	-----	0	-----
5	-----	TDA	VAR	Power plant replacements:									
	9317/72	-----	-----	(a) Goldstone, Calif.	370	370	45	0	10	June 1972	Aug. 1972	0	June 1973
	9311/72	-----	-----	(b) Santiago, Chile	230	230	15	0	50	Feb. 1972	May 1972	0	Dec. 1972
	-----	-----	-----	Space shuttle facilities	20,330	18,500	1,227	5,500	-----	-----	-----	-----	-----
	-----	-----	-----	Engine test facilities	13,000	13,000	1,000	0	-----	-----	-----	-----	-----
6	6428/72	MSF	MTF	(a) Sea level test facilities	(11,000)	(11,000)	(380)	0	95	Apr. 1972	Apr. 1972	0	Jan. 1974
	9320/72	MSF	AEDC	(b) Altitude test facilities	(2,000)	(2,000)	(420)	0	-----	-----	Aug. 1972	0	Jan. 1973
	-----	-----	-----	Thermal protection system facilities.	5,500	5,500	227	5,500	-----	-----	-----	-----	-----
	2147/72	ART	ARC	(a) Interaction heat facility	(3,000)	(2,800)	(50)	(3,000)	100	Nov. 1971	Jan. 1972	0	June 1973
	7214/72	MSF	MSC	(b) Atmos. re-entry facility	(1,200)	(1,200)	(147)	(1,200)	45	Aug. 1972	July 1972	0	Nov. 1973
	2320/72	ART	LaRC	(c) 9' x 6' thermal tunnel	(300)	(300)	(30)	(500)	90	Mar. 1972	June 1972	0	June 1973
	2385/72	ART	LaRC	(d) Combustion facility	(800)	(1,000)	(0)	(800)	100	Dec. 1971	Jan. 1972	0	Nov. 1973
	9321/72	MSF	VAR	Auxiliary prop. system	1,500	-----	-----	-----	-----	-----	-----	-----	-----
7	VAR/72	O. & M.	VAR	Rehabilitation and modification	10,000	7,900	459	3,851	60	June 1972	Dec. 1971	2	Aug. 1973

Work being accomplished by multiple contracts.

Site selection under study.

Redesign required for orbiter engine.

Long lead procurement items only.

Vacuum System being redesigned. Further design held in abeyance pending review of recent failure of air system.

Design in-house.

Fiscal year 1972 authorization available, but appropriation not provided.

Includes over 40 subprojects which have varying completion dates.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION CONSTRUCTION PROJECTS IN PROGRESS—Continued

[Dollar amounts in thousands]

Line No. (a)	Project No. (b)	Prog. office (c)	Field center (d)	Project title (e)	Initial program est. (f)	Current cost est.		Current funds released		Design status				Construction progress				Remarks (o)
						(g)	(h)	(i)	(j)	Est. comp. date (mo/yr) (k)	Start date (mo/yr) (l)	Percent comp. (m)	Est. comp. date (mo/yr) (n)					
8	7672/72	MSF	KSC	Expansion of the visitors information center.	2,100	2,100											Fiscal year 1972 authorization available, but appropriation not provided.	
9	7270/71	MSF	MSC	Emergency repair to central heating and cooling plant.	750	750		750					Oct. 1971		7	June 1972	Emergency repair project undertaken as provided by sec. 370(b) Public Law 85-568. No design required. Damaged parts being replaced.	
10	7707/71	MSF	KSC	Launch support facilities.	575	358		35									Project canceled; substitute minor facility projects planned.	
11	6290/71	MSF	MSFC	Multi-spectral photographic lab.	525	550		30									Statutory reprogram. Not scheduled. Fiscal year 1971 authorization available, but appropriation not provided. Project complete.	
12	7264/71	MSF	MSC	Lunar sample curatorial fac.	450	450		25									Project canceled; substitute minor facility projects planned.	
13	7251/71	MSF	MSC	Calibration laboratory.	900	900		54									Statutory reprogram. Not scheduled. Fiscal year 1971 authorization available, but appropriation not provided. Project complete.	
14	5706/71	SSA	WTR	Alterations to launch complex 2.	3,900	3,900		308									Designed in-house. Design fund release previously indicated have been withdrawn.	
15	5149/71	SSA	GSFC	Earth resources technology lab.	1,403	1,350		49									Project canceled; substitute rehab/mod project planned.	
16	5529/71	SSA	JPL	Modifications to solar simulator.	700	650											Project canceled; substitute rehab/mod project planned.	
17	6297/71	MSF	MSFC	Mods struct/thermal test fac.	1,500	1,500		115									Project canceled; substitute rehab/mod project planned.	
18	4325/71	ART	NRDS	Engine stage test stand No. 2.	3,500	3,500											Statutory reprogram.	
19	2143/71	ART	ARC	Polymer research lab.	1,325	1,325		70									Project canceled; substitute rehab/mod project planned.	
20	2146/71	ART	ARC	Addition to data reduction center for ILLIAC IV comp. syst.	1,200	1,000		70									Statutory reprogram.	
21	2261/71	ART	LeRC	Vertical lift engine test cell.	655	655											Do.	
22	9309/71	TDA	VAR	Power plant addition 210 ft. antenna facility, Goldstone, Calif.	750	840		55									Project cost increase due to construction/equipment cost growth.	

23	9310/71	TDA	VAR	Relocation of transportable facility—Newfoundland.	525	410	25	410	100	-----	Feb. 1972	0	Aug. 1972	Location changed from Santiago Chile to Newfoundland, Canada.
24	5556/71	ART	JPL	Isotope thermoelectric systems application laboratory.	1,250	1,250	75	1,250	100	-----	Apr. 1971	68	June 1972	
25	VAR/71	O. & M.	VAR	Rehabilitation and modification	14,000	14,000	624	12,733	98	Apr. 1972	Sept. 1970	47	Apr. 1973	Includes over 50 subprojects which have varying completion dates.
26	5146/70	SSA	GSFC	Fire protection and prevention modifications.	670	670	120	670	100	-----	Mar. 1970	100	Aug. 1971	Project complete. Prior year work also designed in this project.
27	7709/70	MSF	KSC	Skylab mods (LC 39)	8,000	7,450	178	7,450	96	Mar. 1972	Nov. 1970	40	Sept. 1972	Replace project No. 7694.
28	7649/70	MSF	KSC	Manned spacecraft facilities	1,000	1,550	46	1,550	95	Feb. 1972	Jan. 1971	45	June 1972	
29	7641/70	MSF	KSC	Skylab mods.	3,300	0	219	15	100	June 1970	-----	-----	-----	Project to be canceled.
30	7712/70	SSA	KSC	Utility installations	770	770	60	770	100	-----	Oct. 1971	10	May 1972	Emergency repair project undertaken as provided by sec. 307 (b) Public Law 85-568.
31	2373/70	ART	LRC	Aircraft noise reduction lab	4,767	5,754	378	5,754	100	-----	July 1971	16	Jan. 1973	Cost increase due to growth of construction costs and detailed definition of requirements during design phase.
32	7250/70	MSF	MSC	MCC power generation facility	1,750	1,750	89	-----	100	Mar. 1970	-----	-----	-----	Project deferred until Shuttle impact can be fully assessed. Not scheduled.
33	5328/70	SSA	WS	Flight information control and analysis lab.	500	450	30	450	100	-----	Feb. 1971	90	Feb. 1972	
34	5706/70	SSA	VAR	Space launch complex 2 mods	425	425	210	17,000	100	-----	Nov. 1969	75	June 1972	Project canceled.
35	9156/70	TDA	VAR	Deep space (210 ft.) antenna facilities, Austria and Spain.	17,000	17,000	210	17,000	100	-----	Nov. 1969	75	June 1972	Construction completion, June 1972; operationally ready, June 1973.
36	2260/70	ART	LeRC	Emergency repairs to PSL equip. building.	294	294	-----	294	96	Mar. 1972	May 1971	55	June 1972	Emergency repair project undertaken as provided by sec. 307 (b) Public Law 85-568.
37	VAR/70	O. & M.	VAR	Rehabilitation and modification	9,000	9,425	429	9,414	99	May 1972	Oct. 1969	98	Sept. 1972	Includes over 40 subprojects which have varying completion dates.
38	7620/69	MSF	KSC	Launch complex 39	5,328	5,324	143	5,324	100	-----	Apr. 1969	100	July 1971	Project complete.
39	7666/69	SSA	KSC	Alteration to launch complex 17	700	556	3	556	100	-----	June 1969	100	Feb. 1971	Do.
40	7224/69	MSF	MSC	Modification to the environmental testing lab.	1,500	999	47	999	100	-----	Nov. 1968	100	Mar. 1971	Project complete. Back-up power portion of project reduced in scope.
41	6323/69	MSF	MAF	Rehabilitation, alteration and improvements.	400	400	23	400	100	-----	Apr. 1969	100	July 1971	Project complete.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION CONSTRUCTION PROJECTS IN PROGRESS—Continued

[Dollar amounts in thousands]

Line No. (a)	Project No. (b)	Prog. office (c)	Field center (d)	Project title (e)	Initial program est. (f)	Current funds released		Design status		Construction progress			Remarks (g)
						est. (g)	Design (h)	Const. (i)	Per- cent (j)	Est. comp. date (mo/yr) (k)	Start date (mo/yr) (l)	Percent comp. (m)	Est. comp. date (mo/yr) (n)
42	9156/69 9157	TDA	VAR	Deep space (210 ft.) antenna facilities, Australia and Spain.	17,000	17,000	80	17,000	100	-----	Nov. 1969	85	June 1972
43	9106/69	TDA	VAR	Power plant replacement STADAN.	1,875	2,420	75	2,420	100	-----	July 1970	90	Mar. 1972
44	2131/68	SSA	ARC	Space science research lab	2,195	2,195	72	2,195	100	-----	Jan. 1969	100	Aug. 1971
45	2135/68	ART	ARC	Heater replacement 3.5-ft. wind tunnel.	3,170	2,040	174	2,040	100	-----	June 1970	90	Feb. 1972
46	5548/68	SSA	JPL	Space flight operations facility systems development lab.	1,195	1,195	66	1,195	100	-----	Sept. 1970	100	July 1971
47	5128/68	SSA	GSFC	Utility modification and installation.	565	565	40	565	100	-----	Feb. 1968	96	Jan. 1972
48	7709/68	MSF	KSC	Skylab mods.	3,100	1,000	-----	-----	-----	-----	-----	-----	-----
49	7224/68	MSF	MSC	Mds to environmental testing laboratory.	1,900	669	47	669	95	Jan. 1972	June 1969	95	June 1972

Construction completion June 1972, operationally ready June 1973.

Cost increase due to design definitization of power plant building, requirements and shortage of construction contractors in area. Funding adjusted within \$23,705 authorized for various locations.

Project complete.

Cost reduction due to revised definition of requirements.

Project complete.

Basic project is complete.

Completion date shown is for diesel generator upgrading which is final phase of this project. Design amount includes separate analysis required to insure increased reliability of existing systems.

New project title; combines with 7649/70 and 7709/70 to meet Skylab requirements.

Basic project complete. Design and construction completion dates shown is for miscellaneous mods to Double Manlock.

50	7666/68	SSA	KSC	Alteration to LC 17	2,290	2,916	116	2,916	100	June 1969	100	May 1971	Project complete. Cost increase due to mandatory safety and operational features determined in design phase. Funding adjusted within \$24,885, authorized for KSC. Project canceled. Fund withdrawal action in process.
51	7215/68	MSF	MSC	Center support facilities	525	0	24	255					Not scheduled.
52	2257/68	ART	LeRC	Land acquisition (Cleveland)	15	15		15					Final settlement of 2 tracts outstanding; 1 pending condemnation proceedings;
53	2256/68	ART	LeRC	Land acquisition (Plumbrook)	2,100	2,100		2,100		Dec. 1968		June 1972	the other probate action
54	6323/68	MSF	MAF	Repair, rehabilitation, and improvements	880	508		508	100	Nov. 1969	100	Sept. 1971	Project complete. Design accomplished in-house. Elec. supt., heat/cool system and water tower portion of project reduced in scope.
55	2202/67	ART	LeRC	Expansion of propulsion systems for lab for superionic research.	14,000	14,000	500	14,000	100	May 1967	91	Oct. 1972	Project complete. Special test equipment included in design.
56	2250/67	ART	LeRC	Installation of equipment at hydrogen heat transfer facility for hyperionic propulsion research.	2,000	2,000	133	2,000	100	Oct. 1967	100	Oct. 1971	Do.
57	2356/67	ART	LRC	V/STOL transition research wind tunnel.	5,271	5,545	526	5,545	100	Sept. 1967	100	Apr. 1971	Partial BOD November 1971 (2d floor), slip in completion date result of labor problems in December 1971.
58	7245/67	MSF	MSC	Engineering building	2,600	2,500	163	2,500	100	Aug. 1970	90	Feb. 1972	Project complete. Project scope reduced. Construction of heat plant addition deferred. Excess funds withdrawn.
59	7215/67	MSF	MSC	Center support facilities	1,000	329	59	329	100	May 1968	100	Sept. 1971	All work completed except for Xenon lamps and utility upgrading. Albedo simulation and gimbal mount portion of project deleted.
60	7224/65	MSF	MSC	Mod to environmental test lab	9,416	4,184	231	4,184	100	Jan. 1965	85	Mar. 1972	All work completed except software development for utility control system.
61	7230/65	MSF	MSC	Central heat and cool plant and warehouse ext.	1,625	1,450	93	1,450	98	Feb. 1972	98	Feb. 1972	Work on redundant power transformer is only work remaining. Basic project complete June 1966.
62	9503/64	TDA	VAR	MSF data acquisition and tracking facility, Goldstone.	6,500	6,021	140	6,021	100	Jan. 1964	98	July 1972	

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION,
Washington, D.C., December 16, 1971.

HON. GEORGE P. MILLER,
Chairman, Committee on Science and Astronautics,
House of Representatives, Washington, D.C.

DEAR MR. CHAIRMAN: As Dr. Low promised in his letter to you of June 3, 1970, regarding NASA's acquisition of facilities, I am enclosing a report on NASA minor new construction and additions funded during FY 1971 from the Research and Development and the Research and Program Management appropriations.

Because of the interest expressed by the Senate Committee on Aeronautical and Space Sciences in NASA's acquisition of facilities, I am also sending a copy of the enclosed report to Chairman Anderson.

Sincerely,

H. DALE GRUBB,
Assistant Administrator for Legislative Affairs.

Enclosure.

ANNUAL REPORT TO CONGRESS ON NASA MINOR NEW CONSTRUCTION AND ADDITIONS, FUNDS OBLIGATED
DURING FISCAL YEAR 1971—SUMMARY

[In thousands of dollars]

Installation	New construction		Additions		Total		Installation total
	R. & P.M.	R. & D.	R. & P.M.	R. & D.	R. & P.M.	R. & D.	
Kennedy Space Center.....			127(145)	138(138)	127(145)	138(138)	265(283)
Manned Spacecraft Center..	186(187)	271(271)	93(118)	39(44)	279(305)	310(315)	589(620)
Marshall Space Flight Center.....							
Ames Research Center.....							
Flight Research Center.....							
Langley Research Center.....			164(245)	568(857)	164(245)	565(857)	729(1102)
Lewis Research Center.....				142(157)		142(157)	142(157)
Goddard Space Flight Center.....		244(258)		376(474)		620(732)	620(732)
Wallops Station.....		26(26)				26(26)	26(26)
Jet Propulsion Laboratory.....		98(100)		506(550)		604(650)	604(650)
Total.....	186(187)	639(655)	384(508)	1,766(2,220)	570(695)	2,405(2,875)	2,975(3,570)

Note: Figures in parenthesis on this summary and the attached sheets indicate estimated total cost. The difference from the amount obligated during fiscal year 1971 reflects amount obligated during a prior fiscal year, or scheduled to be subsequently obligated.

ANNUAL REPORT TO CONGRESS ON NASA MINOR CONSTRUCTION

NAME OF INSTALLATION: KENNEDY SPACE CENTER; APPROPRIATION: RESEARCH AND PROGRAM MANAGEMENT

[In thousands of dollars]

Project	Obligated during fiscal year 1971	Estimated total cost
Minor construction (new).....	0	
Minor construction (additions).....	127	(145)
Additions to 2 buildings in the storage and disposal area to provide additional rest room areas, sewage disposal lines and 5,000 g.p.d. sewage treatment facility.....	64	(80)
Modify sanitary sewer system serving the support operations area to provide a 5,000 g.p.d. sewage treatment facility.....	63	(65)
Total.....	127	(145)

NAME OF INSTALLATION: KENNEDY SPACE CENTER; APPROPRIATION: RESEARCH AND DEVELOPMENT

[In thousands of dollars]

Project	Obligated during fiscal year 1971	Estimated total cost
Minor construction (new).....	0	
Minor construction (additions).....	138	(138)
Additional antenna pad at MILA Station to support Skylab program.....	138	(138)
Total.....	138	(138)

NAME OF INSTALLATION: MANNED SPACECRAFT CENTER; APPROPRIATION: RESEARCH AND PROGRAM
MANAGEMENT

[In thousands of dollars]

Project	Obligated during fiscal year 1971	Estimated total cost
Minor construction (new).....	186	(187)
Construct 16,100 sq. ft. metal-wall temporary storage facility, building 33.....	92	(92)
Construct 30,000 sq. ft. metal-wall warehouse, building 336.....	94	(95)
Minor construction (additions).....	93	(118)
Provide 5,160 sq. yds. of additions to parking lots near hangar building 135, Ellington Air Force Base.....	35	(35)
Provide 2,000 sq. ft. dock-type addition to the central gas cylinder storage facility, building 381.....	26	(28)
Provide 480 sq. ft. addition to the auditorium, building 1.....	32	(55)
Total.....	279	(305)

NAME OF INSTALLATION: MANNED SPACECRAFT CENTER; APPROPRIATION: RESEARCH
AND DEVELOPMENT

[In thousands of dollars]

Project	Obligated during fiscal year 1971	Estimated total cost
Minor construction (new).....	271	(271)
Construct 3,600 sq. ft. concrete block film repository facility, building 424 to support Skylab Earth Resources, and Earth Resources Technology Sate lite programs.....	93	(95)
Construct 1,500 sq. ft. dock; (concrete and steel pile); and dredge Clear Lake channel, to support Skylab.....	176	(176)
Minor construction (additions).....	39	(44)
Provide 2,775 sq. ft. fenced enclosure and 400 p.s.i. compressor at Spacecraft Research Office and Laboratory, building 16, to support Skylab and Shuttle.....	39	(44)
Total.....	310	(315)

NAME OF INSTALLATION: LANGLEY RESEARCH CENTER; APPROPRIATION: RESEARCH
AND PROGRAM MANAGEMENT

[In thousands of dollars]

Project	Obligated during fiscal year 1971	Estimated total cost
Minor construction (new).....	0	
Minor construction (additions).....	164	(245)
Provide a 1-story, 10,100 sq. ft. addition to plant support facility, building 1199.....	164	(245)
Total.....	164	(245)

NAME OF INSTALLATION: LANGLEY RESEARCH CENTER; APPROPRIATION: RESEARCH
AND DEVELOPMENT

[In thousands of dollars]

Project	Obligated during fiscal year 1971	Estimated total cost
Minor construction (new).....	0	
Minor construction (additions).....	565	(857)
Provide additional concrete foundations and air-storage bottle racks in the air storage field in the west area, to support research and technology for aero- nautical vehicles.....	90	(240)
Construct addition of 4,095 sq. ft. to 3d floor level of the transonic dynamic tunnel, building 648, to support research and technology for aeronautical vehicles.....	170	(211)
Enclose 780 sq. ft. of ground floor area of flight instrumentation laboratory, building 1202, to support research and technology for electronic systems.....	25	(36)
Provide 1,225 sq. ft. of enclosed space on ground floor of flight instrumentation laboratory building 1202, to support research and technology for space vehicles and electronic systems.....	43	(67)
Provide a 484 sq. ft. addition to flight control laboratory, building 1268-A, to support research and technology for human factors systems.....	42	(73)
Provide a 10, 170 sq. ft. 1-story addition to building 1192, to support Scout launch vehicle.....	195	(230)
Total.....	565	(857)

NAME OF INSTALLATION: LEWIS RESEARCH CENTER; APPROPRIATION: RESEARCH AND DEVELOPMENT

[In thousands of dollars]

Project	Obligated during fiscal year 1971	Estimated total cost
Minor construction (new).....	0	
Minor construction (additions).....	142	(157)
Provide an addition to the aviation gasoline underground storage and trailer refueling station (additional capacity of 20,000 gal.) near flight research building 4, to support supersonic aircraft technology.....	25	(25)
Expand the high pressure helium gas storage facility near electrical propulsion research building 16, to support basic research and technology in thermo- nuclear fusion for propulsion and power.....	64	(64)
Expand liquid nitrogen storage area at Plum Brook Station (225 sq. ft. metal- wall building for a nitrogen vaporizer; and install 1-inch gaseous nitrogen transfer line from the liquid nitrogen transfer facility, building 3233, to the heat transfer facility, building 3411, and the spacecraft propulsion research facility, building 3211) to support testing of improved Centaur propulsion system.....	53	(68)
Total.....	142	(157)

NAME OF INSTALLATION: LEWIS RESEARCH CENTER; APPROPRIATION: RESEARCH AND DEVELOPMENT

[In thousands of dollars]

Project	Obligated during fiscal year 1971	Estimated total cost
Minor construction (new)	244	(258)
Construct 2,400 sq. ft. insulated storage facility at Fairbanks Tracking Station, Alaska, to support scientific satellite programs (Nimbus, Earth Resources Technology Satellite, etc.)	90	(90)
Install 15 ft. L-band antenna at Rosman, N.C., and construct 200 sq. ft. antenna building to support Applications Technology Satellite	27	(37)
Install 15 ft. L-band antenna at Mojave, Calif., and construct 200 sq. ft. antenna building to support Applications Technology Satellite	37	(41)
Construct 4,000 sq. ft. utility building at the Manned Space Flight Network Station, Hawaii, to support, Skylab and scientific satellite programs	90	(90)
Minor construction (additions)	376	(474)
Add Teltrac and VHF/UHF antenna pads at Goldstone, Calif., to support Skylab. Install 2,390 sq. ft., 58-ft. high vertical optical test tank and polishing facility (obtained from closed Electronics Research Center) in the instru- ment construction and installation laboratory, building 5, to conduct basic research in optics	51	(77)
Provide 260 sq. ft. addition to the acoustic testing chamber, building 15, to test Interplanetary Monitoring Platform Satellite and other satellites and to conduct advanced research in acoustic properties in satellites	150	(177)
Provide 300 sq. ft. to 400 sq. ft. additions to command transmitter buildings at Fairbanks, Alaska; Rosman, N.C.; and Quito, Ecuador; to support scientific satellite programs	61	(61)
	114	(159)
Total	620	(732)

NAME OF INSTALLATION: WALLOPS STATION; APPROPRIATION: RESEARCH AND DEVELOPMENT

[In thousands of dollars]

Project	Obligated during fiscal year 1971	Estimated total cost
Minor construction (new)	26	(26)
Construct rocket motor loading platform and access road, to support Scout program	26	(26)
Minor construction (additions)	0	0
Total	26	(26)

NAME OF INSTALLATION: JET PROPULSION LABORATORY; APPROPRIATION: RESEARCH AND DEVELOPMENT

[In thousands of dollars]

Project	Obligated during fiscal year 1971	Estimated total cost
Minor construction (new)	98	(100)
Construct 3,021 sq. ft. 1-story services building No. TM-19 at Table Mountain, Calif., to provide equipment repair shop	98	(100)
Minor construction (additions)	506	(550)
Provide 7,500 sq. ft. 2-story addition to north end of Procurement Office, building 190, to house technical and scientific personnel	245	(250)
Provide 4,300 sq. ft. 2-story addition at southwest end of telecommunications laboratory, building 161, to house technical and scientific personnel	128	(150)
Provide 4,200 sq. ft. 3d floor addition to engineering offices, building 138, to support Mariner/Mars 9 and 10, also Viking	133	(150)
Total	604	(650)

General CURTIN. Thank you, Mr. Chairman.

The funds for facility planning and design, Mr. Chairman, are needed for advance planning and design of facilities as the name implies.

Basically there are four major purposes involved here.

The first is the development of master plans at our various installations, the second is studies and reports, the third is preliminary engineering reports which are the basis of our estimates included in each year's construction of facilities request, and finally, the fourth is contract plan and specifications.

In this year's budget we have a request for \$8 million made up of two basic parts, Mr. Chairman. The first is \$3.5 million which relates to what we have termed the regular recurrent requirements, and a second part of \$4.5 million is for what we have termed "other" or "special" requirements.

This regular requirement of \$3.5 million is the same amount that was appropriated last year and contains funds for master plans and the preparation of studies in the amount of \$550,000, of which \$150,000 is for the upgrading and improvement of the master plans for several of our installations.

Some \$950,000 of the amount is for the preparation of preliminary engineering reports for our potential fiscal year 1975 C of F request. This is geared to a potential program for a preliminary engineering report effort of between \$50 and \$60 million which, as you know, will be considerably reduced as we go through the review cycle. But we consider that as what is needed for the preliminary review effort.

Then there is \$2 million included in the \$3.5 million which is for the final design of a fiscal year 1974 program. This figure is the approximate average of our experience for both fiscal years 1972 and 1973 and which has been used in this budget estimate. It also reflects the additional requirements for design funds needed for the smaller projects that are now included in the construction of facilities budget and which were not so included in the prior years.

The larger portion of this \$8 million request, \$4.5 million, relates to two requirements which I feel are significantly large to justify being separately identified this year.

The first is the significant requirement for space shuttle facilities which is emerging to a larger extent in our potential 1974 and 1975 programs.

We have, therefore, \$3,750,000 included in this request which is specifically related to Space Shuttle facilities. Of that amount some \$1 million is for preliminary engineering reports which is geared to a potential effort of about \$70 to \$80 million related to a potential 1975 program. The balance of \$2.75 million is an estimate geared to a potential 1974 program for facilities on the order of \$45 to \$50 million of final design effort.

The second portion of this relates to large aeronautical facilities. Some \$750,000 is related to continuing design of a full scale subsonic wind tunnel. This tunnel, depending on configuration, would cost in the order of magnitude of \$150 to \$200 million if it is ultimately approved. It would take about \$7 to \$10 million to design.

This year's request for \$750,000 would complete the design of the drive section on this tunnel. As you know, we have done some preliminary work on it, Mr. Chairman. It would also complete minor optimization studies on the tunnel and permit us to undertake design integration studies of various components, perform layout options of various configurations, rough out time phasing and cost funding of the tunnel, and provide a basis for substantive future design effort on the tunnel if the continuation of this effort is ultimately approved.

That concludes my comments, Mr. Chairman.

Mr. DAVIS. Thank you very much, General Curtin.

Now that all three of the statements have been presented, we will open the session to questions from the membership.

I have a few questions I would like to ask of our first witness, Mr. McCurdy.

My first has to do with your testimony at the bottom of page 6. You said that NASA civil service "must soon enter a period in which there can be a reasonable intake of young people. To accomplish this, we shall need to embark upon a period of stability in the civil service work force so that it can return to normal personnel development practices, heal the damage of the past several years." You also have on that page a table which shows, as you pointed out, some nearly a thousand young graduates hired in 1966, whereas in the first half of 1972, only 24 graduates were hired.

Now I have been more or less immersed in the work of the National Science Foundation in the past 2 or 3 years and it is evident from talking to the university people, that there has been a great diminution of students who desire to enroll in the hard sciences, and a dramatic increase in the applications of students, even those who have Ph. D.'s in physics, for example, who want to go to law school. I am wondering if, in addition to the civil service policies you outlined in your statement, if the national mood isn't also a big factor?

Mr. McCURDY. I'd like to comment on that, Mr. Chairman. I believe that there is certainly an element of national mood. I know that many young people are switching from the hard sciences to other things for reasons that are somewhat apart from our problem here. And that is a fact which I wouldn't pretend to be able to analyze here.

Our own situation is one in which we simply cannot offer, under the conditions of the last few years, any reasonable employment for any considerable number of these people and the origin of it really is in my judgment in the structure of the civil service situation itself.

Let me say something first about this, because I don't want to seem to be criticizing the civil service regulations.

In a stable situation or on the way up, this is a very fine way to go because you have a merit promotion system; you exercise judgment and selectivity; and you can mold your organization in a pattern that all good executive and managerial people know how to do.

On the other hand, on the way down, there are certain rigidities and you are unable to use your judgment to anything like the degree that one would like to use it.

Now this is not particularly troublesome if you have one reduction in force, even if it is a large reduction in force, because it happens and then the same processes of recovery can begin to operate again. So an

organization can survive even a hard reduction in force, without any great and continuing damage.

I believe that the situation is different when you have multiple reductions, one after the other, because then the processes of recovery don't take place and this is the situation that we are in here.

I don't believe that the civil service reduction in force arrangements are built to take care of the kind of situation that NASA has gone through in the last few years, which is rather unique, and this is the origin of our particular difficulty.

I have discussed this at length with the civil service people and I believe that they appreciate that there may be situations that are out of the ordinary, which we may well be in, in which these procedures are not particularly fitting to our situation.

Mr. DAVIS. Have you been able to form any opinion as to what impact the Space Shuttle program will have upon this situation?

Mr. McCURDY. I think, Mr. Chairman, that we have to view this in the general context of the NASA forward program; the forward program at the present time is one of stability. The Space Shuttle is a large program, but it fits within a constant budget of NASA work and so there would seem to be no reason why, with this reasonable forward program, we shouldn't come into a period of reasonable stability in the work force and be able to hire and to run our organization in the way that one does during normal situations.

Mr. DAVIS. I noticed that the word environmental work entered into several parts of your statement. And I have also noticed from the standpoint of the science education phenomenon as it exists in our country today, that quite a lot of people who do evince some interest in the higher sciences, nevertheless direct their training toward the matter of environmental matters.

Would you care to comment a little bit about the involvement of NASA in regard to the surface environment?

Mr. McCURDY. Well, there are certainly many involvements of NASA in the environment.

Let me say at the beginning that, although it may not be fully realized and we hope that it can be fully realized, the Space Shuttle itself is a magnificent environmental tool because of the things that it will do and the things that it will carry. In my own judgment, a young man who is working in a hard technical subject and who realizes that he could work on the Space Shuttle, can have his environmental cake and eat it too, if he wishes, because he can pursue his hard subject and still be an environmentalist and this is the thing that I hope our young people will see.

Now, it is very difficult for them to see that through the haze of argument that surrounds this kind of subject. People somehow believe that you can't work properly in environmental subjects unless you are a lawyer or something like that which is completely untrue.

Attacks on the environment are bound to be based on technology and good technology.

Of course, I mentioned the Shuttle, but there are many other instances in our program in which the relationships with environmental processes are very clear and I imagine that many of them have been mentioned in the course of our hearings.

Mr. DAVIS. Well, I think that this will become increasingly clear to our students, and after all the decision as to what a man's going to do in his career is made not by the Government, but by the student himself. It will become increasingly clear that you cannot really find out very much about the environment unless you know the factors concerning environmental problems and, of course, they are greatly simplified in a space capsule which operates in a virtual vacuum. But it was brought to my attention about a year ago, when I was privileged to take a trip down to Antarctica to see scientists working in a limited environment, that if you tried to research, for example, on the factors that enter into the life of a pigeon here at the U.S. Capitol, there are so many factors involved there that you would never come up with any meaningful data. You have to limit the things that control an organ, and I do hope that it will soon become clear to our students when deciding upon a career.

Mr. McCURDY. I have a great deal of not only hope but conviction that this will become clear. The facts are that man in space has not only the unique ability to look at the earth in a way that it can't be looked at otherwise, but its also that technology pervades the operating world in general and produces things that are useful in this regard.

Mr. Low. Mr. Chairman, on that subject, later on this morning we will have a demonstration of aircraft noises. Noise, of course, is another form of pollution that we are concerned with.

In that demonstration you will see what NASA is doing to improve this portion of our environmental problems.

Mr. DAVIS. One part of your statement, Mr. McCurdy, said that you plan a headquarters reduction of 41 personnel in fiscal year 1973. Was that self-imposed?

Mr. McCURDY. It is a portion, a headquarters portion of the general reduction that we have been undergoing.

Mr. DAVIS. They were constraints levied by the overall executive action?

Mr. McCURDY. That is right. We have constraints on us, and we distribute these around the agency to the best of our judgment.

Mr. DAVIS. And is this one that you can accomplish by attrition or will it take a reduction-in-force action?

Mr. McCURDY. We have already accomplished it numerically, by attrition, simply by imposing a hiring freeze. It has however, resulted in an imbalance of workforce which we may have to cure by reduction procedure; we simply don't know at this stage of the game. If we do, I don't think it will be a large one.

Mr. DAVIS. Mr. Mosher?

Mr. MOSHER. I don't have any questions at this time.

Mr. DAVIS. Mr. Cabell?

Mr. CABELL. Mr. Chairman, you have already posed some questions that I had in mind.

I would like to ask Mr. McCurdy, in the light of the rather severe reduction in your employment of scientists and engineers coupled with the fact that for the past couple of years the Office of Management and Budget have rather stringently withheld funds appropriated for institutional support which tends to discourage young men and women from entering this line of work.

Can you foresee in the near future a situation where we might have a definite shortage of good scientists and good engineers entering this field? Because you are going to have attrition in any case. You have got a pretty long lead time before you can fabricate a good scientist and aren't we liable to hit a vacuum if this continues?

Also I am hoping that the present requirements for such talent will not stay as low as they are at the present moment.

Would you care to comment on that?

Mr. McCURDY. Yes, sir; I would be glad to comment on that.

I share your concern very deeply and I have been concerned over the last several years with some universities and have talked with them about this; I very much believe that there is a danger of a shortage. And, as I was saying a while ago, I think that one of the things today most required is that we somehow get the message to our young people that they are not doing something that is useless if they engage in these subjects. The exact opposite is true in my judgment.

Mr. CABELL. You mentioned the constraints that preclude you from stabilizing and balancing your highly technical work force. You have indicated that you have apparently gotten a certain amount of sympathy from the Civil Service Commission but not to the point where you can expect any kind of relief from it?

Mr. McCURDY. I find it hard to predict what will happen to us in this regard.

I keep emphasizing the picture as I see it and hoping that this will convey the reality that I believe is there.

Mr. CABELL. One further question of Dr. Low, if I may and then I will relinquish the microphone, Mr. Chairman.

I am sure that this question has been asked with reference to other units or other phases of NASA's budget and have been handled by specific subcommittees, but for those items for which you are requesting authorization, could you tell me how your initial request stand as compared with that which was ultimately approved by the Office of Management and Budget.

Dr. Low. Mr. Cabell, we had a basic request, which we called our minimum recommended budget, to the OMB and in that request the total NASA budget was \$3,385 million.

We now have in the President's budget, \$3,379 million, a decrease in total of \$6 million. But we had in our request to the OMB, a second budget which we called our alternate recommended budget, where we found many things that still had to be done, still in a highly restricted budget, for which we asked \$3,540 million which is \$160 million more than the \$3,379 million, which is in the President's budget.

Mr. CABELL. You feel then that if you had your druthers, you would have the \$3,540 million?

Do you feel that not having received what you felt you should have that you have been seriously hurt in your program and that additional money, if it could be forthcoming, would pay for itself in the increased activity and performance?

Dr. Low. The additional funds that we requested in our alternate recommended budget were for what we considered to be important things in aeronautics and in space for the Nation to do if it were possible to do so in the total Federal budget.

Mr. CABELL. Would you submit for the record that supplementary budget which you have reference to in order that we can compare that with the recommended budget as a comparison where differences exist in certain line items?

Dr. Low. Yes; we will do that.

Mr. CABELL. We will request that if that is in keeping with you, Mr. Davis?

Mr. DAVIS. Without objection Mr. Camp?

(Information requested for the record follows:)

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, SUMMARY OF FISCAL YEAR 1973 BUDGET SUBMISSION TO THE OMB AND OMB ALLOWANCE

[Millions of dollars]

	Submission to OMB		OMB allowance budget submission to Congress	Change from	
	Minimum recommended budget	Alternate recommended budget		Alternate recommended budget	Minimum recommended budget
Research and development:					
Apollo.....	128.7	128.7	128.7	-48.0	-10.0
Space flight operations.....	1,104.2	1,142.2	1,094.2	-1.0	-1.0
Advanced missions.....	2.5	2.5	1.5	-17.4	+34.5
Physics and astronomy.....	122.1	174.0	156.6	-23.0	-21.0
Lunar and planetary.....	342.2	344.2	321.2	+9	+3.8
Launch vehicles.....	187.8	190.7	191.6	-28.5	-20.0
Applications.....	214.7	223.2	194.7	-12.0	-5.0
Space technology.....	69.8	76.8	64.8	-2.5	-2.5
Nuclear power and propulsion.....	23.6	23.6	21.1	+3.8	+26.0
Aeronautics.....	137.4	159.6	163.4	-9.0	-1.0
Tracking and data acquisition.....	259.1	268.1	259.1	-1.0	-1.0
Technology utilization.....	5.0	5.0	4.0		
Total research and development....	2,597.1	2,738.6	2,600.9	-137.7	+3.8
Construction of facilities.....	80.7	94.0	77.3	-16.7	-3.4
Research and program management.....	707.4	707.4	700.8	-6.6	-6.6
Total NASA.....	3,385.2	3,540.0	3,379.0	-161.0	-6.2

Note: The figures in the "Submission to OMB" columns have been adjusted to be comparable to those in the "Budget submission to Congress." Funding for minor construction projects exceeding \$10,000 and facility modification and rehabilitation projects exceeding \$25,000 has been transferred to the "Construction of facilities" appropriation. Net adjustment is as follows:

Research and development.....	-\$6,200,000
Research and program management.....	-600,000
Construction of facilities.....	+6,800,000

Mr. CAMP. I just have one question with regard to what has already been spoken to.

I just wonder if the reason why the young people are not getting involved in this particular program is because of the insecurity they might feel because of what has happened in the past, as examples, the SST program and the postponement in a decision on the Shuttle program because of the people now unemployed that were capable individuals in their particular position and who today are out of a job?

Dr. Low. I think, Mr. Camp, that has a lot to do with it. There is a general lack of understanding by the young people, I have five of them myself. There is a lack of understanding by the young people of what this is all about, and we are trying very hard to inform the young people why it is so important to them and to their future to move forward in aeronautics and in space.

Obviously we have not yet had enough success in doing this.

Would you like to add to that?

Mr. McCURDY. Well, I really believe that that is a very important consideration and indeed, it goes even to the Battelle survey that was made for us, of people that were laid off in the aerospace industries that we tracked in this reduction that has occurred in the last few years. Going back and giving questionnaires to these people we discovered that many of them would not wish to go back to the aerospace industry even if they had the chance to.

If you take the situation in our own agency with the type of thing that happens, unfortunately, when we have a reduction in force because of the seniority situation, it is usually the younger man that goes out. All right. We can take a man in and we can protect him under a training program for a little while, and then he gets out; then you have the next reduction, the man goes who has been with you for a couple of years and the new man doesn't. But when the new man gets up there he goes too. And finally somebody who is really good—and the good people still have job opportunities nowadays—says why should I get into this ring-a-round-the-rosy, I'll go now and join something in which I have a more reliable opportunity.

Dr. Low. The numbers that I saw recently, Mr. Camp, indicates that 2 or 3 years ago the average enrollment at MIT in the department of astronautics was between 80 and 100 per year, and I understand the sophomore class this year, which is the class that shows what is happening in the future, is down to 16 for the very reasons that we have stated here.

Now this means that when the time comes when young men will again be needed to move into those areas that have moved forward technology in aeronautics and space they just will not be available.

Mr. CAMP. Well do you have any suggestions to us that might bring about a little more stability in the situation?

Dr. Low. I think in one sense, Mr. Camp, you can help us maintain the stability we are seeking at NASA by not cutting below the level of people that we now have on board and will have on board at the end of fiscal year 1973.

As Mr. McCurdy has pointed out, it is most important for us to have stability instead of the ups and downs which have characterized the past several years. This in itself is important.

Second, I think that much of the work that this committee has done and is continuing to do by showing the public at large the benefits of the kind of work that we have been doing in aeronautics and space is important, and I refer here to a booklet that the committee put out last December on the benefits of space exploration.

All of these things are most helpful and most necessary, I think, in changing the trends that we have seen in this country over the past several years in the decline of science and technology.

I think the committee has been most helpful in doing this.

Mr. CAMP. Mr. Chairman, off the record.

(Discussion off the record.)

Mr. DAVIS. I would like to say that I have recognized the problem of the students that are enrolling in a technical career. But this morning is the first time that I realized that the statutory operational procedures of civil service are such an impediment to your operation of NASA in your unique situation and I think it would be very helpful if you gentlemen could have your counsel to prepare an opinion as to whether or not it would be advisable to effect a change in the civil

service organic law. If it would help NASA I think we might take that up with our friends on the Post Office and Civil Service Committee and we might well receive a friendly reception.

Could you submit something for the committee's consideration at a later date?

Mr. McCURDY. Yes, Mr. Chairman.

Mr. DAVIS. I want to say that all of your statements were highly interesting and helpful. I have some extensive questions prepared with the help of our staff for your scrutiny and response. In many instances they are somewhat technical and will require some consultation, so I won't ask you to answer them right off the cuff this morning but I would appreciate it if you would prepare answers for the record to assist us in final mark up.

If there are no further questions, we will proceed with the presentation of Mr. George Cherry, Deputy Associate Administrator for Aeronautics and Space Technology. And if any of the witnesses would like to be excused they may feel free to leave at this time.

Dr. Low. I am so interested in this noise presentation, Mr. Chairman, that I'd like to see it again, if I may.

STATEMENT OF GEORGE CHERRY, DEPUTY ASSOCIATE ADMINISTRATOR FOR AERONAUTICS AND SPACE TECHNOLOGY, NASA

Mr. CHERRY. Mr. Chairman and members of the committee, I have a 1-minute introductory statement and a 12-minute audiovisual demonstration.

An important part of the NASA aeronautics program deals with the reduction of jet aircraft noise. We are requesting \$28.5 million in fiscal year 1973 for research and technology to continue this work. Roughly one-half of this work is research and technology attacking the fundamental problems of noise generation and noise propagation; but \$12.4 million is requested for programs for near-term relief from jet aircraft noise.

Of the \$12.4 million, \$9 million is requested for an engine modification development program and \$3.4 million is requested for development of operational procedures for noise abatement.

I would now like to demonstrate the effectiveness of the engine modifications and operational procedures by the audiovisual demonstration. In this demonstration you will actually hear 95 EPNdb systems. However, many people are now living in areas exposed to as much as 120 EPNdb. The equipment we have here today cannot reproduce 120 EPNdb, nor would you care to hear that intense a noise.

Mr. DAVIS. I forgot what the EPNdb stands for.

Mr. CHERRY. It is a measure of the noise annoyance experienced by the human observer; it is a more meaningful measure than just plain db.

Mr. DAVIS. As I remember it, you can perceive frequencies of about a hundred per second on up to about 18,000 per second?

Mr. CHERRY. Yes; but the very sensitive range is much less than that.

Mr. DAVIS. More effective; how does that fit into the definition?

Mr. CHERRY. Well, two things are taken into account, Mr. Davis. One is the duration of the noise, and the second is the frequency spectrum. The frequencies that are most annoying, for example between

1,000 and 3,000 cycles per second, are given more weight in the EPNdb measure so that this is a more meaningful measure of noise than plain db which doesn't take into account human perception.

Mr. DAVIS. All right.

(Audiovisual demonstration.)

Mr. CHERRY. That concludes the demonstration, Mr. Chairman.

Mr. DAVIS. Thank you very much, Mr. Cherry.

There is just one question that the narrator did not explain. And that is on the approach noise, the noise when a plane is getting ready to land. He kept talking about a two-segment approach. Is that an approach to the airport which envisions a deeper glide angle down to a point pretty close to the runway?

Mr. CHERRY. Yes, sir. The glide slope is 6° to about 650 feet altitude and then the pilot makes the glide slope more shallow and flies on the normal glide slope. By 400 feet altitude he would be on the normal glide slope.

Mr. DAVIS. The normal glideslope is about 3° ?

Mr. CHERRY. About 3° ; yes, sir.

Mr. DAVIS. Now that will reduce noise even without engine modification, will it not?

Mr. CHERRY. Yes, it will.

Mr. DAVIS. Has not that concept met with considerable resistance from the commercial airline pilots?

Mr. CHERRY. It has, sir but it has already been accepted in some areas. For instance, Pacific Southwest Airlines, an intrastate carrier in California is now flying this kind of approach into Los Angeles Airport, but they are making the transition to the 3° glide slope at a slightly higher altitude.

Their pilots are doing it routinely in clear weather and they are doing it in Boeing 727's.

Mr. DAVIS. Then it looks like a selling problem that is necessary?

Mr. CHERRY. This is true. Pacific Southwest Airlines is doing this without any cockpit instrumentation to help the pilot. This is fine for PSA because of the very high frequency of landings that their pilots make, and because of the generally clear weather encountered on their intrastate route structure.

Mr. DAVIS. For PSA.

Mr. CHERRY. PSA is doing it without the help of cockpit instrumentation for their pilots but they make many more landings a day than many trunklines and the visibility in that area is good. But the trunklines say that they don't want to adopt the procedure without some sort of instrumentation to make the approach more repeatable than the visual approach that PSA uses.

And that is what we were working on. The thrust of our program is to convince pilots that it is safe and is repeatable and does not add to their workload in the cockpit.

Mr. DAVIS. It is difficult for me to see how it would involve any more instrumentation that they already have.

Mr. CHERRY. There is no instrumentation in the airplane at all to make a 6° glide slope.

Mr. DAVIS. I wouldn't think so.

Mr. CHERRY. So the concept is to provide them something. We believe, that it would cost about \$50,000 to \$100,000 to add the necessary

equipment to the cockpit to define the steeper glide slope by instruments so that the pilot can fly instruments as he normally does.

Mr. DAVIS. Well, it would require no change in the ground facilities; would it?

Mr. CHERRY. In general, no sir. At a few airports that do not have what is called a distance measuring equipment it might require the addition of one. They cost about \$60,000 apiece.

Mr. DAVIS. Well I would say that there is not a commercial airport that doesn't have a DME.

Mr. CHERRY. Eight of the 10 most noise-afflicted airports have a DME right at the airport. At the other two, it would cost about \$60,000 each to so equip them.

Mr. DAVIS. Well, I believe that is all the questions I have.

Mr. Cabell?

Mr. CABELL. With reference to changing the glide pattern—doesn't the altitude of the airport involved and also the length of the runway have to be taken into consideration with reference to safety procedures?

Mr. CHERRY. No sir; I don't believe so. The last 1½ miles of the approach or certainly the last 1 mile of approach is completely normal; by that time the airplane is stabilized on the normal approach path.

May I say that with respect to approaches to some airports the 6° glide slope for the initial part would add to safety because it would add to the approach obstruction clearance. And the rule on this by the FAA merely says that the pilot must be on or above the glide slope. So in a sense this is a "more legal" approach.

Mr. CABELL. One other question, we hear an awful lot of people who are demanding immediate retrofitting of these engines. Would you care to comment on the economics involved in this?

Mr. CHERRY. I personally believe that given that we have to reduce the noise of jet aircraft, the economics of retrofitting are attractive.

If I were an operator I would look at the economics this way: assuming that I must make my fleet quieter (excluding operating procedures for the moment) I might consider installing engine modifications and acoustic nacelles on my DC-8's, for which I have already paid, or I might consider buying quieter DC-10's. My cost per seat, trading in a noisy DC-8 for a quiet DC-10, would be about \$54,000. My cost per seat, spending about \$2 for quieting a noisy DC-8 with an engine modification, would be about \$10,500. At a cost five times as much per seat for the DC-10, I surely would seriously consider modifying the DC-8.

Mr. Low. The overall problem of airplane economics is a very complex one which definitely involves the CAB and the FAA, and I don't think we are prepared to comment here in detail on that subject.

Mr. CABELL. I recognize that but I stick to my point that it has to be taken into consideration that you don't junk a 707 on a minute's notice. You have got the economic situation confronting a great many of our airlines today that are already in financial difficulty.

Mr. Low. That is why we are working on the joint program with the FAA on the terms of how best to approach this subject. It is nothing that NASA can do unilaterally.

Mr. CABELL. And if I may say also, that even though all of us are interested in improving our ecology and reducing noise levels, we may have to learn to live with them a little while until these things become

economically feasible and we are not forcing somebody to the wall by demanding that these retrofits be accomplished at too fast a pace.

Dr. Low. Yes, sir.

Mr. CABELL. I don't mean to deter all possible experimentation and research on this problem because I think it is one that is overdue. But I would hesitate to push any program that could mean bankruptcy for our air carriers.

Dr. Low. I think the point you make is very important. The NASA role in determining the feasibility of this is clear, and that is what we are moving forward with in this year's budget as rapidly as we can.

The regulations to make this actually happen have to take into consideration the economics of the situation, in addition to the technical aspects, and this is where FAA comes into the picture.

Mr. CABELL. Well I certainly don't want to belittle the efforts of our ecologists, environmentalists or conservationists but if we are stampered by them we will shut down every industrial plant and service organization. That is what concerns me about the emotionalism involved. This is what has projected us into this ecological kick.

That is all Mr. Chairman.

Mr. DAVIS. I think Mr. Cabell has rendered the sentiment of the whole House of Representatives.

I want to thank you gentlemen for being here with us this morning and your helpfulness and we look forward to hearing your answers to the questions which you will receive.

At this time the committee will adjourn until next Wednesday morning at 10 o'clock.

(Whereupon, at 11:30 a.m. the committee adjourned.)

(Questions and answers for the record referred to previously are as follows:)

GENERAL

(Question asked by Mr. Mosher to be answered by Mr. McCurdy for the record of the hearing before the House Committee on Science and Astronautics on March 17, 1972.)

Question. There has been considerable criticism regarding the procedures for establishing competitive levels within NASA. The main complaint appears to be that overapplication of the competitive level system acts to the disadvantage of employees subject to RIF. Would you please comment?

Answer. To avoid any such "overapplication," NASA has required the personal involvement of key officials at each installation to insure that competitive levels are appropriately established. We firmly believe that both the letter and intent of the procedure have been applied correctly; moreover, this belief appears to be borne out by the record of appeals to the Civil Service Commission. For example, 230 appeals to the Civil Service Commission were lodged by employees affected by the NASA reduction in force in 1970. The issue of narrowness of competitive level (i.e., few positions in a competitive level) was raised in many, if not most, of these appeals. To date, NASA has been sustained in 215 appeals and the appellants have been sustained in seven cases, only two of which involved competitive levels.

RESEARCH AND PROGRAM MANAGEMENT-HEADQUARTERS ACCOUNT

Question 1. The overall fiscal year 1972 authorization and appropriation approved for R. & P.M. was \$4 million less than requested. The amount now shown as the 1972 budget operating plan for the headquarters now reflects an increase of \$2.1 million over that requested for fiscal year 1972. Please explain the following differences:

	Fiscal year	
	1972 request	1972 BOP
Personnel.....	\$41.1	\$42.9
Travel.....	3.0	2.7
Facilities services.....	0.3	0.3
Technical services.....	9.9	9.8
Administrative support.....	5.3	6.1
Total.....	59.7	61.8

Answer:

Personnel *Change*
+1.8

The increase in personnel costs is attributable to the increase in salary rates as adjusted by Executive Order 11576 dated January 8, 1971, effective the first pay period beginning on or after January 1, 1971, in the amount of \$2.1 million. The cost of the pay raise is partially offset by a decrease in the number of permanent positions authorized for headquarters.

Travel - .3

The decrease in travel at headquarters is attributable to the reduction of permanent positions and restrictions and economies in travel imposed by management.

Facilities services..... 0
Technical services..... - .1

The decrease is attributable to a reduction in the amount for ADP programing and operations services.

Administrative support..... + .8

The increase is attributable to an increase in the amount due the U.S. Postal Services, in the amount of \$866,000, due to an increase in postal rates, partially offset by a decrease in local telephone services in the amount of \$67,000.

Question 2. The fiscal year 1972 authorization request indicated a projected end year strength of 1,800 permanent positions. The budget plan now reflects 1,746 permanent positions. What caused the further reduction? Will it be effected by attrition or a RIF?

Answer. The reduction in the projected end year permanent position strength from 1,800 to 1,746 reflects the headquarters portion of the 850 agency-wide reduction imposed by the administration. This reduction has been achieved through attrition.

Question 3. Last year's request reflected no nonpermanent positions assigned to the NASA Headquarters. The budget plan now reflects

250 positions for fiscal years 1971, 1972 and 1973. Was this requirement intentionally omitted from the fiscal year 1972 request?

Answer. Last year's request did not distribute the nonpermanent positions by installation. The nonpermanent positions for headquarters were included in the 2,300 other than permanent positions shown on page RPM 1-5 of the personnel function of summary.

Question 4. Please provide for the record a complete listing of all buildings occupied by the headquarters including the cost and square footage of leased space.

Answer. The following buildings are occupied by the NASA Headquarters:

	Sq. ft.	Cost per sq. ft.
Federal Office Bldg. No. 6, 400 Maryland Ave. SW., Washington, D.C., 3 upper floors...	138,910	(1)
Federal Office Bldg. No. 10B., 600 Independence Ave. SW., Washington, D.C.	203,860	(1)
Reporters Bldg., 300 7th St. SW., Washington, D.C.	29,544	\$4.69
Litton Industries Bldg., 5007-9 Calvert Rd., College Park, Md.	91,450	3.90
Warehouse, 1401 South Fern St., Arlington, Va.	24,020	1.64
Warehouse, 1411 South Fern St., Arlington, Va. (includes office space).....	15,855	3.27
Emergency Relocation Site (classified).....	400	1.50

¹ Government owned.

Note: The cost of leased space, with the exception of the emergency relocation site, is funded by the General Services Administration and is not included in the Headquarters request.

The cost of leased space, with the exception of the Emergency Relocation Site, is funded by the General Services Administration and is not included in the Headquarters request.

Question 5. How much of the amount being requested is to be allocated to the operation of the NASA Pasadena Office? (Please break out by functional category.)

Answer. Of the amount requested for fiscal year 1973, the following is for the operation of the NASA Pasadena Office:

	Thousands
Personnel	\$906
Travel	40
Facilities services	43
Technical services	0
Administrative support	278
Total	1,267

Question 6. It is noted that a reduction of 41 permanent positions will be effected in fiscal year 1973.

(a) *Is this a self-imposed reduction, or was it directed by the administration?*

(b) *Will the reduction be effected by attrition or a RIF?*

Answer. The reduction of the 41 positions to be effected in fiscal year 1973 is the Headquarters portion of the 650 agency reduction directed by the Administration.

It is expected to achieve the reduction through attrition.

Question 7. Under personnel benefits it is noted that Workman's compensation has increased by 27 percent over the level indicated for fiscal year 1972. What are the reasons for this increase?

Answer. A large part of personnel benefits and the only item showing a significant increase is Workman's Compensation, for which Headquarters covers the entire agency. The amount shown for 1973 represents the amount for which NASA has been billed by the Labor Department pursuant to section 35 of the Federal Employees' Compensation Act as amended by Public Law 86-767, which provides among other things that:

(a) The Secretary of Labor shall, prior to August 15 of each year, furnish each executive department or agency, having employees who are or may be entitled to compensation benefits, a statement showing total cost of benefits and other payments made from the Employees' Compensation Fund during the preceding fiscal year on account of the injury or death of employees or persons under the jurisdiction of such agency occurring after December 1, 1960.

(b) That each agency shall include in its annual budget estimates for the next fiscal year a request for an appropriation in an amount equal to such costs. Sums appropriated pursuant to such request shall, within 30 days after they become available, be deposited in the Treasury to the credit of the Employees' Compensation Fund.

The Department of Labor in their letter of August 13, 1971, stated that "The increase in Workman's Compensation is largely due to the higher salary schedule which is the base for the payment of compensation, the cost of living increases, and to increasing costs of medical care. In addition, long term disability and death cases have increased as have new claims for compensation."

Question 8. A total of \$47,000 has been requested for parking areas at JPL, hangar and workshop space at Burbank, and relocation site costs in Washington. Where is the office leased space in the District of Columbia and storage area in Virginia included?

Answer. The amount for leased office space in Washington, D.C., and storage area in Virginia is not included in the headquarters request. These costs are funded by the General Services Administration.

Question 9. How much of the fiscal year 1973 request for headquarters R. & P.M. is devoted to Public Affairs activities? How many personnel are involved?

Answer. Of the fiscal year 1973 request for headquarters, \$3.8 million is devoted to Public Affairs activities. Eighty-three permanent positions are involved.

FACILITY PLANNING AND DESIGN

Question 1. The prior year's funding shown in the justification statement for Facility Planning and Design indicates a total of \$70.4 million allocated to this account through fiscal year 1972. This amount does not check with data compiled from the legislative history of the account. It is presumed to be derived from an adjusted compilation of past years' budget operating plans. Please provide for the record by fiscal year, the amounts requested, authorized, authorization rescinded, and funded for this account.

Answer:

	Requested	Authorized	Authorization rescinded	Funded
Fiscal year:				
1972	\$3,500,000	\$3,500,000		\$3,500,000
1971	5,000,000	5,000,000		4,500,000
1970	3,500,000	3,500,000		3,500,000
1969	3,000,000	1,000,000		1,000,000
1968	3,000,000	5,500,000	\$3,000	5,497,000
1967	7,000,000	5,500,000		5,500,000
1966	7,500,000	5,000,000		5,000,000
1965	15,000,000	10,000,000	1,298,338	8,701,662
1964	10,000,000	20,000,000	9,554,161	10,445,839
1963	10,000,000	8,000,000	451,767	12,895,733
1962	15,347,500	5,347,500		
1962	10,000,000	10,000,000	166,031	9,833,969
Total	82,847,500	82,347,500	11,473,297	70,374,203

¹ Statutory reprogramming sec. 3, Public Law 87-584 R. & D. to construction of facilities.

Question 2. A total of \$3.5 million has been requested for "regular requirements."

(a) *How much is included for the updating of master plans?*

(b) *The request for preliminary engineering reports, investigations and studies for the fiscal year 1975 Construction of Facilities program totals \$950,000. What volume of construction requirements is this based upon?*

(c) *For design, plans, drawings and specifications to accomplish the fiscal year 1974 Construction of Facilities program, \$2.0 million is being requested. What is the volume of the construction program anticipated for that year?*

Answer:

(a) \$150,000 has been included for the updating of master plans.

(b) This request is based on accomplishing preliminary engineering for construction estimated to cost some \$50 to \$60 million.

(c) This request is based upon the anticipated need to design construction estimated to cost \$30 to \$35 million.

Question 3. It is noted that \$3,750,000 is being requested for preliminary engineering and design of projects in support of the space shuttle program.

(a) *What volume of construction is being planned for fiscal year 1975?*

Answer. The estimate of \$3,750,000 is based on providing about \$1 million for the preparation of fiscal year 1975 preliminary engineering reports and \$2,750,000 for final design effort relative to a fiscal year 1974 program. Both of these amounts are specifically based on estimated requirements for space shuttle facilities. We estimated that the fiscal year 1975 initial preliminary engineering report effort will be related to a program on the order of \$70-\$80 million.

Question 3(b). What volume of construction is being planned for fiscal year 1974?

Answer. We estimated that the funds requested for the fiscal year 1974 final design will provide for this scale of design for a program on the order of \$45 to \$50 million. In this connection, we currently estimate that this space shuttle facilities program for fiscal year 1974 may be significantly greater than that for which final design funds are being requested. Revised phasing of requirement coupled with better

definition of detailed requirements and costs have expanded the estimate of potential fiscal year 1974 final design needs.

Question 3(c). If the site for launch, landing and refurbishment has not been selected, what basis was used for these estimates?

Answer. The design costs for launch, landing and refurbishment facilities, as projected in our fiscal year 1973 estimates, were based on the potential maximum use of existing facilities, such as KSC for launch and landing, and therefore represent minimal facility planning requirements.

Question 3(d). Does the overall estimate for F.P. & D. include any engineering and design for planned construction at contractors' plants? If so, where?

Answer. No. This estimate for F.P. & D. includes only the requirements for facilities at NASA installations.

Question 3(e). What specific type of facilities will be required for:

(1) Final checkout of assembled vehicles?

Answer. For the orbiter, the final assembly and checkout station, within the manufacturing and final assembly facility, embraces an area of approximately 87,000 square feet. A portion of this area should have a clear height of 65 feet to accommodate the tail and vertical stabilizer of the vehicle. Sectional sliding doors on one end of the structure would provide an opening of approximately 65 feet high by 85 feet wide for the egress of the orbiter after final assembly and checkout. Within this station, special isolated rigid pads for alinement fixture would be required. Bridge cranes and mechanical handling equipment would also be needed to perform the functions.

The major operation to be performed include the joining together of fuselage, wings, engines, tail section and control surface. As these large and critical items are joined, continuous checks including leak checks, hydraulic checkout, electrical system checkout, mechanical system checkout and integrated system checkout would be conducted. For these reasons, special electronic instruments would be used during these operations requiring special facilities. The facilities would have raised floor system and house computers, data acquisition and control equipment.

For the solid fueled booster, the final assembly and checkout facility is currently planned at a contractor plant.

Concerning the external propellant tanks, the final assembly and checkout position would require approximately 17,000 square feet of manufacturing space with a clear height of approximately 40 feet. In this facility, the liquid hydrogen and liquid oxygen tank assemblies are mechanically joined and the forward fairing attached. The principle checks to be performed include alinement as well as weight and center of gravity determination.

With regards to the \$3,750,000 request for preliminary engineering and design, the funds required to design the fiscal year 1973 project will be accomplished with prior year funds. This project provides for structural buildup and final assembly of the orbiter and subassembly stations for the external tanks. A follow-on requirement in fiscal year 1974 will provide for installation of the special electronic equipment cited above to perform the checkout operation for the orbiter, as well as the final assembly and checkout facilities for the propellant tanks.

Design of these follow-on requirements are included in the facility planning and design funding request (\$3,750,000) programed in fiscal year 1973.

Question 3(e)(2). Propulsion and structural testing?

Answer. The propulsion test program for a vehicle such as the orbiter would require a static test stand, designed for approximately 1.5 to 2 million pounds of thrust, and fully equipped with a deflector, water deluge system, high pressure gas system and instrumentation. A test control center, from which the test operations are conducted and controlled would also be required. Data acquisition, and reduction facilities and general support facilities would also be needed to perform the propulsion test program.

Concerning the structural testing, high bay facilities, fully equipped with loading machines that can apply the static and dynamic loads to be encountered in flight would be required. To support the test program data acquisition and reduction facilities necessary to acquire and evaluate the test data would also be required.

Question 3(e)(3). Landing and "safing"?

Answer. The landing and safing facilities are necessary to provide for a landing field for the orbiter upon return from outer space and to place the vehicle in a "safe" condition before refurbishment and reuse.

The facilities include a runway of about 15,000 feet by 200 feet, approximately 1,500 feet overrun on each end and the associated control tower, communications, lighting and navigational aide instrumentation for an operable facility. The orbiter safing pad would be approximately 6,000 square feet of paved concrete area and support facilities to provide for cooldown of the aircraft exterior, crew and passenger egress, payload removal, waste products off-loading, residual fuel draining and vehicle safing. An operation building and the requirement power, lighting, high pressure gases, fire protection and related utilities and facilities would be provided.

Question 3(e)(4). Servicing, maintenance and checkout of the orbiter?

Answer. The types of facilities here include approximately 90,000 to 100,000 square feet of very high bay space to maintain and service orbiters, 70,000 to 80,00 square feet of other high bay area for the refurbishment of thermal protection system, approximately 30,000 square feet of shop area for servicing the orbiter components, clean rooms, and approximately 30,000 square feet of space for storage of the external propellant tanks.

Question 3(f). Of the \$1 million requested for preliminary engineering for the fiscal year 1975 construction of facilities program, what is your best estimate of the amount required for launch, landing and refurbishment facilities?

Answer. Approximately two-thirds of this amount will be applicable to launch and landing site facilities other than that associated with the required landing field.

GENERAL PROVISIONS

Question (1). There was recently completed by the NASA Oversight Subcommittee a review of the legislative authority as well as policies and procedures in effect regarding the acquisition of capital plant by

NASA. The report issued by this committee and the report of the NASA facilities management review appear to be reasonably in consonance with one another.

(a) This committee's report stated that any item of a capital nature not previously specified in the annual budget request to be acquired should be the subject of a notification to the Congress and that a 30-day waiting period should be imposed. The proposed legislation submitted does not include such a provision.

(1) Is NASA aware of this requirement?

(2) Does NASA intend to comply with the congressional intent expressed in this recommendation?

(3) If not by legislative change, how?

Answer. The report of the Subcommittee on NASA Oversight on "Acquisition of Capital Plant-NASA" recommended the following actions:

"(a) Revise the annual Authorization Act to require that construction of any major facility, either at a contractor's plant or at a NASA installation, the estimated cost of which, including collateral equipment, exceeds \$250,000, using research and development funds, be the subject of a notification by the Administrator, NASA, to the Congress.

"(b) Revise the annual Authorization Act to require a 30-day waiting period after notification before proceeding with proposed construction indicated above at NASA installations."

These recommendations are implemented in the NASA authorization bill, 1973, which was recommended to the Congress by NASA and introduced in the House of Representatives by Chairman Miller as H.R. 12824.

With respect to the "construction of any major facility, the estimated cost of which, including collateral equipment, exceeds \$250,000," at a "location other than installations of the Administration," subsection 1(d) would require notification of the Speaker of the House and the Committee on Science and Astronautics of the nature, location and estimated cost of each facility. Such notification must occur prior to proceeding with the construction of the facility.

With respect to construction at a NASA installation, subsection 1(g) of H.R. 12824, provides that "not in excess of \$250,000 for each project, including collateral equipment, may be used for * * * unforeseen programatic needs." Under subsection 1(g) the "Research and development" appropriated would not be available for projects at NASA installations, the cost of which exceeds \$250,000. Such projects would be the subject of a reprogramming action under section 3 of the bill, and section 3 does require formal notification and the observance of a 30-day waiting period in accordance with the subcommittee recommendation (b) above.

Accordingly, we believe that NASA has implemented fully the recommendations of the subcommittee, with the operative provisions included in H.R. 12824.

(b) This committee's report contained a recommendation that the use of research and management funds for minor new construction should be limited to projects costing not more than \$25,000. The language proposed by NASA (sec. 1(g)) indicates that both research and

development and research and program management authorization may be used for new construction not exceeding \$10,000, and \$25,000 for modification and rehabilitation. Your provision also allows NASA to use R. & D. funds up to \$250,000 per project for facilities requirements to meet unforeseen programmatic needs.

Question (1). In view of rising construction costs, do you consider the \$10,000 limit for new construction to be adequate to meet your needs?

Answer. The NASA Facilities Management Review Committee recommended the limits of \$10,000 for new construction, and \$25,000 for modification and rehabilitation as being in their judgment, a modest break point for small, very routine type work. This is considered as "routine facilities work" and directly relates to, and is a natural continuation of the accomplishment of routine day-to-day facilities maintenance, repair and operation activities from these same appropriations; that is, R. & P.M. and R. & D.

This concept of "routine facilities work" is considered a realistic and practical extension of the recurrent facilities activities mentioned, and is specifically cited in the bill to provide a legal basis for this use of the R. & P.M. and R. & D. appropriations. This concept is based on several considerations:

(a) There is no real clear-cut, sharp distinction between recurrent facility maintenance and repair activities, and smaller facilities projects. Many of the very small work efforts which are encompassed, such as moving partitions, are accomplished by the established facility maintenance work force. The funding of this work force for segments of its effort from dual appropriations (that is, R. & P.M. or R. & D. and construction of facilities) for these very small work efforts would create exceptional accounting and related workloads. Coupled with this factor is that of formalizing these very minor work efforts as "facility projects" which, in itself, would involve considerable extra engineering and administrative work. At present \$10,000 is the level at which most centers formalize facilities projects, so this was proposed as a threshold for minor construction despite the fact that reports to Congress on this work employ a \$25,000 threshold. This latter figure was, however, proposed for the rehabilitation and modification work.

(b) These routine projects, by themselves or collectively, do not do much to impact overall center capabilities.

(c) This concept puts these very small projects in direct competition for resources from R. & P.M. and R. & D., and in this manner insures a keener evaluation of need and relative priorities than is possible under any other procedure since this is done by senior management onsite.

(d) The centralized management of the resources for these very small work efforts, including budgeting and funding, would perhaps generate a workload which would not be in consonance with the resources involved, and dilute our efforts to improve management in respect to our larger projects.

(e) This concept has been previously recognized as valid by the Congress, and therefore, in light of the above, proposed for NASA since it has direct application. Title 10, United States Code, section 2674 permits the Secretaries of the various military services, DOD to "spend from appropriations available for (facility) maintenance and

operations, amounts necessary for any project costing not more than \$50,000." This was examined, and in concept found to be directly applicable to our circumstances for similar reasons.

The following additional points support the concept to use R. & D. and R. & P.M. appropriations for these small work efforts rather than the expansion of construction of facilities for these purposes: the expansion of C. of F. for these purposes:

(a) The very nature of these small work efforts makes reasonably accurate forecasting of needs on the development of budget estimates essentially impossible except on some "level-of-effort" basis.

(b) The establishment of practices within and between centers for the allocation of resources for these "routine facilities" projects would likewise be essentially impossible to accomplish from the Washington level with any real degree of effectiveness.

(c) Consequently, with limited lump sum resources in one appropriation, such as construction of facilities, it would be most difficult to equitably allocate these resources and, once allocated there would undoubtedly be real pressures to continually adjust these allocations as well as to provide additional resources. The presently proposed concept would avoid this, at least for these very small projects, but recognizes this condition will, to a lesser degree prevail for the somewhat larger (under \$250,000/\$500,000) projects now contained on the construction of facilities.

In conclusion, while this "routine facilities work" could be handled in construction of facilities there are no advantages to so doing. In fact, the use of construction of facilities for these very small projects entails many distinct disadvantages and as previously covered would not result in as effective a use of resources as the concept proposed.

Specifically regarding the \$10,000 limitation for new construction, which is taken from the historical figure set in 1958, there has been a rise in construction costs with an efficacy of approximately 55 percent of its original capability. For this reason, there is merit in utilizing the same limitation of \$25,000 for both the new construction and the rehabilitation and modification effort, and NASA would interpose to objection to this. This also would be in keeping, of course, with the fact that \$25,000 is the threshold for reports to Congress for this work.

Question (2). Why is there a differential between new construction and modification work proposed in your language?

Answer. It was the judgment of the NASA Facilities Management Review Committee, that new construction and modification work were separate and distinct, and that perhaps the controls on new construction should be more restrictive than on rehabilitation and modification work.

Question (3) Would it not be preferential to set an overall single monetary limit for new construction and modification work?

Answer. As previously indicated, the NASA Facilities Management Review Committee's judgment separated the monetary limit for new construction and modification work, however, there is no objection to consider them together, and utilize the \$25,000 limitations as set for the modification and rehabilitation type work.

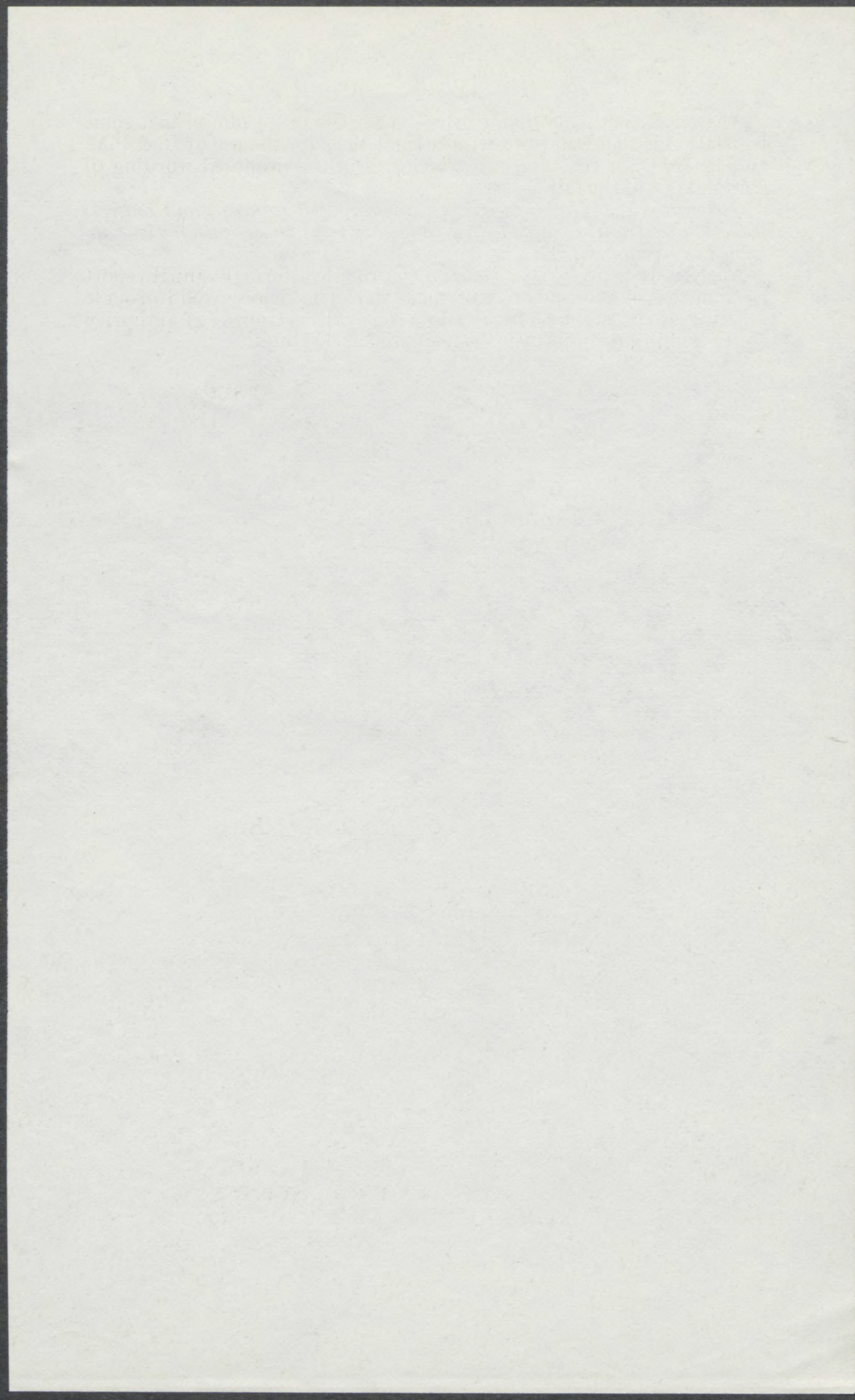
Question (4). Does such a measure have to be prescribed in legislation or could it not be imposed by regulatory device providing adequate congressional intent were prescribed?

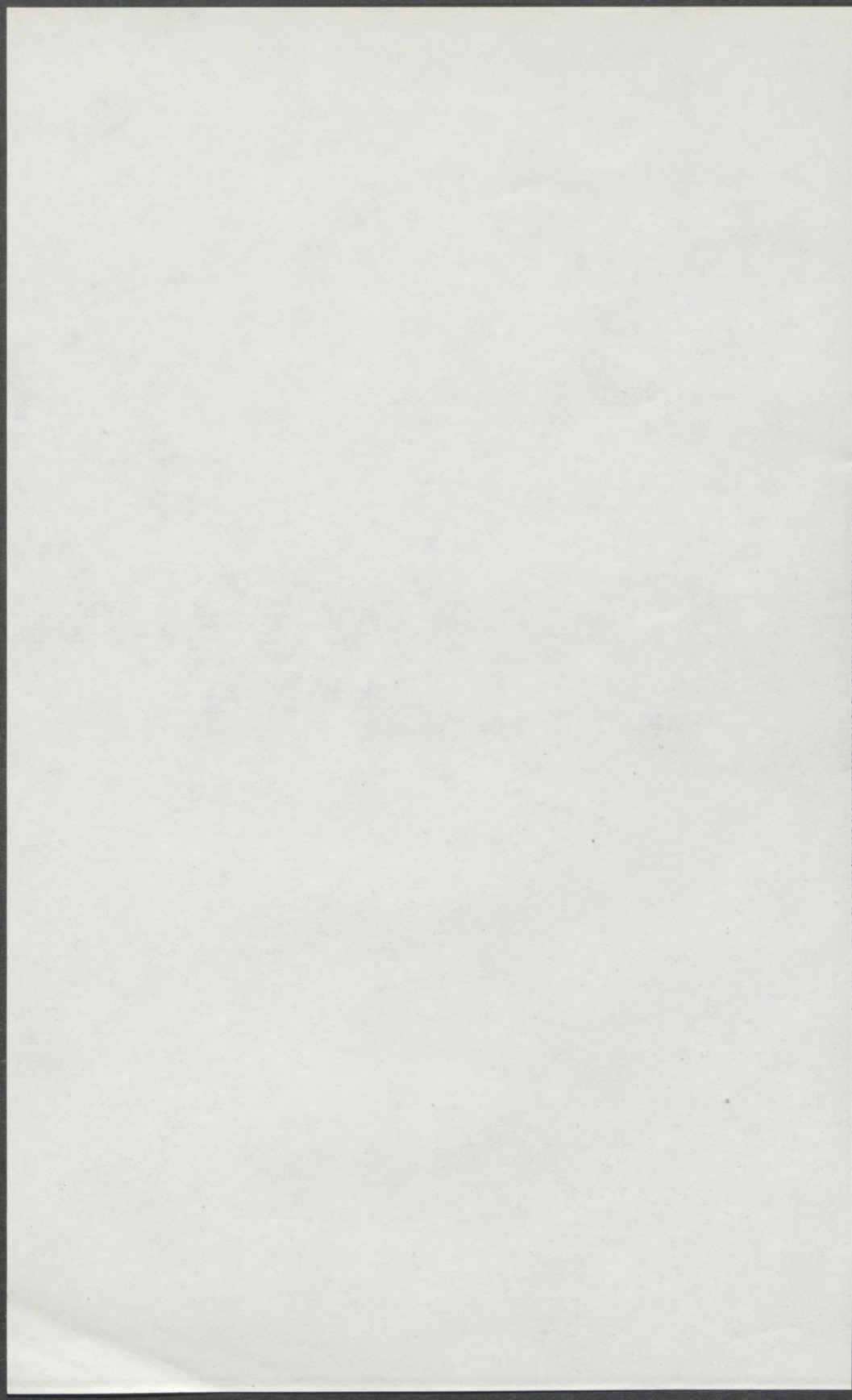
Answer. It is the opinion of the NASA General Counsel that some legislation is required to provide a legal basis for the use of R. & P.M. and R. & D. for the type effort included in the proposed wording of section 1(g) of the bill.

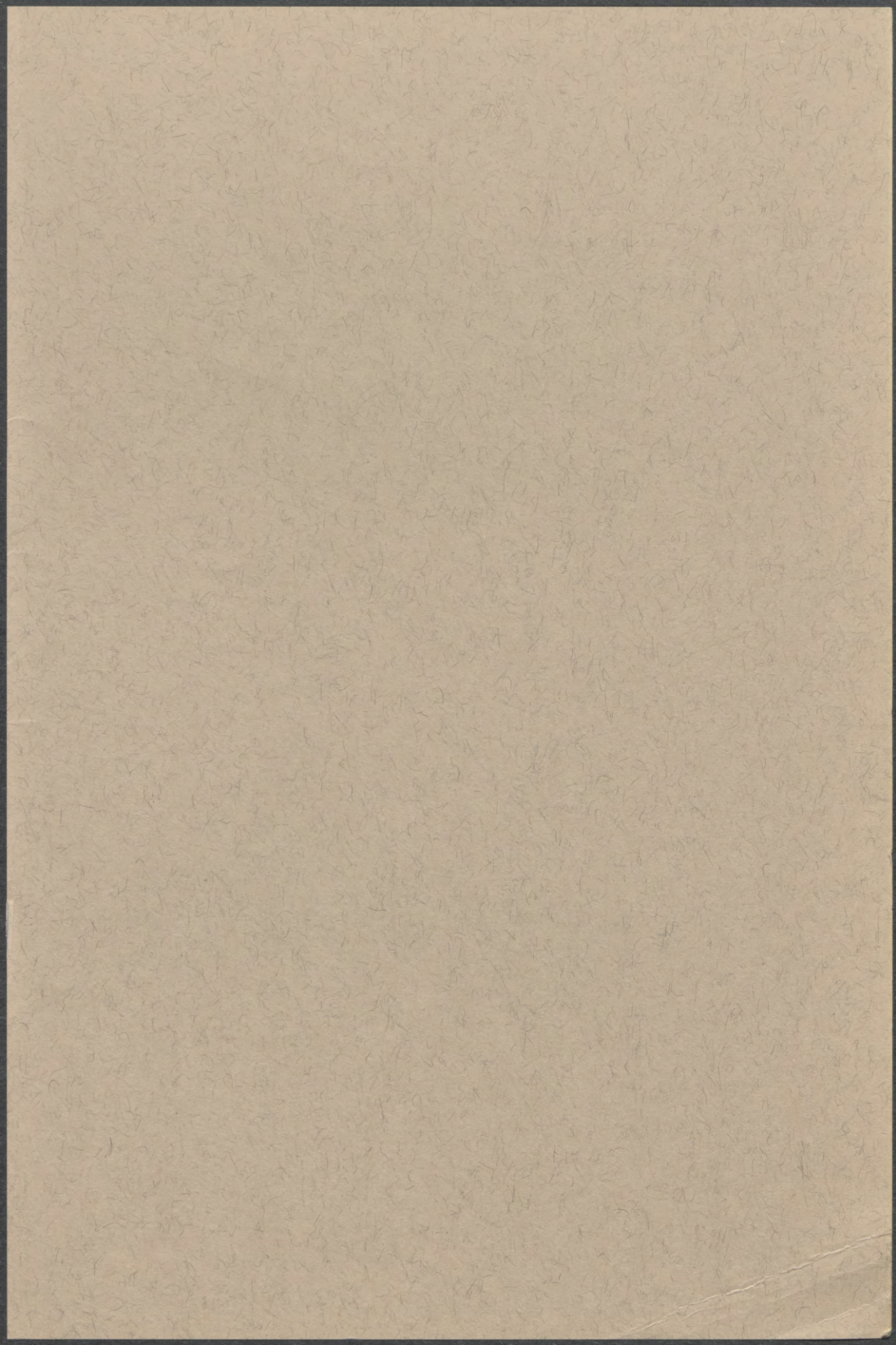
Question (5). What procedures are proposed to keep the Congress fully and currently informed of the exercise of those authorities contained in section 1(g)?

Answer. It is presently proposed to provide a formal annual report to Congress by November 30 of each year. The report would provide a listing of the previous fiscal year's use of the section 1(g) authority for all facility projects over the nominal \$25,000 limit.











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