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HEARINGS

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BEFORE THE

COMMITTEE ON

SCIENCE AND ASTRONAUTICS

U.S. HOUSE OF REPRESENTATIVES

NINETY-THIRD CONGRESS

SECOND SESSION

ON

H.R. 12689

(Superseded by H.R. 13998)

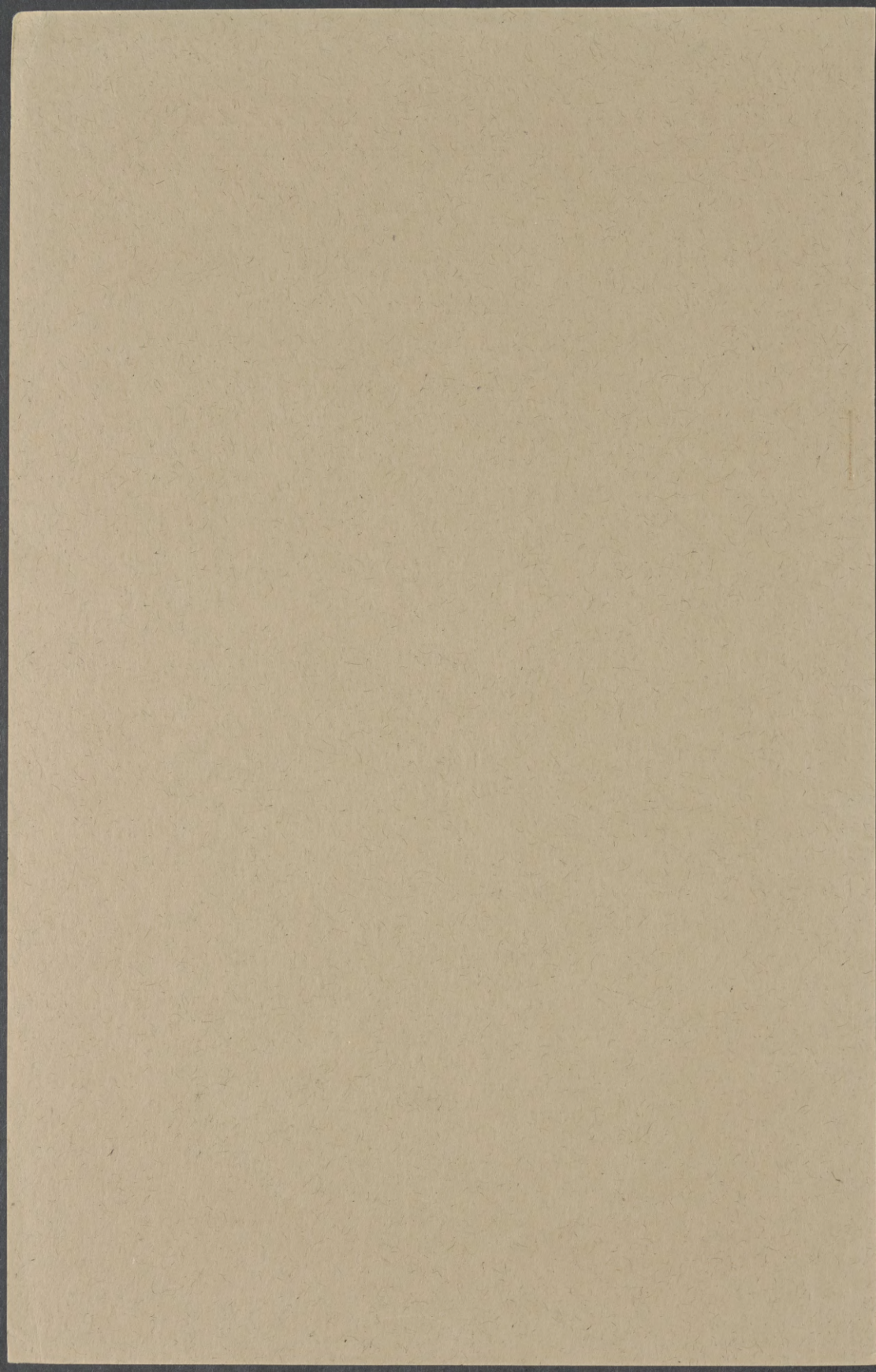
MARCH 21, 1974

[No. 25]

Part 1

Printed for the use of the
Committee on Science and Astronautics





1975 NASA AUTHORIZATION

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BEFORE THE
COMMITTEE ON
SCIENCE AND ASTRONAUTICS
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U.S. GOVERNMENT PRINTING OFFICE

WASHINGTON : 1974

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NOTES

CHAPTER I

The first part of the book is devoted to a general survey of the subject. It begins with a definition of the term "philosophy" and then proceeds to a discussion of the various branches of the subject. The author then discusses the history of philosophy and the different schools of thought that have developed over the centuries.

The second part of the book is devoted to a more detailed examination of the various branches of philosophy. It begins with a discussion of metaphysics, which is the study of the nature of reality. The author then discusses epistemology, which is the study of knowledge. This is followed by a discussion of ethics, which is the study of morality. The book concludes with a discussion of aesthetics, which is the study of art and beauty.

1975 NASA AUTHORIZATION

THURSDAY, MARCH 21, 1974

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

The committee met, pursuant to notice, at 9:30 a.m. in room 2318, Rayburn House Office Building, Hon. Ken Hechler presiding.
[H.R. 12689 follows:]

93D CONGRESS
2D SESSION

H. R. 12689

IN THE HOUSE OF REPRESENTATIVES

FEBRUARY 6, 1974

Mr. TEAGUE (for himself and Mr. MOSIER) introduced the following bill; which was referred to the Committee on Science and Astronautics

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.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*

3 That there is hereby authorized to be appropriated to the
4 National Aeronautics and Space Administration:

5 (a) For "Research and development," for the following
6 programs:

7 (1) Space Shuttle, \$800,000,000;

8 (2) Space flight operations, \$323,300,000;

9 (3) Advanced missions, \$1,500,000;

- 1 (4) Physics and astronomy, \$140,515,000;
- 2 (5) Lunar and planetary exploration, \$266,000,-
- 3 000;
- 4 (6) Launch vehicle procurement, \$140,500,000;
- 5 (7) Space applications, \$177,500,000;
- 6 (8) Aeronautical research and technology, \$166,-
- 7 400,000;
- 8 (9) Space and nuclear research and technology,
- 9 \$74,800,000;
- 10 (10) Tracking and data acquisition, \$250,000,000;
- 11 (11) Technology utilization, \$5,500,000;
- 12 (b) For "Construction of facilities," including land
- 13 acquisition, as follows:
- 14 (1) Addition to flight and guidance simulation
- 15 laboratory, Ames Research Center, \$3,660,000;
- 16 (2) Rehabilitation and modification of science and
- 17 applications laboratories, Goddard Space Flight Center,
- 18 \$890,000;
- 19 (3) Modifications for fire protection and safety,
- 20 Goddard Space Flight Center, \$1,220,000;
- 21 (4) Acquisition of land, Jet Propulsion Laboratory,
- 22 \$150,000;
- 23 (5) Addition to systems development laboratory,
- 24 Jet Propulsion Laboratory, \$4,880,000;

1 (6) Addition for integrated systems testing facility,
2 Jet Propulsion Laboratory, \$3,790,000;

3 (7) Modification of water supply system, Lyndon
4 B. Johnson Space Center, \$935,000;

5 (8) Modification of 6,000 pounds per square inch
6 air storage system, Langley Research Center, \$515,000;

7 (9) Rehabilitation of 16-foot transonic wind tunnel,
8 Langley Research Center, \$2,990,000;

9 (10) Modification of propulsion systems laboratory,
10 Lewis Research Center, \$2,580,000;

11 (11) Modification of rocket engine test facility,
12 Lewis Research Center, \$660,000;

13 (12) Construction of X-ray telescope facility, Mar-
14 shall Space Flight Center, \$4,060,000;

15 (13) Modification of beach protection system, Wal-
16 lops Station, \$1,370,000;

17 (14) Construction of infrared telescope facility,
18 undesignated location, \$6,040,000,

19 (15) Modifications for fire protection and safety at
20 various tracking and data stations, \$1,430,000;

21 (16) Space Shuttle facilities at various locations,
22 \$86,020,000, as follows:

23 (A) Construction of Orbiter landing facilities,
24 John F. Kennedy Space Center,

1 (B) Construction of Orbiter processing facility,
2 John F. Kennedy Space Center,

3 (C) Modifications to launch complex 39, John
4 F. Kennedy Space Center,

5 (D) Modifications for dynamic test facilities
6 Marshall Space Flight Center, and National Aero-
7 nautics and Space Administration Industrial Plant,
8 Downey, California,

9 (E) Construction of Orbiter horizontal flight
10 test facilities, Flight Research Center,

11 (F) Modifications for crew training facilities,
12 Lyndon B. Johnson Space Center,

13 (G) Modification of the vibration and acoustic
14 test facility, Lyndon B. Johnson Space Center,

15 (H) Construction of materials test facility,
16 White Sands Test Facility,

17 (I) Modifications for solid rocket booster struc-
18 tural test facilities, Marshall Space Flight Center,

19 (J) Construction/modification of solid rocket
20 motor production and test facilities, undesignated
21 locations;

22 (17) Rehabilitation and modification of facilities
23 at various locations, not in excess of \$500,000 per
24 project, \$14,900,000;

1 (18) Minor construction of new facilities and ad-
2 ditions to existing facilities at various locations, not in
3 excess of \$250,000 per project, \$4,500,000;

4 (19) Facility planning and design not otherwise
5 provided for, \$10,900,000.

6 (c) For "Research and program management," \$749,-
7 624,000, and such additional or supplemental amounts as
8 may be necessary for increases in salary, pay, retirement, or
9 other employee benefits authorized by law.

10 (d) Notwithstanding the provisions of subsection 1 (g),
11 appropriations for "Research and development" may be
12 used (1) for any items of a capital nature (other than
13 acquisition of land) which may be required at locations
14 other than installations of the Administration for the perform-
15 ance of research and development contracts, and (2) for
16 grants to nonprofit institutions of higher education, or to
17 nonprofit organizations whose primary purpose is the conduct
18 of scientific research, for purchase or construction of additional
19 research facilities, and title to such facilities shall be vested
20 in the United States unless the Administrator determines
21 that the national program of aeronautical and space activities
22 will best be served by vesting title in any such grantee in-
23 stitution or organization. Each such grant shall be made
24 under such conditions as the Administrator shall determine

1 to be required to insure that the United States will receive
2 therefrom benefit adequate to justify the making of that grant.
3 None of the funds appropriated for "Research and develop-
4 ment" pursuant to this Act may be used in accordance with
5 this subsection for the construction of any major facility, the
6 estimated cost of which, including collateral equipment,
7 exceeds \$250,000, unless the Administrator or his designee
8 has notified the Speaker of the House of Representatives and
9 the President of the Senate and the Committee on Science
10 and Astronautics of the House of Representatives and the
11 Committee on Aeronautical and Space Sciences of the Senate
12 of the nature, location, and estimated cost of such facility.

13 (e) When so specified in an appropriation Act, (1)
14 any amount appropriated for "Research and development"
15 or for "Construction of facilities" may remain available with-
16 out fiscal year limitation, and (2) maintenance and opera-
17 tion of facilities, and support services contracts may be en-
18 tered into under the "Research and program management"
19 appropriation for periods not in excess of twelve months
20 beginning at any time during the fiscal year.

21 (f) Appropriations made pursuant to subsection 1 (c)
22 may be used, but not to exceed \$35,000, for scientific con-
23 sultations or extraordinary expenses upon the approval or
24 authority of the Administrator and his determination shall

1 be final and conclusive upon the accounting officers of the
2 Government.

3 (g) Of the funds appropriated pursuant to subsections
4 1 (a) and 1 (c), not in excess of \$10,000 for each project,
5 including collateral equipment, may be used for construc-
6 tion of new facilities and additions to existing facilities, and
7 not in excess of \$25,000 for each project, including collateral
8 equipment, may be used for rehabilitation or modification of
9 facilities: *Provided*, That of the funds appropriated pursuant
10 to subsection 1 (a), not in excess of \$250,000 for each proj-
11 ect, including collateral equipment, may be used for any
12 of the foregoing for unforeseen programmatic needs.

13 SEC. 2. Authorization is hereby granted whereby any
14 of the amounts prescribed in paragraphs (1) through (18),
15 inclusive, of subsection 1 (b) may, in the discretion of the
16 Administrator or his designee, be varied upward 10 per
17 centum to meet unusual cost variations, but the total cost of
18 all work authorized under such paragraphs shall not exceed
19 the total of the amounts specified in such paragraphs.

20 SEC. 3. Not to exceed one-half of 1 per centum of the
21 funds appropriated pursuant to subsection 1 (a) hereof may
22 be transferred to the "Construction of facilities" appropria-
23 tion, and, when so transferred, together with \$10,000,000
24 of the funds appropriated pursuant to subsection 1 (b) hereof
25 (other than funds appropriated pursuant to paragraph (19)

1 of such subsection) shall be available for expenditure to con-
2 struct, expand, or modify laboratories and other installations
3 at any location (including locations specified in subsection
4 1 (b)), if (1) the Administrator determines such action to
5 be necessary because of changes in the national program of
6 aeronautical and space activities or new scientific or engineer-
7 ing developments, and (2) he determines that deferral of
8 such action until the enactment of the next Authorization Act
9 would be inconsistent with the interest of the Nation in
10 aeronautical and space activities. The funds so made avail-
11 able may be expended to acquire, construct, convert, rehabili-
12 tate, or install permanent or temporary public works, includ-
13 ing land acquisition, site preparation, appurtenances, utilities,
14 and equipment. No portion of such sums may be obligated for
15 expenditure or expended to construct, expand, or modify
16 laboratories and other installations unless (A) a period of
17 thirty days has passed after the Administrator or his designee
18 has transmitted to the Speaker of the House of Representa-
19 tives and to the President of the Senate and to the Commit-
20 tee on Science and Astronautics of the House of Representa-
21 tives and to the Committee on Aeronautical and Space
22 Sciences of the Senate a written report containing a full and
23 complete statement concerning (1) the nature of such con-
24 struction, expansion, or modification, (2) the cost thereof
25 including the cost of any real estate action pertaining thereto,

1 and (3) the reason why such construction, expansion, or
2 modification is necessary in the national interest, or (B)
3 each such committee before the expiration of such period has
4 transmitted to the Administrator written notice to the effect
5 that such committee has no objection to the proposed action.

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

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

13 (2) no amount appropriated pursuant to this Act
14 may be used for any program in excess of the amount
15 actually authorized for that particular program by sec-
16 tions 1 (a) and 1 (c), and

17 (3) no amount appropriated pursuant to this Act
18 may be used for any program which has not been pre-
19 sented to or requested of either such committee,

20 unless (A) a period of thirty days has passed after the
21 receipt by the Speaker of the House of Representatives and
22 the President of the Senate and each such committee of
23 notice given by the Administrator or his designee containing
24 a full and complete statement of the action proposed to be
25 taken and the facts and circumstances relied upon in support

1 of such proposed action, or (B) each such committee before
2 the expiration of such period has transmitted to the Admin-
3 istrator written notice to the effect that such committee has
4 no objection to the proposed action.

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

11 SEC. 6. Section 203 (b) (9) of the National Aeronautics
12 and Space Act of 1958, as amended (42 U.S.C. 2473 (b)
13 (9)), is amended to read as follows:

14 “(9) to obtain services as authorized by section
15 3109 of title 5, United States Code, but at rates for
16 individuals not to exceed the per diem rate equivalent
17 to the rate for GS-18;”.

18 SEC. 7. This Act may be cited as the “National Aero-
19 nautics and Space Administration Authorization Act, 1975”.

Mr. HECHLER. The committee will come to order. This morning we welcome again the Administrator of the National Aeronautics and Space Administration, Dr. James Fletcher. We also welcome his associates who will bring us up to date on the recent developments in the aeronautics and space programs.

In addition to that, Dr. Fletcher, I understand, you will bring us up to date on some recent developments in technology utilization for development of resources on our Spaceship Earth.

Now, accompanying you here this morning is Dr. Low, Dr. Petrone and other associates. Do you have an opening statement to make?

Dr. FLETCHER. Yes, I do.

Mr. HECHLER. Then you may proceed with your statement.

STATEMENT OF DR. JAMES C. FLETCHER, ADMINISTRATOR, NASA

Dr. FLETCHER. Mr. Chairman and members of the committee, we are pleased to appear before the committee today to present an overall summary of NASA's fiscal year 1975 authorization request, and to discuss with you the main features of the programs in aeronautics and space we are recommending for the coming year.

In the course of my statement, I will also discuss briefly the organizational changes within NASA which went into effect on March 15 of this year and the other topics you have asked that we address on this occasion. In response to your invitation, Mr. Chairman, we will also have presentations on some examples of benefits coming out of the space program and have others on display here in the committee room. Dr. Low will introduce that part of the program later on.

I should also note that we are supplying for the record comprehensive statements on research and program management, construction of facilities, equal employment opportunity, and the NASA integrated life sciences program.

Accompanying me today, in addition to Dr. George M. Low, the Deputy Administrator, are Dr. Rocco Petrone, our new Associate Administrator; Mr. Willis H. Shapley, Associate Deputy Administrator; and Mr. William E. Lilly, the NASA comptroller. Also present are the principal officials in charge of the NASA programs we will discuss today, who have already appeared before the various subcommittees of this committee to discuss NASA's programs for the coming year in detail.

Mr. Chairman, during the past year, NASA has produced many outstanding accomplishments.

On February 8 of this year the flight phase of the Skylab program came to a successful end with the splashdown of Skylab 4. During the Skylab mission, three crews of Skylab astronauts traveled over 61 million nautical miles in space and orbited the earth 2,475 times in a working scientific laboratory—a giant step toward the routine use of space for science and for practical benefits.

As Skylab was demonstrating the importance of near-earth space, Pioneer 10 swept past the planet Jupiter on December 3 of last year. Pioneer 10 made hundreds of scientific measurements of the giant planet, its inner moons, and its mysterious red spot. We found that Jupiter has a magnetic field 20 times as strong as the earth's; a powerful, strangely configured radiation belt; the surprising presence of helium, and many other new features of the largest planet in our solar system and its moons.

Pioneer 10 was the first spacecraft to fly beyond the orbit of Mars, the first to penetrate the Asteroid Belt, and will be the first man-made object ultimately to escape the solar system, as such.

On February 5 of this year, Mariner 10 approached to within 3,600 miles of Venus on its way to Mercury. In passing Venus, Mariner 10 returned over 4,000 television pictures, the first closeup views of that planet.

Pictures of Venus' upper atmosphere revealed for the first time a multilayered cloud structure. These pictures also detected an upper atmospheric circulation pattern that is in some respects rather amazing—that, Mr. Chairman, is that Venus' upper atmosphere rotates around the planet approximately 60 times faster than the planet itself rotates.

1973 will also be marked as the year the earth resources survey program came of age. After its first full year of operation, the earth resources technology satellite, ERTS-1, has acquired and relayed to earth over 100,000 multispectral scenes of our planet—more than a billion square miles of coverage.

We have provided over a million copies of these images to Federal and State agencies, resource managers, and investigators here and abroad. The operational values of remote sensing from space are rapidly becoming apparent across a wide spectrum of needs. The full benefits of even ERTS-1 have not yet been tallied, but a current study underway by the Department of Interior is showing that very significant returns above cost can be expected from a continuing earth resources survey satellite program.

Another major milestone in 1973 was the consumation last September of our agreement with nine European nations on the Spacelab, under which the Europeans will develop, at their expense, the laboratory module to be used with the space shuttle. This agreement marks a new high level in international cooperation and in international cost sharing in the U.S. space program, and will provide a key piece of equipment for realizing the full utility of the space shuttle.

During the past year we also made significant progress in other programs. Some examples of this will be as follows, Mr. Chairman, and I will point them out.

Space shuttle design and development proceeded well. All major prime hardware contractors have been selected, although, as you now know, the contract award for the solid rocket motors is currently under protest. We now have completed and published our comprehensive analysis of the number and kinds of payloads we could launch with the shuttle during its first 12 years of operations. The analysis confirms our previous estimates that we can expect savings resulting from the use of the shuttle of over \$1 billion a year during that 12-year period.

You may wish to include in the record of these hearings portions of the final report of our economic analyses which we sent to the committee recently.

Mr. HECHLER. Yes, that may be inserted in the record.

[Referenced material may be found at appendix C.]

Dr. FLETCHER. In aeronautics we continued to attack problems of aircraft noise and pollution and extended our efforts to enhance safety and improve aircraft fuel economy.

From flight tests with aircraft incorporating NASA technological advances such as the supercritical wing, we estimate that a total

potential fuel savings of 30 percent in the operation of civil transport aircraft is possible. Substantial progress has also been made in the JT8D engine refan noise reduction program.

Ground testing of this engine modifies with NASA-developed technology has already begun.

Finally, technological benefits of NASA's program are continuing to flow into our economy and make useful contributions to important national and human interests, as you can see from the exhibits around this room. These exhibits here today are only a few examples of the technological benefits the Nation is receiving from NASA's space and aeronautics programs.

Mr. Chairman, we have prepared a more comprehensive factual statement on last year's highlights, and we would be glad to furnish it for the record if you wish.

Mr. HECHLER. That may be done. That will be a committee insert. [Information requested for the record follows:]

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, HIGHLIGHTS OF 1973 ACTIVITIES

MANNED SPACE FLIGHT

On May 14, 1973, Skylab, the nation's first experimental space station was launched. Shortly after liftoff a large area of external shielding was torn away from the Skylab workshop. Severe aerodynamic forces also peeled away an undeployed solar-cell array and twisted a metal strip across a second array preventing deployment of that vital electric power source. Four other solar-cell arrays elsewhere on the station deployed as planned.

For eleven days the overheated and underpowered space station taxed the skill and ingenuity of Mission Control's flight controllers, who succeeded in stabilizing the thermal and power environment within the 100-ton spacecraft until a crew of astronauts could be properly prepared and launched.

On the eleventh day after launch, astronauts Charles Conrad, Joseph Kerwin and Paul Weitz began demonstrating beyond a doubt that man can perform difficult repair and construction work in space. A portable sunshade was deployed. The undeployed solar wing was freed and began supplying its quota of electrical power. Skylab and its crew were then ready to fulfill the original mission objectives. The objectives are: to determine man's ability to live and work in space for extended periods; to extend the science of solar astronomy beyond the limits of Earth based observations; to develop improved techniques for surveying Earth resources from space; and to increase man's knowledge in a variety of other scientific and technological regimes. An added objective of the final manned mission is to obtain observations of the Comet Kohoutek.

Skylab provides man with a useful laboratory that has features which cannot be found on Earth. These include: a constant zero gravity environment, Sun and celestial observations from above the Earth's hampering atmosphere and a broad view of the Earth's surface features.

By year's end, Skylab will have circled the Earth more than 3,350 times and served as the orbiting home for three crews of three astronauts each. The Conrad crew spent 28 days in space. The second crew, launched July 28 on a mission that lasted 59 days, consisted of Alan L. Bean, Dr. Owen K. Garriott and Jack R. Lousma. The third and final crew rocketed to Skylab Nov. 16 for an open-ended mission that could last as long as 84 days with a splashdown in the Pacific Feb. 8. Members of the final crew are Gerald P. Carr, Dr. Edward G. Gibson and William R. Pogue.

Development of the Space Shuttle, the transportation system for future space activities, proceeded in 1973. Major new contracting actions were taken in the selection of Martin-Marietta Corp. to design and test the external liquid propellants tank, and the Thiokol Chemical Corp. to develop the twin solid rocket motors. The solid and liquid booster systems will be attached to the Shuttle's Orbiter and spacecraft at launch. The solid boosters will be recovered and reused. The tanks are to be expendable.

Nine European countries agreed to design and deliver a flight unit of the Space-lab that will be a major Shuttle element. The Spacelab will be carried in the

Orbiter's payload bay. Spacelab will consist of a pressurized manned laboratory and instrument platform, or pallet that can expose equipment and instruments directly into the environment of space.

Prime contractor for the Space Shuttle Orbiter is Rockwell International Corp. The first major test article to be built by Rockwell is in final assembly. It is a 20-foot long midsection of the Orbiter's 60-foot long, 15-foot diameter cargo bay.

SPACE SCIENCE

On December 3, 1973, Pioneer 10 swept past the planet Jupiter at a distance of 131,400 km (81,000 miles), making measurements and taking the first photographs of that planet from such a close distance. Culminating a two-year, billion-kilometer (600-million-mile) journey, the encounter marked the beginning of man's probe of the outer solar system.

Pioneer 10 was the first spacecraft to fly beyond the orbit of Mars, the first to penetrate the Asteroid Belt, and may eventually become the first manmade object to escape the solar system.

Pioneer has returned more than 300 closeup pictures of Jupiter and its inner moons, and provided much new information on its turbulent atmosphere and cloud currents, its bizarre Red Spot, its murky interior and the surrounding magnetic, electrical and radiation environments.

Pioneer 10 is now beginning a five-year extended mission—to reach the orbit of Saturn in 1976, and the orbit of Uranus, the present limit of earth spacecraft communications, in 1979. The spacecraft will then continue its journey out of the solar system.

At year's end, Pioneer scientists, continuing their study of radiation belt data obtained by the spacecraft, are determining whether a second Jupiter probe can be safely retargeted closer to the giant planet and then on to Saturn.

The second probe, Pioneer 11, launched in April 1973, has passed safely through three-fourths of the asteroid belt. It still has some quarter of a billion miles to travel before arriving at Jupiter in early December 1974.

Mariner 10, headed toward Mercury by way of Venus, is currently more than nine million miles from Earth and about 30 million miles from Venus. The spacecraft, launched in November 1973, is scheduled to sweep by cloud-shrouded Venus in late February and past Mercury on March 29, 1974. The craft will provide man with his first closeup look at this tiny planet, the closest to the Sun.

During 1973 NASA also continued working toward a 1976 unmanned landing on the planet believed most likely to harbor life: Mars. Landing sites for the Viking project were selected in April 1973, and the first test flight of the Viking Titan 3-Centaur vehicle is imminent.

The heaviest and most complex U.S. space observatory, the Orbiting Astronomical Observatory 3 (Copernicus), launched in 1972, has continued to return data on astronomical phenomena which can provide clues to the origin and evolution of the universe.

Three other U.S. scientific satellites were launched during 1973: Explorer 50 (IMP-J), to complete a study of the interplanetary environment over an entire 11-year solar cycle; Explorer 49 (Radio Astronomy Explorer B), to make measurements of galactic and solar radio noise using occultation of the Moon to reduce background interference from Earth; and Astronomy Explorer C (AE-C), a maneuverable unmanned spacecraft that would be linked through a sophisticated ground computer with scientists in widely scattered parts of the country in a global study of Earth's outer atmosphere.

At year's end, NASA was engaged in an intensive project to obtain a wide range of scientific data on Comet Kahuotek, which made its closest approach to the Sun on Dec. 28, 1973. Provided with an unprecedented advance notice of nine months preceding the advent of the fiery object, NASA scientists were able to study the comet in visible, ultraviolet and infrared light regions with optical telescopes, radio telescopes and radar. It was observed from the ground, from high-flying aircraft, with instruments aboard unmanned satellites, with sounding rockets and telescopes and cameras on Skylab. 4.

SPACE APPLICATIONS

As 1973 ended, the first spacecraft designed primarily to observe Earth's surface completed its 7,000th picture-taking circuit of the earth.

Since launch in July 1972 the Earth Resources Technology Satellite (ERTS-1) has radioed back nearly 100,000 115-mile-square scenes of mountains, prairies,

and deserts; oceans, lakes, rivers, and reservoirs; forest, ranches, farms, and cities. More than a million photos have been distributed to 312 investigators in the United States and 36 other countries.

Users of the pictures in government, industry, and universities reported to four-day meetings in March and December, 1973 attended by several hundred colleagues and potential users. More than 300 papers described the value of ERTS data for such practical purposes as:

- Monitoring urban development and planning future land use;
- Estimating crop yields and taking inventories of timber;
- Locating air and water pollution and mapping strip mine and forest-fire scars;
- Exploring for minerals and petroleum;
- Discovering linear landscape features that may someday help in predicting earthquakes;
- Updating maps and coastal and navigation charts;
- Keeping watch on volcanoes;
- Surveying the breeding ground of migratory waterfowl;
- Studying flood hazards and managing water resources;
- Determining the distribution of marine life.

NASA's newest weather satellite, Nimbus-5, began measuring the daily distribution of rainfall over all the earth's oceans, providing information important for long-range weather forecasting.

Pictures from Nimbus-5, launched in November 1972, are also correcting standard maps of the polar ice caps and, by showing the location of ice masses, may extend the shipping season in the Arctic and Antarctic several months into the polar night.

Scheduled for launch early in 1974 is the first of a new generation of weather observers, the Synchronous Meteorological Satellite (SMS). SMS will keep continuous watch, and make immediate reports on changing storm patterns.

Another type of synchronous spacecraft, NASA's sixth Applications Technology Satellite, is being prepared for launch in April of 1974. ATS-F's experiments include demonstrations of educational TV broadcasts through its precisely pointed, nine-meter (30-foot) antenna to low-cost ground receiving stations in isolated communities of Alaska, the Rocky Mountain states, and Appalachia and, later, to remote villages in India.

AERONAUTICS AND SPACE TECHNOLOGY

NASA aeronautical programs this year continued to attack problems of aircraft noise and pollution, to enhance safety, to improve the efficiency and the operational economics of aeronautical flight, and to study and develop technology for future generation aircraft.

A good example of progress during the past year, in view of current attention to efficient use of energy, is the NASA supercritical wing program. NASA has flight tested this new wing design on an F-8 aircraft; flight results indicate that by using this wing, the test aircraft could fly 15 per cent farther without using any additional fuel.

NASA has also been flight testing an advanced aircraft flight control system called digital fly-by-wire. It appears that aircraft equipped with this advanced control system could have improved handling qualities for all flight conditions, enhancing flight safety.

Because of its responsiveness, the fly-by-wire control system can be used to directly reduce aircraft loads and structural weight. Additionally, light-weight wires replace a heavy system of metal rods, hinges and hydraulic lines that previously translated the pilot's signals from the aircraft control stick to the aircraft's control surfaces. These reductions in aircraft weight result in increases in payload potential and in more miles flown per gallon of fuel expended.

The computer system flight tested in the digital fly-by-wire program was originally used aboard the Apollo 15 spacecraft on its mission to the Moon. NASA is adapting this space technology for use here on Earth.

Substantial progress was also made this year in reducing the noise of jet engines and engine pollution emissions. The JT8D engine refan program progressed to a point where in February 1974, NASA will start ground testing this jet engine modified with NASA-developed technology. The engine modifications, incorporated on JT8D engine-powered aircraft (727, 737, and DC-9), could reduce by 75 percent or more the aircraft areas affected by jet noise from these aircraft. Since these aircraft comprise more than 60 percent of the commercial aircraft in use in this country, noise reductions should be quite significant.

In a cooperative Federal Aviation Administration/NASA noise abatement program, the NASA-developed two-segment landing procedure was tested in regular airline passenger service late this past year. Reactions from passengers and pilots to the modified approach and landing techniques were very good. It is anticipated that a 67 percent reduction in ground area impacted by objectionable aircraft noise will be achieved during landings of 727 aircraft using this procedure.

Another area where NASA aeronautics research and technology programs could have a major impact is the internal combustion engine. NASA general aviation aircraft engine research work is currently using automobile engines to demonstrate the feasibility of an internal combustion concept which appears to significantly reduce pollution emissions while actually increasing engine efficiency—that is, increasing the miles per gallon performance of the engine.

In this experimental concept, a small portion of the gasoline is converted to a hydrogen-rich mixture of gases by a hydrogen generator and fed to the engine for combustion with regular gasoline. This hydrogen injection technique allows the engine to run on a much leaner gasoline/air mixture.

NASA started several new flight research programs this past year, including the remotely piloted research vehicle program, where the pilot actually flies the aircraft from a cockpit located on the ground.

The advantage of this NASA-developed technique is that there is no risk to the test pilot during flight maneuvers. High-risk, more advanced technology can be investigated and high risk maneuvers can be performed very early in the flight test program. Additionally, scale models of aircraft of spacecraft are used instead of more expensive experimental vehicles and the systems themselves (cockpit, etc.) do not have to be man-rated. Consequently, an RPRV flight test program may cost less than half of a full-scale manned program.

TECHNOLOGY UTILIZATION

During 1973 more than 2,000 new examples of space-developed innovations and techniques were reported under NASA's comprehensive Technology Utilization Program.

This program is the focal point for the transfer of potentially beneficial space technology to the civilian community. Since its inception 11 years ago, more than 30,000 items have been reported. As a result, hundreds of important new products and applications have become part of our everyday life.

To speed the technology transfer process, NASA has liberalized its patent licensing procedures and is granting more exclusive patent licenses. This new policy often includes provisions for payment of royalties once the product is on the market. During this past year, NASA granted five exclusive patent licenses, the largest number since the inception of the program.

Making new technology available to potential users involves an extensive nation-wide dissemination program. In addition to publications announcing innovations, seven specialized regional dissemination centers work directly with about 2,000 companies each year. During 1973 more than 57,000 industrial inquiries were handled under the program.

Under a pilot program established in 1972, a NASA liaison office was opened in New York City to work directly with city agencies on such problem areas as public safety, drug detection, and fire protection. The effort has proved highly successful.

Perhaps the single most important innovation introduced through the Technology Utilization Program during the year was the rechargeable heart pacemaker. This unique device, adapting electronic components originally designed for space use, was developed under NASA auspices by the Applied Physics Laboratory of the Johns Hopkins University. Once implanted, the device can be recharged by the patient at home using an external power source, thus eliminating the need for surgery every two years to replace conventional devices. The device is also smaller and lighter than earlier pacemakers.

Other significant biomedical advances stemming from the program during the year include:

- Development of a radio transmitter temperature pill which passes through a patient's alimentary tract and allows doctors to check localized temperature changes which could reveal presence of infection or other disorders;

- A technician-operated, portable visual testing device—the Automated Visual Sensitivity Tester—to permit early detection of eye disorders;

- Demonstration of a test hospital room for paralyzed patients using space-developed devices such as sight switches, monitors and servomechanisms to permit remote operation of communications systems and appliances for the comfort and recreation of bedridden persons;

A compact, light-weight emergency medical package called Telecare, containing essential medical equipment need for on-the-scene emergency treatment.

New developments announced by NASA during 1973 also included development of a tiny burglar alarm based on a NASA invention originally designed to measure blood pressure within the heart; a radar reflective, self-inflating life raft; a fluoride-metal composite material which is self-lubricating at high temperatures and should have wide industrial application, a new psychomotor testing device called EPIC with wide application for aptitude testing; and, development of a technique involving cavitation which can restore obliterated serial numbers on various metals.

INTERNATIONAL AFFAIRS

A major new development occurred in international space cooperation in August when nine European countries which are members of the European Space Research Organization (ESRO) agreed to develop a space laboratory for flight with NASA's Space Shuttle. The Spacelab which will be carried into orbit by the Shuttle Orbiter will accommodate experiments and personnel on missions of 7 to 30 days. The estimated cost of \$300-400 million will be borne by the ESRO countries involved.

Progress continued on the Apollo Soyuz Test Project (ASTP), the joint US/USSR manned flight scheduled for 1975. In November, eight American astronauts met with their counterparts in Moscow to become familiar with the Soviet spacecraft to be used in the ASTP project which will test a docking mechanism permitting astronauts and cosmonauts to pass between the two spaceships while they are joined in orbit.

LAUNCH RECORD

NASA came close to equalling 1972's perfect record with 13 of 14 launches successful in 1973.

The United States' giant Saturn rockets upheld their unprecedented 100 per cent performance record in 1973. The 13th Saturn V with a booster stage thrust of 7.5 million pounds placed the Skylab Earth orbital space station in orbit on May 14. Three 1.6-million-pound-booster-thrust Saturn 1B vehicles maintained their perfect launch record when Skylab astronauts in their Apollo spacecraft were placed in orbit to man the workshop. The Saturn 1B launches marked the sixth, seventh and eighth consecutive successes.

Three Atlas Centaurs launched two planetary spacecraft and a communication satellite for COMSAT Corp. Pioneer 11 is on a trajectory to encounter Jupiter late in 1974, and Mariner 10 is enroute to photograph and collect data from Venus early in February and scheduled to cross the orbit of Mercury in late March.

Five successful Delta launches sent communication, meteorological, and scientific satellites into space. They were Canada's Telesat communication satellite, the National Oceanic and Atmospheric Administration's Operational Tiers (ITOS), and NASA's Explorer 49, 50 and 51, scientific payloads. One attempt to launch an ITOS for NOAA was unsuccessful due to malfunction of the Delta vehicle's second stage.

NASA's four-stage, all solid-fueled Scout launch vehicle placed a U.S. Navy Transit satellite in Earth orbit.

Dr. FLETCHER. I will continue. I should report briefly three problems we have had. Two of the three have already been discussed in detail before the appropriate subcommittees of this committee.

First, there was the problem of the near catastrophic damage to Skylab when the micrometeorite shield broke away, carrying with it one of the solar panels and leaving the Skylab without sufficient insulation from the Sun's heat. As you all know, the damage was repaired in a dramatic effort by the team on the ground and the astronauts in space, and the mission was an outstanding success.

Second, we are experiencing technical developmental difficulties in the Viking program with some of the exceedingly complex equipment required for landing and conducting automated scientific experiments on the surface of Mars. Because these difficulties have been greater than had been envisioned, we have now had to accept

the likelihood of an overrun of approximately 10 percent in the projected total cost of \$838 million we estimated for Viking research and development 4 years ago.

We will shortly be submitting to the Congress a reprogramming action covering the adjustments necessary in our fiscal year 1974 budget plan. Further adjustments required in our fiscal year 1975 budget will depend on progress in resolving the technical problems and the effectiveness of efforts by NASA and our contractors to control costs.

Third, as the committee is aware, we have had problems in our equal employment opportunity program. In hearings before Senate committees and the House Subcommittee on Civil Rights and Constitutional Rights, we have been frank to say that NASA has not done as well as we should in this area. We have recently taken measures to strengthen our EEO programs, and have set ourselves specific goals and timetables for 1974. With NASA's civil service employment now stabilized, with no further across-the-board reductions in force required, I believe these goals, while difficult, are attainable and will be met.

Now, Mr. Chairman, I would like to address our programs and budget for the coming year.

As shown in the following table, NASA's fiscal year 1975 request for authorization and appropriations totals \$3.247 billion. This is an increase of slightly more than \$200 million over fiscal year 1974 appropriations, but only of about \$100 million over our current budget plan for fiscal year 1974 because fiscal year 1973 funds have financed some of the fiscal year 1974 budget plan.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1975 AUTHORIZATION REQUEST

[In thousands of dollars]

	Fiscal year—		
	1973	1974	1975
Research and development:			
Space shuttle.....	198,575	475,000	800,000
Space flight operations.....	879,000	580,000	323,300
Advanced missions.....	1,500	1,500	1,500
Apollo.....	56,700		
Physics and astronomy.....	126,200	94,000	140,515
Lunar and planetary exploration.....	331,969	333,000	266,000
Launch vehicle procurement.....	221,000	175,000	140,500
Space applications.....	188,700	161,000	177,500
Aeronautical research and technology.....	150,640	168,000	166,400
Space and nuclear research and technology.....	81,860	69,000	74,800
Tracking and data acquisition.....	248,331	244,000	250,000
Technology utilization.....	4,000	4,500	5,500
Subtotal, research and development.....	2,488,475	2,305,000	2,346,015
Construction of facilities.....	78,725	101,100	151,490
Research and program management.....	721,783	1,744,786	749,624
Subtotal, budget plan.....	3,288,983	3,150,886	3,247,129
Fiscal year 1973 funds applied to fiscal year 1974 budget plan.....	111,000	-111,000	
Unobligated balances lapsing and other adjustments.....	7,667		
Total appropriations (fiscal year 1973 and fiscal year 1974) and fiscal year 1975 authorization request.....	3,407,650	1,3,039,886	3,247,129

¹ Includes \$37,786,000 proposed supplemental for civilian pay raises.

You will recall that NASA's fiscal year 1974 budget reflected a sharp temporary reduction, because of Government-wide fiscal problems at that time, to below the \$3.4 billion level previously planned as the long-term NASA budget level and approved by Congress for fiscal year 1973. Last year, the need was clearly recognized for increases in the NASA budget in fiscal year 1975 and subsequent years in order to again approach the level required to maintain a balanced program of continuing advances in the space and aeronautics.

The fiscal year 1975 budget does provide an increase for NASA as I have indicated. However, because of the financial constraints within which the President's overall fiscal year 1975 budget has been prepared, the increase provided is less than would have been required to maintain NASA's entire program as planned last year after taking into account the effects of inflation and other necessary adjustments.

We have been obliged, therefore, to make some program adjustments, the principal one being in the development schedule for the Space Shuttle. Under this and predicted future budgets, the first manned orbital flight of the Shuttle is now expected to occur in the second quarter of 1979, instead of at the end of 1978, a change of from 4 to 6 months. A firm schedule is extremely important in a large-scale complex development program like the Space Shuttle. Projected increases in future NASA funding levels should enable us to avoid further schedule changes in the Space Shuttle program, and at the same time maintain continuity and balance in other NASA programs within the previously planned total NASA budget levels.

To provide continuity and balance in our overall program, we have initiated this year three important new flight projects in space science and applications—Pioneer Venus, SEASAT, and a heat capacity mapping mission (HCMM).

PIIONEER VENUS

Detailed study of the composition and global dynamics of the atmosphere of Venus, 100 times more dense than the Earth's, will give us a better understanding both of that planet and of the forces that drive the Earth's atmosphere, meteorology, and climatology.

Two Atlas-Centaur launched missions will fly to Venus in 1978. One will send entry probes into four locations in the Venus atmosphere to measure the composition and global dynamics of that atmosphere. The other will place a spacecraft in orbit about the planet to study the characteristics of the atmosphere and their temporal changes.

SEASAT will be a specialized experimental applications satellite. It will observe and measure the oceans, both to develop a scientific understanding of ocean dynamics and to determine the feasibility of developing an ocean dynamics forecasting system which could be of great economic value to the shipping and fishing industries, for example. SEASAT-A will be launched in 1978. We are working closely in this program with the National Oceanographic and Atmospheric Administration (NOAA), the Coast Guard, and the Navy.

HEAT CAPACITY MAPPING MISSION (HCMM)

This will be another specialized experimental applications project. It will use a small Explorer-type satellite to make thermal measurements of the Earth's surface. These measurements will be used to

identify favorable locations for further ground investigations which will determine our ability to discriminate rock types and rock structures on a regional basis. This discrimination can be of major value in locating targets for the further exploration of mineral resources and in the planning of the construction of major civil works such as highways and canals. The measurements will also be used to investigate further the feasibility of locating geothermal sources by remote mapping from a spacecraft. The HCMM will be launched on a Scout launch vehicle in 1977. The Department of the Interior is working with us on this project.

Let us also mention another new item of interest in our fiscal year 1975 program. We plan to build an infrared telescope facility to be used primarily to provide supporting and complementary data to our planetary exploration and astronomical missions. For instance, it is very important that we have this additional source of data on Jupiter and Saturn and their moons prior to the launch of the Mariner Jupiter/Saturn mission in 1977. The infrared telescope will be built on Mauna Kea, Hawaii.

Mr. Chairman, although it is not a new start per se, a significant aspect of our fiscal year 1975 program plans is a legislative proposal that NASA be authorized to enter into a long-term lease arrangement for tracking and data relay satellite services—or TDRS services. On March 8, I transmitted to the Congress a bill which would amend NASA's basic charter, the National Aeronautics and Space Act of 1958, to authorize such a contract.

We have for some time been studying the feasibility and practicality of using satellites in synchronous orbit to relay communications directly between spacecraft in low Earth orbit and a ground terminal in the continental United States. Such services will greatly improve our Earth orbital-tracking and data-acquisition capabilities, and at the same time permit closing of many of the ground stations in our present worldwide network now dedicated to spacecraft in near-Earth orbit.

The technology is ready. Its potential contribution to more efficient and cost-effective space operations has been verified. Industry is willing and able to provide such services.

If the legislation we are recommending is approved, we plan to solicit proposals from industry late this summer, looking forward to entering into a long-term contract during fiscal year 1975. Under the proposed legislation, although we would be authorized to contract for the TDRS services now—to accommodate the long leadtimes necessarily involved in establishing a TDRS system—the services themselves would be acquired beginning in 1979. And funds for the services could be obligated only after they are authorized and appropriated to NASA for that purpose. The approach we are proposing will permit us to obtain the tracking and data acquisition services we will need when the Space Shuttle becomes operational, without requiring substantial capital expenditures by NASA during the shuttle development period.

On the institutional side, NASA's civil service employment will be stabilized at the end of fiscal year 1974 levels except for a further reduction of about 350 at the Marshall Space Flight Center at Huntsville, Ala., related to the completion of the Skylab program. Stabilization of our civil service employment will be extremely beneficial to NASA. It will permit us to take advantage of normal turnover to em-

ploy more young people on whom the vitality of NASA depends and, especially important, give us a better opportunity to increase the employment of members of minority groups and women in NASA.

At this point, Mr. Chairman, I would like to summarize the organizational changes within NASA which went into effect on the 15th of this month and which were reported to the committee in my letter of March 5 of this year. We believe these changes will strengthen the organization and management of NASA.

As the committee knows, NASA is going through a period of transition and consolidation. With the completion of the Skylab flights and with Space Shuttle development well underway, Dr. Low and I have recognized the need for a stronger mechanism for an orderly phaseover from conventional launch vehicles to the Shuttle and for innovative and coordinated approaches in planning and developing all our future payloads—manned and unmanned, science, applications, and technology.

In addition, we have felt for some time the need for stronger central leadership of the NASA field centers which are NASA's most important resource and on which the success of all of NASA's activities depend.

We have, therefore, redefined the position of Associate Administrator of NASA to be the senior line official in charge of the planning and direction of NASA's research and development programs. He is now responsible to Dr. Low and me for directing the activities of all the headquarters program offices, including manned space flight, space science, applications, aeronautics and space technology, and tracking and data acquisition.

Dr. Rocco Petrone, who is with us here today, is the new Associate Administrator of NASA. For the past year, Dr. Petrone has been the Director of Marshall Space Flight Center. Prior to that, he was Director of the Apollo program at NASA headquarters; before that, he was for many years Director of launch operations at the Kennedy Space Center.

Dr. John Naugle, who is well known to the committee, has been named as Dr. Petrone's deputy.

The other major changes we have made is to strengthen our institutional management by establishing a new position of associate administrator of center operations as the senior line official in charge of the overall planning and direction of our field center operations. The Directors of the 10 major NASA field centers, who in recent years have reported to the associate administrators in charge of program offices, will now report directly to the associate administrator for center operations, who, in turn, will report to Dr. Low and me.

Dr. Low will serve as acting associate administrator for center operations during an interim period until a full-time associate administrator for center operations is named.

Mr. Chairman, the details of NASA's current and proposed programs have been presented to the various subcommittees during the past several weeks. Let me conclude my statement by saying that even within the constrained budgets NASA has had in recent years and has again in fiscal year 1975, I am confident that we can carry out a hard-hitting, useful and exciting program in space and aeronautics, one that deserves the support of the Congress and the Nation.

The CHAIRMAN. Thank you, Dr. Fletcher.

Are there reasons, other than financial, for the shift in the Shuttle schedule?

Dr. FLETCHER. No, there are no other reasons. There are no major technical problems which have come up so far.

The CHAIRMAN. Go ahead, Mr. Hechler.

Mr. HECHLER. I note that you spent 10 lines on aeronautics in your statement. My computer tells me that is less than one-half of 1 percent of your entire statement.

I wonder if you still consider that this is of importance in the mission of NASA, in view of the fact that the recommended authorization for such problems as noise and pollution and safety has been decreased this year. Therefore, what do you consider the future NASA effort in advance research and aeronautics should be?

Dr. FLETCHER. I think there was a slight decrease in the recommended authorization for this year in aeronautics. I think it was \$2 million. However, it is still something like \$16 million above fiscal year 1973.

The reason for the sharp increase from 1973 to 1974, and then the decrease, was the refan program. The refan program is a little bit out of the ordinary for NASA to do. It was a crash program to see if we could do something to quickly affect major noise reductions in aircraft.

The decrease in fiscal year 1975 represents a dropoff or completion of that program.

Mr. HECHLER. I am sure you are aware of the very strong support this committee has given to the development of aeronautics and the results that can be achieved by the application of additional effort in this field.

Mr. MOSHER. You used the phrase such as "out of the ordinary for NASA." Toward the end of your testimony you talked about changes on the institutional side and strengthening your management team. As you make those changes, and particularly as you talk about a new position of the Associate Administrator for Center Operations, are you going to encourage top management to be looking for things that are out of the ordinary for NASA, say for opportunities where you could use NASA's genius for management and competence in many fields?

This would be to serve national goals beyond the narrow confines of your original mission. Frankly, I am hoping very much that you will do that, and I think one way you can do it is to call to the attention of this committee any opportunities that we may miss where you could do that.

At the Lewis Research Center, for instance, it could be done. This could help in the solution of national problems that are beyond the original mission and also working in coordination with local community people to solve local problems.

Do you consider this as an obligation and an opportunity or responsibility for NASA?

Dr. FLETCHER. Yes, I count it as both an obligation and an opportunity. I feel very strongly that NASA does have a technology capability which is unique. Within the limits of our charter, we are doing just that. We are doing this in a number of ways.

We might supply additional information for this record if you wish. We are helping a fairly large number of other Government agencies with this technology. We are cooperating with almost every branch

of Government to supply technological assistance. This is done mostly at their expense. We do supply some of the manpower to help them solve difficult technological problems.

It is my goal to continue this effort in a major way.

Mr. MOSHER. You said "within the limits of our charter." I hope you will consider those limits not to be narrow, but that they would be broad. I hope you could define them as to encourage you to look to new opportunities.

This may be an unrelated question, but speaking about the sensitive and difficult problem that you are referring to on pages 6 and 7, the equal employment opportunity program, for instance, I am glad you do not hesitate to acknowledge your problems.

You refer to these goals as being difficult to attain. I can imagine what some of the difficulties are. Do you want to expand on that a little bit?

Dr. FLETCHER. I will start off by saying that the biggest problem is the fact that we have not been allowed to hire very many people over the last several years. We have been in a constant reduction-in-force (RIF) mode. During a RIF period, because of the rules in the Civil Service Commission, we tend to lose the more junior people who have fewer retention rights, and some have been minority people and women. So, being unable to hire very much, in fact, reducing our work force has led to us remaining status quo in terms of minority and women on our work force.

I think we can do better in the coming year because, hopefully, the only place we have an additional reduction is at the Marshal Space Flight Center.

Another problem is that when you go after scientific and engineering personnel, you find there is a shortage of personnel among the minorities and women. We are doing something about that. We have scholarship programs and cooperative programs. We have to make their special efforts to see that there is a pool of qualified people who can be brought in.

There are also many internal changes that have to be made. I would like to defer to Dr. Low on that, if he wishes to comment.

Dr. Low. The goals that we have set for ourselves for this year are to bring on 80 professional women and 80 professional minorities into the NASA work force. We will strive to reach these goals by hiring outside people and through upward mobility of nonprofessionals within NASA.

Now, the 80 figure would represent about 1 out of 3 of all the professionals we intend to bring on during the coming year.

In terms of availability of minority and women scientists and engineers, this represents a very large number. So we have established special recruiting teams at all our centers. They are composed of young people. Minorities and women are also represented on these teams.

The initial results that I have seen are quite encouraging. As Dr. Fletcher mentioned earlier, our goals will be difficult to obtain, but we are optimistic.

Mr. MOSHER. The difficult problems are practical problems but you have the will and the effort to do it, and this is also very real.

Dr. Low. Yes, this is very much in evidence throughout NASA. I have visited most of the centers in the last several weeks. We are doing better than we have in the past. We have the will and desire and effort to improve even more in the future.

The CHAIRMAN. Go ahead, Mr. Fuqua.

Mr. FUQUA. On page 10 you mention leasing arrangements and legislation that you have forwarded to the Congress as to tracking and satellite services. Is this in connection with the Space Shuttle for a larger percentage of communications with the Shuttle, the tracking and data relay satellite service?

Dr. FLETCHER. That is a part of it, but it also has to do with the fact that all the users of space have an increasing demand for data. With this large demand, we have to go to something like this to keep the cost within balance.

There is a third aspect. It will be economical, since we will be able to phase out some of our overseas stations.

Mr. FUQUA. Do you have a figure as to how much savings this would bring about?

Dr. FLETCHER. We have made a study and we could supply it for the record.

The CHAIRMAN. That may be a committee insert.

The net savings resulting from implementation of the TDRSS, after ground stations have been phased out, will be in the order of \$20 million per year. The savings and cost avoidances effected by the TDRSS in station operations, systems implementation, and communications will be approximately \$70 million to \$75 million per year. The estimated cost of the TDRSS service, including lease payments and associated NASA operations, will be in the order of \$50 million to \$55 million per year.

Mr. HECHLER. It was pointed out that the cost to NASA of the leased service would be \$584 million and the NASA-owned service could be obtained for \$299 million. These figures were developed by testimony before the Subcommittee on Aeronautics and Space Technology.

Mr. FUQUA. What is the rationale between owning and leasing this? If you have to lease, you have to continue to pay.

Dr. FLETCHER. You have to distinguish between the savings of the TDRS system and the issue of leasing or buying. As far as the savings of the TDRS system, over one which is not a TDRS system, we can supply that, as I said.

Now, as to a choice between leasing and buying, that is a separate question. The main reason we are proposing to lease rather, than any is that we felt in order to keep our overall expenditures within bounds we ought not to be spending the investment for the TDRS system now, but preferably during the use period.

At the time we start using the TDRS system we would phase down some of the overseas stations. This would fit nicely into our budget at that time. The difference between the two figures that Mr. Hechler mentioned seems large, but you must remember that in order to be accurate here, you must calculate in the cost of money. That is a part of the difference between the two figures. There are many other factors that we would be glad to go into with you in detail at some later date.

Mr. FUQUA. I think the figures Mr. Hechler gave indicated it costs twice as much to lease as to own. Are we deceiving ourselves, or are we just deferring the cost this will ultimately cost the taxpayers?

Dr. FLETCHER. There is no question that our intent is to do what will save money for the taxpayers.

Mr. FUQUA. I think we need to give more thought to the comparability of lease versus ownership.

Thank you.

(At this point the Hon. Olin E. Teague assumed the chair.)

The CHAIRMAN. Go ahead, Mr. Wydler.

Mr. WYDLER. I am delighted to have you here. I want to make this comment to you. Although your work over the past few years has become less spectacular than it was during the 1960's, I personally feel, as somebody who was here observing those years, that the work you are doing now is better than any of the work you did during those years. It is more professional.

I congratulate you and your organization. It is being done under very difficult budgetary circumstances and constraints. It is an excellent job for the country.

This does not mean I do not have some criticism of it. This is my own state of mind regarding the program. I want to congratulate also Dr. Petrone for his new assignment and appointment. I think this was an excellent one, and I think the program will be well served.

Dr. FLETCHER. Thank you.

Dr. PETRONE. Thank you.

Mr. WYDLER. On page 3 you say Pioneer 10 will be the first man-made object ultimately to escape the solar system. When will that happen?

Dr. FLETCHER. It is hard to say where the solar system ends. If you say the solar system ends at Pluto, which is the most distant known planet, we can give you a definite answer in about 7 or 8 years when it passes the orbit of Pluto.

Mr. WYDLER. Do you know which solar system that would be in then?

Dr. FLETCHER. We could tell you the general direction that it is going, but I would not want to hazard a guess as to what star would capture it first.

Mr. WYDLER. Is there enough scientific evidence to suspect it might ever return to our solar system?

Dr. FLETCHER. There is no evidence that indicates it would ever return to the solar system, although if you wait for an infinity of time all things could happen.

Mr. WYDLER. I will not be around to worry about that.

The only other thing in the statement that struck me was I do not think you mentioned the joint mission with the Soviet Union. Is that here anywhere?

Dr. FLETCHER. This is a short version of the statement. It was not mentioned, but it is a very important program scheduled for launch July 15, next year.

Mr. WYDLER. How is that progressing? I will accept a broad answer because that is a broad question. I want to get a feel for this program. It is important not necessarily because of the space aspect, but for other reasons. How is it progressing?

Dr. FLETCHER. It is progressing very well. We have had people from the Soviet Union here at the Johnson Space Center. We also have had our people in Moscow in connection with the operational aspects of the flight.

The technical problems seem pretty well in hand. There are no major technical difficulties, but there are things such as joint training that must yet be accomplished and the public information aspects have to be considered.

Mr. WYDLER. Are you on schedule?

Dr. FLETCHER. I will let Dr. Low comment.

Dr. Low. Even in the areas just mentioned we are progressing well. The Soviets have had their people over here for training and we have been over there. The mutual training plan has been worked out. The crews and support people are learning each others' languages well.

I understand Tom Stafford is spending 7 hours a day studying Russian, and they are studying English. We will start joint simulation in December of this year. We have visited their Mission Control Center and they have visited ours.

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

The CHAIRMAN. Go ahead, Mr. Symington.

Mr. SYMINGTON. Thank you. It is a pleasure to see you, Dr. Fletcher, and your colleagues. It is comforting to see the team together.

As you know, I have been chairing the Subcommittee on Space Science and Applications. We have concluded our authorization testimony. I am rather please to see the amount of space that has been taken in Dr. Fletcher's report showing the renewed emphasis in this area.

I think that one of the things that we have been trying to do in this country is to make the public aware of the importance of the space program and also to make them aware of the reasons why it should receive continuing support. I believe that your statement helps greatly, and I think Dr. Low's statement is helpful.

I hope without getting into any major public relations efforts that no opportunity is lost to make clear to the American people the spin-off benefits of the space program. We do not want any rough sledding.

I think in my visits to the various contractors involved in the Viking and other programs that many of them are working on Earth-related and Earth-based problems with small amounts of money. We do not really know where NASA is headed ultimately. I have worked on the Energy Subcommittee, and we have tried very hard to see to it that none of NASA's capabilities were ignored in pursuing solar energy.

There are bureaucratic decisions that have to be made to the satisfaction of the executive branch. We do not want to see any part of NASA's skills lost. We look to you to keep them before us, and we hope you will let us know if you are losing a team because of want or work or a challenge. We do not want this to happen.

The systems approach that you developed will be valuable to this country in dealing with waste and recycling. We have seen small but fascinating experiences in this field. There is a whole range of problems of this type. I hope you will recognize the work of the committee has had some relevance.

I see, for example, on page 3 that you refer to ERTS. ERTS-1 was initially to have been experimental, and ERTS-2 was on the drawing board, but it was not going to fly until the committee urged that it do so.

Dr. FLETCHER. Yes, it had been postponed.

Mr. SYMINGTON. We have been shown the immense benefits that can flow from this program. We went to the seminar and it was

decided the additional \$8 million might be well spent. We went ahead with it. I think the results confirm the joint judgment.

We hope very much that we do not lose any opportunities of this kind because of the want of congressional attention.

Now, your people see just about everything that might be done. We hope you will not let any of it go by without giving us a chance to recommit the Nation to that particular approach. Is that a fair statement?

Dr. FLETCHER. Yes, we will do our best not to overlook any of it.

Mr. SYMINGTON. Thank you.

The CHAIRMAN. Go ahead, Mr. Winn.

Mr. WINN. Dr. Fletcher, on page 10 in your prepared remarks, you refer to the infrared telescope facility. As a general rule, the responsibility for the ground-based astronomy falls within the National Science Foundation and that of the space-based astronomy falls within NASA.

To what extent is NASA involved in the ground-based astronomy at the present time?

Dr. FLETCHER. Everything we do in the way of ground-based astronomy is very closely coordinated with the National Science Foundation. In this case, we have their encouragement to go ahead with this program.

The reason we in NASA are interested in the infrared telescope is that it bears on our planetary research. We want to know what the infrared characteristics of some of the planets like Jupiter and Saturn are. This is what we want to know before we plan the details of the Mariner-Jupiter-Saturn mission, the MJS.

Mr. WINN. I think you partially answered my second question that apparently projects are needed initially to support the Mariner-Jupiter-Saturn mission also, which is scheduled for launch in 1977. What is the long-term need for this facility?

Dr. FLETCHER. Well, the main long-term need is for planetary studies, and infrared investigation of the planets is a new field of study. It is hard to know where it will lead. We plan to have infrared telescopes on the Shuttle, particularly in the Spacelab. Infrared telescopes must be high in order to get above the interfering effects of the atmosphere. High mountains, high altitude aircraft, and, preferably, space are the only locations where infrared telescopes will be useful.

NASA plans to move ahead in the infrared astronomy in the 1980's.

Mr. WINN. Now, along the lines of another question, what is the total aggregate annual under graduation of all types of scientists and engineers from the minority groups in the United States? Do you have any figures or does NASA have any figures?

Dr. FLETCHER. It is about 500.

Mr. WINN. What percentage does NASA hire in the 500?

Dr. FLETCHER. Our goal for the next calendar year is to bring onboard 80 professional people. This would include scientists, administrators, and engineers.

Mr. WINN. How does that compare with other branches of the Government?

Mr. MALAGA. I do not have this.

Mr. WINN. Are you aware of their goals in the same fields with scientists and engineers?

Mr. MALAGA. I do not know, but our competition is extremely keen. It is keen from Government and industry. We have established a special recruiting program. We divided the country into sections. We will go out and do our job to bring these people onboard.

Mr. WINN. The competition is keen?

Mr. MALAGA. Yes.

Mr. WINN. Partially in defense of NASA, the staff points out 579 minority engineers graduated in 1972 and only 519 women engineers graduated in 1972 in the entire country. It makes it pretty hard for you to fill those spots.

Mr. MALAGA. It is extremely difficult. We are attempting a nationwide approach in recruiting. We are giving people on-the-spot authority to go ahead. We have divided the responsibility by regions of the country.

Now, the lead centers are hiring for NASA, not necessarily for their own particular center.

Mr. WINN. Please keep up the good work. NASA may have a black eye in this field or a bad reputation. I think under your new program and guidelines that you will get the job done.

Mr. MALAGA. Thank you.

Mr. COTTER. I offer my compliments for a fine presentation.

On page 8 you mention a firm schedule is extremely important in the large-scale complex development program like the Space Shuttle, and you talk about projected increases in future NASA funding levels. Have you outlined what these increases will be over the next several years?

Dr. FLETCHER. Yes. We have a projection of what the runout of the Shuttle cost ought to be. We also have a reasonable commitment from the OMB and the President that overall NASA levels will be commensurate with the Shuttle figures.

We could give them to you if you are interested.

Mr. COTTER. I am not interested in the dollar amounts, but I was curious as to any contacts made with the OMB and the executive branch of Government; if they were not available, if it would jeopardize the time schedule that you had outlined.

Dr. FLETCHER. I think this year for the first time we have a pretty good commitment from both OMB and the President that this would be our budget level. This, of course, is subject to general escalation or cost increases.

I think we can fit everything we are planning into that budget.

Mr. COTTER. You may recall there was some criticism of the South African tracking station. Has that question been resolved?

Dr. Fletcher. I do not know if the criticism matter was resolved, but we are in the process of phasing out our activities in the South African tracking station. We have somebody who may want to add to that.

Mr. TRUSZYNSKI. I think we do have a plan for the phasing out of that station. This is generated by changing requirements in our planetary programs. There is a key station earlier. Now the future planetary launches can be done in other areas of the world.

Mr. COTTER. When will this be accomplished?

Mr. TRUSZYNSKI. The current plan is to phase it out in the latter part of calendar year 1975.

Mr. COTTER. Thank you, Mr. Chairman.

The CHAIRMAN. Go ahead, Mr. Pickle.

Mr. PICKLE. Thank you, Mr. Chairman.

Dr. Fletcher, on page 8 you mention that the Pioneer and Venus—well, there is an attempt to determine the quality of the atmosphere, which is the purpose of it. You comment that you assume or also believe the atmosphere is 100 times more dense than the Earth.

Why do you think this? What is the composition or what do you think you will find?

Dr. FLETCHER. We have a pretty good idea of what the composition of the Venus atmosphere is at the top. We have taken readings by visual means with ground-based telescopes of the chemical constituency. At the top it is a mixture of a large number of things.

I think Mr. Johnson could also talk about what we see at the top normally in the visible range. Recently with Mariner 10 we found there was another layer below that which was of quite different material. Sulfuric acid was involved which had quite a different character than the rest of the atmosphere. We do not really know for sure what the atmosphere is clear down to the surface. That is the reason for the probe.

Mr. JOHNSON. We do know that the Venus atmosphere is primarily carbon dioxide, but as mentioned, we found traces of hydrogen and hydrochloric acid in the atmosphere and other substances.

As to Pioneer Venus, we will send in four simultaneous probes. These will be at widely separated places. We will sample the atmosphere simultaneously. We will check the constituents of the atmosphere and the circulation.

It is very important for fundamental meteorological research to understand the total circulation of the Venus atmosphere. On Venus we cannot do that unless we send probes.

Mr. PICKLE. Will this take a period of years, such as 12 years?

Mr. JOHNSON. No. We plan to launch the orbiting and probe mission in 1978. It will arrive at the planet in the fall of 1978. We will get that circulation information as the probes go in. The orbiter will remain in orbit for about a year. This gives us information on the upper atmosphere.

Mr. PICKLE. We had testimony from Dr. Peter Glazer from Cambridge, Mass. There was some information about what we might find on microwave transmission of energy. A member of the staff has made some investigation on this.

Are we far enough along to make sure that we should make some request for a fund for such a program? Dr. Glazer indicated we need preliminary studies on the subject of satellite solar power and long-distance microwave transmission.

It is my understanding the staff member said the cost associated with the studies would be \$2 or \$3 million. Is that amount in the budget, or have you made such a request? Do we need such a bill?

Dr. FLETCHER. We have not requested fiscal year 1975 funds specifically for study of a space solar power station. In fiscal year 1974 Congress authorized \$2 million for general studies in new energy sources. Part of that money is being used to fund studies for portions of the technology involved in a solar power station.

The \$2 or \$3 million that you mentioned would be above what we have programmed for fiscal 1974. We are doing a fair amount in that area, but not the specific things you suggested.

Mr. PICKLE. In view of the great potentiality that exists in the satellite field as it relates to solar energy, should we not consider an additional sum to advance this work? If you leave it on the present basis, it is part of the overall general study. Perhaps we should earmark something for this.

Dr. FLETCHER. I would not object to that specifically. I think the first question is whether we should undertake an intensive study of the possibility of solar power stations and what the tradeoffs are. I think it makes good sense to make an intensive study of the tradeoffs and the best type of station.

We have done one of these before, and Dr. Glazer was involved, and we could do it again. Now, whether the funds should be earmarked, I think that is something for you to judge; that is, if you think we are not putting a proper amount of effort in this area then you could earmark funds. We think we are pursuing this and that we should continue our studies.

There are examples of our current effort in front of me. We are spending about \$300,000 on solar power conversion and power relay system studies and \$200,000 on solar thermal power conversion and delivery systems for Earth-based power stations.

Mr. FREY. There is just \$11 million being spent on the project, such as this, in NASA. Yet \$250 million is projected for the Science Foundation. There seems to be some misuse of our resources in NASA.

Dr. FLETCHER. It is very difficult for me to comment on the relative distribution of funds between NSF and NASA.

Mr. FREY. I do not know why it would be.

Dr. FLETCHER. NASA proceeds with its programs according to the way the funds are programed from OMB. I do not think it is out of order, however, to pursue the system studies that were described by Congressman Pickle. I have no objection to that.

Mr. SYMINGTON. I think we should acknowledge that the application share of the NASA R. & D. budget is roughly 7 percent of R. & D. as to application, yet it is the application which is being stressed so as to justify this continuance of effort.

Mr. PICKLE. I would comment that we are encouraged by the passage of the solar energy bill. We are excited about the possibilities of things we might develop in the demonstration projects, but we are considering what might develop in the field of satellite solar stations.

It would seem to me that perhaps we ought to reconsider our timing on this. Can you give us a schedule of what you hope to present to the Congress as to what we hope to accomplish on the satellite program, say in a measure of 1, 2, or 3 years?

Dr. FLETCHER. I could present a preliminary outline of a program which would probably be more of a 20-year program. I could, I think, give you an impression as to what kind of a program that would be.

A space based solar power station is not in the immediate future. There is just no way that it would be wise to go ahead with a practical use of space solar power; that is, space-based solar power for use on Earth. We are talking about 20 years from now before it would be economically feasible. It is not in the same category as solar heating and cooling, which can be done at this time.

There are some basic difficulties that have to be overcome before we can make the solar power station economical. Some of the difficulties probably have already been discussed with you.

What, for instance, is the cost of the solar cell that you have to produce in order to make this economical? We have a long way to go. In fact, we must improve the cost by a factor of 1,000.

Now, the microwave transmissions are also a technical problem which, on the surface, do not seem as tough as the solar cell. It is, however, a technical problem that some people, in and out of NASA, think may be more difficult than the solar cells themselves. Therefore, there are technologies that have to be considered before you can proceed. With the right approach it is likely that someday we will be using solar power in a major way for energy here on Earth. It is the long-term source of energy, and it is likely we will be using some sort of a solar power station to harness it.

We cannot afford to neglect this concept even though it is some distance into the future.

Mr. PICKLE. From a flash of the eye when we thought that solar energy and thermal nuclear and geothermal energy was so far in the future that we could not grasp it, but now we are talking about it. It seems the time schedule for this satellite approach is no more difficult than a lot of the older programs.

I think greater emphasis should be put on it.

The CHAIRMAN. Go ahead, Mr. Milford.

Mr. MILFORD. I share a concern with my colleague from West Virginia, Mr. Hechler, that the first situation in NASA may not receive adequate attention. You mentioned research on the supercritical wing and its application to commercial aircraft, and I note in your remarks that you say this wing could save up to 30 percent in energy use.

This factor is of vital national interest at this time. I have three questions on this.

What is the stage of development of the wing, or when can we expect to see the wing on commercial aircraft?

Second, is research on the wing progressing at the fastest practical pace?

Third, how much participation are you receiving from commercial airplane manufacturers along with developers as to this flight?

Dr. FLETCHER. I will defer the third part of this question to Mr. Kilgore, but the NASA development of the supercritical wing is very far along. It is ready now for both military and commercial people to pick up and use.

There are plans for this. I think that Mr. Kilgore will present them.

I want to correct one impression. The 30-percent fuel savings that we believe we can achieve for commercial aircraft is due only in part to the supercritical wing. We do know that the supercritical wing is being considered right now for things such as improvements to the Learjet.

Now, Mr. Lear has in mind increasing the range of the Learjet using supercritical wing technology. In this case we do not have to do anymore in terms of the technology. The problem is to transfer the technology to the users.

Mr. KILGORE. The major aircraft companies are very interested in the supercritical wing and are planning to apply it to the next generation of transports. At present, however, it is not being used on any transports. The industry has not built a new transport in quite some time.

Major companies are looking into it for the next generation of design.

There is the adaptation of the wing for general aviation that Dr. Fletcher mentioned. We have provided information to and worked with several general aviation manufacturers, and our technology is being applied to some of the general aviation aircraft. Several things result, such as fuel savings, increased range, and decreased stalling characteristics. These are things which are important. These may be the major benefits.

There would be an increase in fuel saving from the wing, estimated to be about 15 percent. The other 15 percent comes from the composites and other technology.

Mr. MILFORD. This would prompt another question. Pursuing the potential 30-percent savings in fuel, which is a considerable saving of vital national interest, have you made any sort of study or do you think it would be wise to make a study as to possibly looking into a demonstration program on the part of NASA where this particular goal could be sought?

It is extremely expensive for a commercial airplane manufacturer to simply start from scratch with a new airplane. Yet if some of the research factors were worked out and looking toward the national interest of saving 30 percent of fuel, would this be an advisable or practical approach for NASA?

Dr. FLETCHER. I think it makes very good sense to not only do the research and technology, but to also make a demonstration of an airplane that could, indeed, affect the 30-percent savings.

Dr. LOW. We have studies underway to do this.

Mr. SYMINGTON. Now, as to the STOL technology, I understand NASA had dropped a \$20 million STOL investment. Is that true?

Dr. FLETCHER. We had a program 2 years ago which actually involved a demonstration of a quiet experimental short takeoff and landing aircraft. That program was terminated in favor of what we now call a quiet propulsive lift program. This does much of the same sort of work as the QUESTOL program. I think we are making considerable progress.

Mr. MILFORD. In pursuit of my original question as to whether the first A—as you state the supercritical wing work has generally been done. It would appear that the only real significant thing being done as far as aeronautics is concerned would be your experimental work to quite down the engine.

Dr. FLETCHER. I think that would be an oversimplification. We have a large number of programs. If you do not mind, I will ask Mr. Kilgore to list some of those programs.

Mr. MILFORD. We would also like it included in the record later as a more detailed statement.

Dr. FLETCHER. We will do that.

The CHAIRMAN. That will be a committee insert.

[Material for inclusion in the record follows:]

Question. The question concerns the OAST aeronautics programs.

Response. The NASA Aeronautics Program contains a base R&T element and Systems and Experimental Programs which verify and demonstrate the more promising outputs from the base R&T Program. Our base R&T Program is centered in Research and Technology in the disciplines of Materials, Structures, Avionics, Propulsion Systems and Components, Air Breathing Engine Systems, Fluid and Flight Dynamics, Low-Speed Vehicle Systems, High Speed Vehicle

Systems, Man Vehicle Technology, and Aircraft Operations. These categories include the long term programs which provide the concepts for our Systems and Experimental Program studies.

Some of our on-going Systems and Experimental Programs include Supersonic Cruise Aircraft Research, Quiet Propulsive Lift Technology, several experimental propulsion programs including the JT8D Refan Program and the Quiet, Clean Short-Haul Experimental Engine Program, and the C-8 Augmentor Wing Flight Experiment, the YF-12 Flight Experiments, and the Digital Fly-by-Wire Flight Experiment. In FY 75 we plan to add to this list of programs a total of 10 new starts which are as follows:

- Materials for Advanced Turbine Engines.
- Integrated Program for Aerospace Vehicle Design.
- Active Control Aircraft Flight Experiments.
- General Aviation Low Cost Avionics.
- Advanced Multi-Stage Compressor.
- Rotor Systems for Rotor Systems Research Aircraft.
- Wake Vortex Minimization Flight Research.
- Composite Primary Structures Flight Research.
- Advanced Acoustic Composite Nacelle Flight Program.
- Highly Maneuverable Aircraft Technology Flight Research Program.

We feel that the Aeronautics Program summarized above is a viable, productive Research Program which balances the long term base R&T Program with Systems and Experiments which verify and demonstrate our most promising concepts.

Mr. KILGORE. We are doing work in quite a number of areas which will have a significant impact on the aeronautics program. An example is the composites program, which is part of the structures program. This could have considerable effect as to fuel savings resulting from lighter aircraft. We plan a demonstration program using a C-130 aircraft. We will make the wing box structure out of composites. We have to demonstrate to the designers and to the aircraft manufacturers that composite structures can be flown safely without problems such as fatigue cracks.

We are also doing quite a bit of work in connection with helping the FAA to reduce congestion around airports by improved avionics. This also has an impact on fuel savings.

Dr. Low. One area of work has to do with studying the wake turbulence behind airplanes. A significant problem is the wake of larger airplanes. We are studying ways to reduce that. We are having some measure of success.

Another of our projects is called fly-by-wire control concept. There are no cables going from the stick to the tail. Electronic signals from stick motion are fed to a computer which in turn commands the activators that move the control surfaces. Together with the super critical wing technology, this could lead to a plane far more efficient from a fuel economy viewpoint.

We are planning to have a conference in Los Angeles in July involving all of the aircraft industry, NASA, and the Armed Forces. We will discuss the fly-by-wire technology, which involves a demonstration type program. Our intent is to bring this technology to the industry as quickly as possible.

Another project is the control-configured aircraft project. We will design the control system so that we can fly the airplane more efficiently with smaller control surfaces.

Still another example is the terminal configured vehicle. This configuration is such that the plane will be able to fly the optimum approach trajectory into an airport so that existing airports can be used to land and take off more airplanes. The experiment is being tested at Langley at the present time.

There is also the rotor systems research test airplane.

Mr. DAVIS. Will you yield?

Mr. MILFORD. Yes.

Mr. DAVIS. I have trouble understanding something unless I know what words mean. I have a few questions on this. Now, critical, for instance, I thought of that in connection with reactors and what a critical mass would be. The word "super" is a Latin word identical to a Greek word.

I noticed in discussing supersonic aircraft they called it hypersonic. What is a critical wing?

Dr. FLETCHER. I think the term is a nickname.

Dr. Low. In aeronautical research we have traditionally used the term "critical Mach number" or "critical speed." This was the speed, close to the speed of sound, where the resisting force of the air started increasing very sharply. We could fly up to nine-tenths of the speed of sound and not see much effect of speed, but as we got closer to the speed of sound, very suddenly the resisting force of the air built up very sharply. The airplane had trouble flying, and that was called its "critical speed."

We have a very clever man by the name of Richard Whitcomb at Langely. He made the wing flat on the top and curved at the bottom. This allowed the "critical speed" to come later. We could fly at a higher speed with the same powerplant and energy. This technology, then, was called "super-critical" technology.

Mr. DAVIS. Thank you.

The CHAIRMAN. Go ahead, Mr. Frey.

Mr. FREY. I think putting the budget in perspective that you should be congratulated in view of the fact that over the last 5 years the NASA budget as a percentage of the overall budget has been reduced over 50 percent. We ought to keep this in mind.

However, it has been indicated before that there are those of us that feel that NASA has the ability and technology and facilities and people to get much more into the energy area, such as hydrogen and solar energy and other forms of energy. We just do not see it.

If OMB designated NASA as the lead energy in solar power concept, would you be comfortable with this? Would you want this?

Dr. FLETCHER. If OMB would designate NASA to do this, I would be quite comfortable with it.

The CHAIRMAN. Would you yield?

Mr. FREY. Yes.

The CHAIRMAN. We talked with OMB yesterday, and that is the exact plan that OMB said they would follow. NASA would be the focal point within the executive branch as to the solar satellite.

Mr. FREY. Thank you, Mr. Chairman.

The \$89 million in the shuttle program that we did not get which was asked for, we have had estimates that in the end it will cost about \$500 million. Do you agree with those estimates?

Dr. FLETCHER. I will turn to someone to answer that.

Mr. LILLY. The reduction in our request of the \$89 million figure, our assessment was it probably would defer our first manned vertical flight by something like 6 months. Our estimate right now in terms of additional cost, as defined in 1971 dollars, this was about \$50 million. If you convert \$50 million to where you are right now, this comes to about \$58 million.

This overlooks the matter of escalation that may or may not occur once you get there. I do not think it would come close to \$500 million.

Mr. FREY. I compliment you for holding basically within the original estimate. On February 20 we had Dr. Gatos here from MIT, and there was interesting testimony in which he reported on experiments in the Skylab program and the manufacture of crystals in space.

His testimony is a little contrary to what you said about solar power. If my memory is correct, his statement was that if we did develop it, solar power from space could be reached at quite an earlier date than the estimates that we have just heard. Not only that, but he indicated the ability to manufacture crystals in space and that this was among the most important experiments in his lifetime that he has ever seen.

You might want to comment on this.

Dr. FLETCHER. On the matter of manufacturing crystals in space or manufacturing in space generally, I think I would support what you or what Dr. Gatos proposed. I think a lot of people have picked up from Skylab the idea that this can be a very large commercial industry, such as manufacturing materials in space. We have in NASA a study which was done before Skylab. This study was done by the General Electric Co. and addressed the potential total sales from space manufacturing. They estimated that sales of about \$1 billion per year were possible.

It is a program that is worth pursuing.

Mr. FREY. The ability to manufacture the crystals in space and not have any imperfections there and to be able to store more energy, he felt this would be a tremendous help. Now, I think it is important to emphasize the savings of about \$1 billion per year through the shuttle.

Can you comment on the hardness of your mission model and what we picked up in the last year in terms of missions over and above the preceding years? It is important for the record that this is understood.

Dr. FLETCHER. Congressman Frey, when we first started analyzing this subject we did not realize all of the potential of the shuttle. We did not include all of the possible savings.

Mr. FREY. Such as the European space lab program?

Dr. FLETCHER. The Spacelab was included in our last study, and it made quite an impact on the savings. I want to be sure, however, that you understand we do not think our latest mission model is the final answer.

By the time we get to 1980 people will think of many more uses for the Shuttle that we have not foreseen.

Mr. FREY. You are saying in simple terms the \$1 billion per year is a pretty hard figure. It is not a pie in the sky. You have a breakdown of the missions, and it is your understanding and belief that this will be added to as we go along?

Dr. FLETCHER. Yes. I would go beyond that. I would say our current mission model is a lower limit to the ultimate use of the Shuttle.

Mr. FREY. Thank you.

The CHAIRMAN. Go ahead, Mr. Ketchum.

Mr. KETCHUM. It is nice to see you again. I was interested in your response to a question of the chairman when he asked about the slippage in the Space Shuttle program. Your reference was entirely within the framework of funding.

To what extent does this litigation over the solid rocket booster enter into that?

Dr. FLETCHER. The litigation so far has not contributed to any slip in the Shuttle program. We hope the litigation will be solved pretty soon so it will not have an impact on the Shuttle schedule.

At the present time we are quite concerned about that. If the matter goes unresolved longer than another month or two, we may have to take some sort of action in this regard.

Mr. KETCHUM. If it goes on for another month, what are we talking about in terms of slippage beyond what you have said?

Dr. FLETCHER. We have not calculated how much additional slippage we may have. We would have to take some actions that we are not taking now. It is not clear whether we would slip the Shuttle program, or if it would be wiser to take some other type of action, such as going ahead with the contract.

Mr. KETCHUM. As to the Space Shuttle, has there been a request made by NASA in line with or in conjunction with a large space telescope?

We heard something about this.

Dr. FLETCHER. We have a fairly major program on the Large Space Telescope. This is in the study phase. It is not an approved program as yet.

Dr. PETRONE. This is a phase B study at the Marshall Space Flight Center. We have two contracts. We plan to have two more. They would be advertised about the 1st of April.

In this budget we are talking about \$6.2 million to support the phase B studies. Upon a successful conclusion of the technology, we would have a new start. Now, the exact year for a new start has to be decided by NASA.

Mr. KETCHUM. In view of that and your comments on the infrared telescope and the reasons that you gave as necessary for that, how do these two fit together? Which one is more important?

Dr. FLETCHER. It is a question of timing. Initially the infrared telescope is the most important because we need the data in time to help us decide on the orientation and the kind of instrumentation that goes on the MJS mission. If we do not get going with that in fiscal 1975, the data cannot be used on that mission.

Now, later the large space telescope could very well be the most important thing that we would do in that period.

If the LST program proceeds along the lines we now plan it would allow us to see 10 times farther into the universe than we can now see. This is an enormous factor. It would be a bigger leap forward than the 200-inch telescope completed after World War II. That would be a most important program.

Mr. DAVIS. You are talking now about the optical band?

Dr. FLETCHER. That is right.

Mr. KETCHUM. I wanted to understand because as you know, we are responsible for selling this to the public.

Dr. FLETCHER. Yes.

Mr. KETCHUM. One last question. This relates to solar energy.

In testimony before the Energy Subcommittee recently we were told that if 1 percent of our homes were heated and cooled by solar energy by 1985 there would be a 600,000-barrel-per-day oil savings. In view of that, do you feel that there has been enough emphasis placed on all forms of solar energy R. & D.?

Dr. FLETCHER. I do not think there has been enough emphasis placed on solar R. & D. in the past, but in the present fiscal 1975 budget there is a fairly large increase in this.

This should make a good beginning.

Mr. KETCHUM. For the record it is interesting to note that an article written in the Detroit News, Thursday, February 21, 1974, said Federal Government was optimistic about solar energy applications more than 25 years ago when a Presidential Commission predicted, by 1975, there would be about 13 million American homes heated by this method.

According to this article at the present time there are only about 1 dozen.

Mr. PICKLE. Will you yield?

Mr. KETCHUM. Yes.

Mr. PICKLE. I want to ask a question in line with your earlier planetary questions.

The general planetary program has been kept at about \$4.2 million. I was hoping we could increase that. This could help take care of inflation which is difficult to handle by these institutions. I am concerned about the lunar science operation. We have recommended a sizable increase from about \$1.6 million to about \$4 million. Do you think that is enough?

The observatory in Texas needs \$500,000 just for a mobile telescope and a laser to go with the laser program. They said if they had the mobile telescope and the laser they could measure within 1 inch the marks on the continental plates. They could gain valuable information about the continental drifts and information about possible earthquakes. Is it your intention for them to hope they might get the extra money out of the lunar science operation? Are there specific funds for that program?

Dr. FLETCHER. I would turn to Mr. Johnson to get the complete answer, but one of the problems we have is that there is not enough money to go around. We have an increase in this area. It takes the wisdom of Solomon and a lot of people to decide what the highest priority program should be. Let me ask Mr. Johnson to respond please.

Mr. JOHNSON. I am not certain on the details on this specific item. Perhaps somebody else could comment on this, but I think the mobile laser program is in another area. But in the area of funding for the lunar science research, I think the funds are adequate. We could always use more.

Mr. PICKLE. Are you saying as to the amount being budgeted that you could hope for the funds to come out of this rather than making an additional request?

Mr. JOHNSON. I think the funds are adequate, but I suggest that someone else might comment on this.

Mr. PICKLE. If they have the mobile laser, then it is adequate?

Dr. FLETCHER. I would rather research this and insert something later for the record.

[Information for the record follows:]

A proposal has been received from the University of Texas for the construction of a mobile lunar laser ranging station. We have not budgeted for this item in our Lunar Program. The proposal is being evaluated for possible future support.

Mr. PICKLE. The problem of the funds is critical, I think it is important as we concentrate on the shuttle and carry the program and not let the other science programs lag too much.

The CHAIRMAN. I would like to mention two or three things and then ask for a general comment.

First, the President asked for Congress to authorize an agency on energy. Then he appointed—or he wanted to create an Energy Office. There are 14 different committees or subcommittees working in Congress working in energy. OMB told us that you people would be the focus on this in the executive branch and they would contract with you for many parts of the energy research and development. We were also shown advertisements of the complete solar systems for homes for heating and cooling.

Now, your laboratories, those laboratories you have, how efficiently are they being used? We also hear that Mr. Simon tells Mr. Ash to take his cotton picking hands off energy. How organized or disorganized are we and what kind of progress are we making on these different aspects and different committees? Are we dragging our feet or are we slowing our feet? Are we making any progress?

Dr. FLETCHER. It is difficult to comment on how well organized the rest of the executive branch is on energy. The organization to handle energy R. & D. assigned to NASA has improved considerably. I have appointed Doctor Schmitt as my special assistant for energy. He is coordinating all of the energy R. & D. in NASA. He is also defining the work that we anticipate coming from other agencies. The current major energy R. & D. funding for 1975 will go to other agencies such as the Department of the Interior, the NSF and the Atomic Energy Commission. We expect that some of those funds will pass through to NASA. I think we are well organized to handle the energy R. & D. work, no matter which way things might go. I think the position of the administration is that a final decision will not be made until the ERDA bill is passed within Congress. All of the other plans are interim measures pending the passage of that bill. We are preparing at NASA for whatever mechanism arises.

The CHAIRMAN. There is no unanimous opinion here on the Hill. We do not know what type of legislation you will get. Has Mr. Simon told you to keep your cotton picking hands off energy?

Dr. FLETCHER. No, he has not told us to do that.

The CHAIRMAN. He has not? All right, go ahead, Mr. Bell.

Mr. BELL. I want to congratulate you, Dr. Fletcher, because this is the first time the budget has not been cut for NASA since 1965. I think this is very good. I also hope that the fact that you did not mention or discuss, except a small amount, the aeronautics or the aviation aspect in the statement, that this is not indicative of your feeling as to the importance of that area. Also, particularly I am thinking of the quiet engine. This becomes very important from my standpoint because of the international airport in my district.

Dr. FLETCHER. We do anticipate that the aeronautics' budget will increase over the years. The increase is not as fast as we predicted back in 1973 because of the large budget cuts. However, we feel it will increase with out requirements.

Mr. BELL. Thank you. I congratulate you.

The CHAIRMAN. Go ahead, Mr. Hechler.

Mr. HECHLER. Testimony before several of our subcommittees indicated that NASA has done considerable research on the development and utilization of coal. I think we all appreciate that. The near term answer to the Nation's energy needs lies in the development and utilization of coal prior to the coming onboard of the development of other forms of energy such as solar, geothermal wind energy, and other forms of energy. What could NASA do to concentrate efforts in such areas as improving safety in mining, and better utilization of coal by removing sulfur?

It would seem to me that the great research and engineering talents of NASA should be harnessed to concentrate on these problems. If you continue at the same low level of concentration and expenditure you may be able to solve some of these problems eventually. Then it will be, perhaps, too late. The critical need for safer and cleaner mining comes within the next few years.

Dr. FLETCHER. Do you want me to comment on the statement?

Mr. HECHLER. Yes. I would like for you to comment on the possibility of NASA's concentrating additional efforts in areas which could pay off in the near term.

Dr. FLETCHER. We have been interested in this for some time. NASA has provided technical assistance to an Academy of Engineering Committee on Mine Rescue and Survival study some few years ago and has also provided special consultation to an EPA sponsored project to investigate the problems associated with mining coal in an inert or oxygen-free atmosphere.

As a result of that study, the Department of Interior is interested in NASA's expertise in these areas, particularly in the area of automation of equipment, so that you could minimize the number of people that have to go into the deep mines. There is the factor of personal safety and reliability which we have had considerable experience with in the space program.

There is also the problem of life support systems in the presence of methane gas. This is another area where there is some interest. I think this is the Department of Interior's prime responsibility. We will work with them in whatever way they wish us to. I think this is an area where NASA can help.

I should add, since you mentioned the business of the gasification of coal, that we have worked with another group of people in the Department of the Interior in coal research in this area. Again, it is only technical support. There is no hardware involved. This could very well be a program of the future for NASA.

Mr. HECHLER. I hope I can enlist the support of the chairman and members of this committee to emphasize the developments in this area.

Mr. PICKLE. Is coal gasification a practical reality by 1980?

Dr. FLETCHER. I think there is not much question that it is a practical reality. There is, however, an economic consideration, and that depends on the price of natural gas and what it will be in 1980.

Mr. PICKLE. Is it possible for mining of coal such as strip mining?

Dr. FLETCHER. All we know is that coal can be used in much larger quantities than it is now being used; that is pretty well known. We also know that technically it is possible to gasify coal and to liquefy coal.

Now, as to how coal is brought out of the ground, that is a technical problem. There is deep mining and strip mining. Both of those can be used effectively with the application of appropriate technology.

Mr. HECHLER. There is eight times as much deep minable coal.

Mr. MILFORD. Would you yield?

Mr. HECKLER. Yes.

Mr. MILFORD. I would like to ask this question in a specific way: is NASA structured in such a way that it could manage all of the various types of energy research and development work by, one, coordinating basic research and coordinating practical or coal oil oriented research, and by contracting and managing demonstration projects and capable of establishing standards for production for the manufacturing of energy related hardware. Is that within your present structure?

Dr. FLETCHER. If you are talking about all energy R. & D., NASA is not now structured to do that. We have 10 centers that have capabilities for managing highly technological programs. However, we would have to reorganize at the headquarters level and at the project level in order to do a monumental task such as you described.

Mr. MILFORD. Is there agency organized to do this?

Dr. FLETCHER. Not to my knowledge.

Mr. MILFORD. Is there one that is best able to do this?

Dr. FLETCHER. I find it difficult to comment on that. As you know, the pending ERDA legislation would establish a lead agency for energy R. & D.

Mr. WINN. Would you care to comment on whether the problems associated with solar heating and cooling and wind conversion forms of solar energy are predominately basic research or the engineering development or materials research, that is, if it is this or that?

Dr. FLETCHER. I think it would not be correct to call this basic research. It is more exploratory development. It is possible that solar heating and cooling and wind conversion could be moved into advanced development and made ready for production. We are not in that state now in these areas.

Mr. WINN. What would the dividing line be in your opinion?

Dr. FLETCHER. I would say if we move to a prototype system that is economically viable, that this would be advanced development. If we are talking about demonstrating that a system can work and is in the right ball park from an economic point of view, that is more in the nature of exploratory development.

I think there is another aspect of advanced development which is important. That is, you have to be thinking about the way you are going to transfer this development into the private sector. Exploratory development has that in mind ultimately, but it is not part of the program.

Mr. WINN. We had a conversation with Roy Ash on this yesterday. OMB called the dividing line as the proof of concept, but I am trying to figure out if in your opinion, have we reached that point in this stage of the game?

Dr. FLETCHER. In our space and aeronautics programs we have not reached the proof of concept in all cases since we are doing basic research in many areas, such as in the area of our aerodynamic research, which could relate to windmills.

In the solar heating and cooling area the technology is probably between proof of concept and early or exploratory development. The

Langley facility that we are designing to accommodate solar heating and cooling falls in the gray area between proof of concept and exploratory development.

Mr. WINN. This came up yesterday because there were some commercial solar heating panels on display before the committee. I understand that the solar heating panel that has been installed in the NASA demonstration home at Huntsville, Ala. which the member of the committee saw about 1 month ago is shown on the wall. We are trying to figure out if that falls within the category of proof of concept. I understand that there are some per square foot prices shown or evaluated. There are some prices or decisions being arrived at.

Dr. FLETCHER. The demonstration system at Marshall probably could be ultimately described as a proof of concept for a total integrated system. Right now, however, it is intended to be more of a development test bed for testing the various pieces of the system. It could easily turn out to be a proof of concept for a total system. Again, this technology is in that rather gray area between proof of concept and development.

Mr. WINN. Would it be considered a prototype?

Dr. FLETCHER. Not a prototype because it is not a real house. The object of the Marshall effort is to test a number of experimental solar panels with the idea of getting the cost down and the efficiency up—a true development problem. We could then very well move that development to a prototype system.

Mr. WINN. That is one thing the members of this committee are having a hard time trying to figure out as to exactly what category the various experiments or prototypes or demonstrations of solar heating panels that we have seen would fit into.

Mr. FREY. We are also interested in when these are going to be available commercially. And how much will it cost to get them? I do not care what you call it. It seems like a bunch of doubletalk as to whether it is prototype or not. We want to know when they will get in line and when we can use them.

Dr. PETRONE. We think we have a first step in proof of concept. We have to expose this to the elements to see what deterioration takes place. We do not want to take an immediate step to put it into a house except an experimental house. As to commercial application, we had discussions with the industry. The panel was bought from industry. We are putting on a coating. We have a patent on this, and we are making it available.

Mr. FREY. Will we know in 1 or 2 years that we have this ability to do it in a significant number of homes?

Dr. PETRONE. I would say so. I would say within 1 year to 18 months. We are working on air-conditioning units with industry. We are working with industry to make improvements in the absorption system with heat and cooling. I think within 18 months we will have good baseline data.

Mr. WINN. The point was made yesterday that industry is waiting for the Government in the field of experimental prototypes. Do you think industry is really waiting? You say you have worked with them and are using part of their basic concept.

Dr. PETRONE. One hand has to lead the other. We are working with one of the companies which markets commercially a cooling system

with the absorption process. We are planning additional studies to make it even better. The product is not quite ready. It is a bootstrapping process with industry.

Mr. WINN. The point I am making is, the Government is proceeding, NASA is proceeding, in the solar heating panel and so is industry.

Dr. PETRONE. That is correct. We are using industry's ability to make those panels. We are working together.

Mr. WINN. Thank you, Mr. Chairman.

[Other statements submitted for the record follow:]

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

Mr. Chairman and members of the committee, the formulation of the FY 1975 Construction of Facilities (CofF) program essentially followed the same basic processes as did the FY 1974 estimates. The requests of the field Centers and appropriate activities were considered by the Institutional and Program Offices and were given wide staff analysis. The results of these actions were reviewed by the Facilities Review Board and senior management. The program presented in these estimates reflects the distillation, or program compression, resulting from these actions and reviews, as well as the final action taken by the Office of Management and Budget. Overall, this year, about \$350 million of requirements, as initially expressed by the field Centers, have been reduced some 50% to the \$151,490,000 now included in the FY 1975 estimates.

The trend that continues to be reflected in our CofF estimates is the significant portion devoted to space shuttle facilities. These facility requirements constitute well over half of this year's request as they did in FY 1974. This is in general agreement with our earlier time-phased projections of the shuttle facility needs, as revised to adjust to current program schedules and milestones.

At the same time, these estimates include some increase in non-shuttle facility projects but not one of undue magnitude in consideration of the very minimal FY 1974 estimate for these projects. The supporting programs of Rehabilitation and Modification and Minor Construction of facilities, as well as Facility Planning and Design activities are continued into FY 1975 at about the same level as for FY 1974.

This year's CofF program involves twenty-five (25) line item projects. Of these, fifteen (15) are for non-shuttle requirements estimated at \$35.17 million, and ten (10) are for unique shuttle needs estimated at \$86.02 million. Thus, of the total estimate \$121.19 million relates to these individual discrete projects, for which detailed documentation is presented describing the work planned and explaining the basis of the requirement. Cost estimates data and other documentation are also presented with the overall objective of fully justifying these needs. These line item projects constitute some 80% of this total request. Additionally, \$14.90 million is included to provide for the continuation of the facility Rehabilitation and Modifications program which was begun several years back and has been found to be so essential to the protection of our plant investment, and so effective in maximizing its utilization. As in the past, this program includes rehabilitation and modification work estimates to cost less than \$500,000. The estimates also contain \$4.50 million for minor new construction and addition type work estimated to cost less than \$250,000. Finally, there is a \$10.90 million requirement for facility planning and design. This latter amount includes \$4.40 million related to space shuttle facility planning and, this amount, when coupled with the included discrete shuttle projects, generates a total of \$90.42 million directly relatable to shuttle facility needs—about 60% of the total CofF request for this year.

The development of these estimates was enhanced this year by more advanced preliminary engineering and by requesting Program and Institutional Directors for initial CofF estimates in April 1973, which was much earlier than in prior years. These and other related actions have given us more lead-time and, we feel, have permitted us to accomplish a better review of both requirements and costs, and to evolve a very sound and balanced program reflecting our most urgent needs.

In our continuing actions to improve the management of our CofF, we have initiated efforts to revitalize and extend our five-year forecast and planning for facility work. It is our objective that this improved visibility will permit better budget planning, especially for the accommodation of the larger and clearly most essential requirements. This planning will also have many important by-products such as: (1) permitting the further advancing of facility planning to make it more

effective in the decision-making process, (2) making possible an earlier assessment of potential impacts resulting from the present energy situation and related factors, and (3) improving the basic soundness of our installation master planning.

As implied, in this total effort we have been working on moving our advance planning, especially the preparation of Preliminary Engineering Reports (PERs) as far forward as we can in a prudent and effective manner. These reports are most valuable in the clarification of the basic requirement for a given facility and the establishment of its relative urgency, as well as its best and most probable cost. Coupled with this is the continuation of our "value analysis" of appropriate projects during the design phase. This becomes more important in the light of the more fluid present situation with regard to materials and equipment availability, delivery lead times and projected costs.

Again, in FY 1975, the CoFF program is characterized by a predominance of facility modifications and additions indicating our continued emphasis on making maximum use of our available assets. Of the twenty-five (25) major projects, eighteen (18) are either modification or addition of what we have. For example, \$42.69 million of this request is associated with the conversion of Launch Complex 39A at the Kennedy Space Center from Apollo to shuttle use. This complex by itself represents a facility investment of some \$1 billion at today's prices (\$500 million "Book Value"). At the same time, in this work we are making every effort to use materials, components and equipment otherwise excess such as crawler transporters, test instrumentation and controls, and a launch umbilical tower for a pad service and access tower.

The fifteen non-shuttle facility projects included in these estimates are:

(a) *Ames Research Center, \$3,660,000*

Addition to Flight and Guidance Simulation Laboratory—The major short-coming of the existing simulator is its limitation on vertical motion. The simulator to be housed in the proposed addition to the existing Simulation Laboratory will supplement the existing capabilities by providing greater vertical displacement capabilities, together with high fidelity integrated simulation for the pilot. This added capability will meet pressing needs, especially in STOL and VSTOL systems to:

- (1) Help define acceptable height control in situations of degraded aircraft stability;
- (2) Improve the definition of automated landing modes;
- (3) Assist in the further development of airworthiness standards.

The availability of this augmented capability will go a long way in reducing the higher risk of prototype flight development and retrofit programs.

(b) *Goddard Space Flight Center, \$2,110,000*

This amount is made up of two projects. It includes \$890,000 for Rehabilitation and Modification of Science and Applications Laboratories, which provides for the rearrangement of office, laboratory and storage space, thus generating additional on-site accommodations for some of the activities now in leased space. This is closely meshed into a broad rearrangement program made necessary at GSFC as a consequence of progressive individual adjustments over the years which now require detailed appraisal and corrective action in light of today's situation and estimates for the future. This \$890,000 represents the first phase of this total effort and, when carried out, will permit the release of some 60,000 SF of leased space and the concurrent relocation on-site of some 300 personnel thus also providing for more effective operations for the activities involved.

The second project included here is one for \$1,220,000 for facility Modifications for Fire Protection and Safety. While considerable progress has been made in this area of improvements to fire protection and safety at GSFC over the past few years, it is considered important that those most critical deficiencies as reflected in this project be accomplished at an early date. The protection of personnel as well as spacecraft, experimental packages and "high value" equipment, such as computers, has been provided for by these modifications. This one-time effort will meet these critical requirements which now represent "high risks". Subsequent work of this nature can in all probability be accomplished on a priority basis as smaller Rehabilitation and Modification projects in following years' programs.

(c) *Jet Propulsion Laboratory, \$8,820,000*

This total for JPL is composed of three separate items. Included is \$150,000 for the acquisition of about 9.5 acres of land immediately contiguous with the Laboratory. On a portion of this land are eleven Laboratory buildings. The remainder is used for essential parking. This land has been under lease from the

City of Pasadena and as a matter of prudent management it is now felt appropriate to purchase this strip on the east side of the Laboratory as being in keeping with ownership and use interests.

The second project involved at this location is the Addition to the Systems Development Laboratory (SDL) for \$4,880,000. This addition is to be accomplished by adding six floors to the existing two-floor structure which was designed to take these added floors. The lower three floors will house essential Viking project mission operations and support activities. In the FY 1974 estimates we provided for the modification of space in the Space Flight Operations Facility (SFOF) and in the SDL for certain Viking mission control activities. Since that time, Viking mission planning has evolved in considerably more detail and requires the additional space as indicated. The expanded requirements, as a reflection of the simultaneous need to control the two orbiters and two landers for this MARS project, are most critical. This requirement has been coupled with the general housing shortage at JPL to also permit the relocation to the Laboratory of some personnel now in leased space. The upper three floors of this six-story addition will be devoted to this partial alleviation of the long-standing critical housing situation here. Despite the late evolution of this requirement, it was envisioned that the normal sequential acquisition process would provide at least the most urgently needed first three floors for Viking use by the "need date" of January 1976.

This was earlier recognized as a "tight" but realistic and feasible schedule. The subsequent development of delays and difficulties in steel delivery causes us deep concern and will require that we take many concurrent actions in order to do everything appropriate to insure the availability of this facility for Viking use.

The third project included is \$3,790,000 for an Addition for the Integrated Systems Testing Facility. This is an addition to the Spacecraft Assembly Facility (SAF) and would be used for new spacecraft assembly, checkout and integrated testings of spacecraft and their large radioisotope fueled thermoelectric generators (RTGs). The essential element of the requirement is adequate, properly-designed space for the so-called "all-up" systems testing of spacecraft and their larger RTGs. The improved clean environment will also permit assembly and checkout of deep space mission spacecraft and their RTG power units. The existing SAF will continue to be used in support of less critical assembly operations and as a staging area for subsystems and equipment, thus producing a greatly improved facility with enlarged overall capabilities, especially as to cleanliness and radiological shielding. This project will directly support and is essential to the Mariner Jupiter-Saturn (MJS) 1977 test program.

(d) Johnson Space Center, \$935,000

This modification of the water supply system at JSC basically reorients the present water source from ground water to treated surface water. Our ground water is now obtained from Government-owned on-site wells. The treated surface water will be purchased from the City of Houston and supplied through its newly-completed water line near JSC. The drawdown of ground water in the Houston-Galveston region, which our wells have contributed to, is felt to be the cause of very serious problems of land surface subsidence, salt water intrusion, and surface faulting. It is, therefore, necessary that we now take advantage of the expanded City of Houston surface water supply by connecting to it and arranging with local water authorities for our needed supply. This project will accomplish that objective and permit us to place our on-site wells in an "emergency standby" status.

(e) Langley Research Center, \$3,505,000

At Langley there are two projects which make up this total; one involving the 6000-psi air storage system, and one relating to the 16-foot Transonic Wind Tunnel.

The first of these, \$515,000, for the Modification of the 6000-psi Air Storage System, is a final phase of priority rehabilitation now in progress. This work provides a "thermal control enclosure" for the air storage "bottle field" to protect it from the degradation resulting from lower winter temperatures in the area. This enclosure will maintain a minimum storage environment of 60°F. Safety reviews of Langley facilities, which are critical from a personnel safety aspect, indicate that temperature constraints imposed by ambient levels below 60°F require that operating pressures be reduced. For a "normal" winter, this could mean a 50% reduction in capacity and consequent impact on the test activities of the 8-foot High Temperature Structures Tunnel and the Thermal Protection Text Facility served by this supply. The useful life of the system, as a consequence of this total facility effort, will be significantly extended.

The second project for \$2,990,000 is the Rehabilitation of the 16-Foot Transonic Wind Tunnel. This is a continuation of our efforts to update these large and valuable test facilities. This facility dates from 1941 and its present drive system from 1953. The main drive fan system and other critical ancillary components require major rehabilitation for continued safe operations. This planned program of rehabilitation and modification will preclude unscheduled major impediments to research due to breakdown, as well as minimize attendant hazards. In carrying out this work, it is now estimated that important research such as with transonic, aerodynamic and propulsion systems integration will only be off-line for eight months. However, on completion of this work, mainly involving the drive section, safe and effective continual operation of this primary research tool will be assured.

(f) *Lewis Research Center, \$3,240,000*

Again, this total is made up of two projects. The first, \$2,580,000, is for the Modification of the Propulsion Systems Laboratory (PSL).

This facility is most important in aircraft engine propulsion research with its ability to simulate high altitude flight environment. The PSL initially became operational in 1952 and subsequent improvements have been made in combustion air supply, exhaust capabilities, and in the provision of additional large altitude test chambers. The work proposed in this project increases the capability to refrigerate air and thus improve the operating capabilities to cover more critical portions of high altitude flight envelopes for better investigation of such engine characteristics as stall margin, compressor inlet distortion, combustor blowout, pollution emissions and afterburner ignition. The major elements of this work are the expansion turbines required for the refrigeration, and dryer and dehydrator equipment. This step in improving the PSL capabilities is a most significant one in terms of the relative scope of improved capabilities vs. investment, as well as in terms of critical need in aircraft engine research.

At Lewis, an additional \$660,000 is included in these estimates for Modification of the Rocket Engine Test Facility. This work basically adds high-pressure cryogenic propellant storage and distribution capabilities to an existing test facility. This is needed so that research on small rocket engines using LH_2 and LOX may progress. These engines will be needed for near-earth space vehicle stages and like missions of the future. To carry forward the technology advances needed in this area, the pressure capabilities of this test stand must be increased by adding the planned high pressure cryogenic system. The existing test facility is ideally located and sized for this experimental program.

(g) *Marshall Space Flight Center, \$4,060,000*

The single item involved in this amount is the Construction of an X-Ray Telescope Facility. This facility need is keyed to the testing of the HEAO-B flight mirror and x-ray detector assembly. It will provide the capabilities to verify, align and calibrate large x-ray focussing mirrors and detectors as a system. This must be done prior to the final assembly and integration of the HEAO-B spacecraft x-ray experiment package. There are no other facilities available for testing an x-ray telescope system of this size. This test facility will incorporate an existing building to provide the telescope instrument chamber and support areas. A remote x-ray source chamber will be connected to the instrument chamber by a 3-foot diameter vacuum tube some 1000 feet long so that spaceflight conditions can be most closely approximated. The prototype development testing of the mirror and the x-ray detector assembly is to begin early in 1976 to support the HEAO-B spacecraft launch scheduled in 1978. The lack of this facility could result in serious degradation of the scientific results from and performance of this mission.

(h) *Wallops Station, \$1,370,000*

This is for Modification of the Beach Protection System at the Wallops Island launch facility, facing the Atlantic Ocean. A portion of the existing seawall and groin system must be raised and strengthened to provide minimum protection from inundation resulting from heavy Atlantic storms. The early 1943 protection system was built to an 8-foot level above mean sea level.

Subsequent additions were made extending the system progressively to the north as experience proved necessary. In 1969 the height was increased to 10 feet and, more recently, to 12 feet. The 8- and 10-foot sections have suffered heavy damage and continue to erode due to wave and sea action. The more recent 12-foot section, however, has to date held up very well and, based on the best estimates now available, is felt to be optimum. This work will then raise the 18,100 linear feet of 8- and 10-foot seawall to the 12-foot level, and repair and strengthen the

existing underlying wall and supporting groin system. Without this work, there will be a very high risk of water breakthrough and damage to the Wallops Island assembly and launch facilities.

(i) Various Locations, \$7,470,000

This amount includes \$6,040,000 for the Construction of an Infrared Telescope at a location to have been designated when these budget estimates were proposed. Since that time, the site selection activities have been concluded and the site is now designated as being Mauna Kea, Hawaii. This project will construct a large-aperture ground-based infrared telescope on this mountain site. This will be for the observation of planets, their satellites and the study of their radiation which is mainly in the far infrared spectrum. This is necessary to provide basic data on the temperatures and surface characteristics of these planets and satellites which in turn, will be used to provide supporting and complementary data on these cold bodies, and thus optimize the scientific return of planetary exploration flight programs. This project is basically composed of two major elements: (1) an observatory building, and (2) the large infrared telescope. While the project was drawn and presented as "Location to be Designated," the cost estimate was based on the Mauna Kea site since it then appeared to be a most optimum site. Subsequent studies have confirmed this, both as to its infrared "seeing" capabilities, as well as its proximity to other astronomical support facilities. It is planned to have this facility available early in 1976 to permit resulting data to be used in the planning of the Mariner Jupiter/Saturn missions. For this purpose such data must be ready early in 1977. No existing telescopes provide this necessary capability for this and any follow-on outer planetary missions.

The second project in "Various Locations" is Modifications for Fire Protection and Safety at several of the Spaceflight Tracking and Data as well as Deep Space Network Stations. While this is the fifth increment of this program, it is the second and final major increment, the first having been in FY 1974. This FY 1975 request is for \$1,430,000 and it is mainly related to the installation of sprinklers and fire detection systems, as well as the improvement of water supply and distribution systems at these generally remote sites. This increment basically completes the priority work of this nature required at these important stations.

This completes a review of the 15 non-shuttle facility projects which total \$35.2 million. The remaining 10 discrete line item projects are for the support of the space shuttle and total \$86,020,000. These are an extension of the facility work previously provided for and result in a total for shuttle facilities, through FY 1975, of \$191.6 million for facility projects for this purpose. This represents approximately half of the total estimated facility requirement. In this regard, of significant concern to these space shuttle facilities is the overall target cost of \$300 million in terms of 1971 dollars, as previously established. As we indicated last year, this will probably translate into about \$400 million in actual or budget year dollars depending mainly on the details of ultimate time phasing and, of course, on the presently more critical uncertainties stemming from the energy situation and related factors. These include equipment fuel shortages and difficulties in materials availability such as with steel and cement. However, at present, while the internal composition of these estimates has changed somewhat with the evolution of the programmatic details, the totals indicated are still our "best estimates" and are considered as being sound estimates. We feel reasonably confident, despite the emergence of these latter energy-related "unknowns", that the unique CoFF shuttle facilities needed to achieve initial shuttle operational capability can and will be provided for these approximate "target cost" amounts.

The FY 1974 and prior years' shuttle facilities work is moving ahead in the design and construction phases. The initial testing of main engine components at the test facilities at Santa Susana, CA, will start shortly when the igniter/preburner test position is placed in operation. We have had problems here involving a series of materials availability difficulties and certain technical problems associated with the very high-pressure stainless steel piping systems. While these problems have been essentially overcome, it is now clear that additional costs will need to be incurred to complete the remaining test positions. We will shortly be advising you further on this matter. The research and development facilities for the shuttle thermal protection system will, for the most part, be operational this year. Work is moving ahead on the modifications of the A-1 and A-2 test stands at the Mississippi Test Facility for main engine testing, and will support the first engine firing scheduled next year. We anticipate that in the first half of this year work will be in progress on the first phase of the orbiter landing facilities at Kennedy Space Center. Other test, manufacturing and related shuttle facilities are likewise moving forward in support of specific shuttle program "need dates" or milestones.

The major portion of the FY 1975 estimates for shuttle facilities provides essentially for the completion of the orbiter landing facilities at KSC, and a first and major increment of launch capability at that location. This launch capability involves modifications of the Vehicle Assembly Building (VAB), modification of a mobile launcher, and Launch Pad 39A. This again clearly illustrates a continuing, salient feature of the shuttle facilities program, which is to make maximum use of existing assets by adaptation to shuttle needs.

(a) Orbiter Landing Facilities, KSC, \$15,880,000

This project provides \$10.9 million for the completion of the FY 1974 project which has been funded for \$17.3 million. It also provides additional funds for the construction of: (1) a landing aids control building of 4,500 SF to house monitoring, control and termination equipment for such systems as an automated landing system, airfield lighting and navigational aids; (2) supporting structures for the landing instrumentation system consisting of 8 small masonry buildings. These systems are required to support the navigational aids and the fully automatic microwave instrument landing system; and (3) the associated utility and site work to provide a usable landing facility for the space shuttle orbiter.

(b) Construction of Orbiter Processing Facility, KSC, \$13,380,000

A new facility is required at KSC for the safing and maintenance and checkout of the shuttle orbiter. It is also needed for payload integration and removal, as well as for thermal protection system refurbishment. These functions are most important and will consume about two-thirds of the total orbiter processing time. This facility consists of a large "high bay" clean and environmentally-controlled area, as well as a large "low bay" storage, shop and support area. The cost indicated for this facility also provides for the later expansion to meet planned future increases in shuttle mission activities. This facility will be located near the VAB on the tow-away from the landing facility to the VAB. In the safing operation, explosive actuators and hypergolic pods (RCS-OMS) are removed from the orbiter and hypergolic and main engine fuel lines must be drained and purged. In the normal operational sequence, payloads will be inserted, removed and checked out in this facility, as will the normal aircraft maintenance type operations associated with the orbiter.

(c) Modifications to Launch Complex 39, KSC, \$42,690,000

These modifications to Launch Complex 39 are necessary to provide space shuttle launch capabilities by the adaptation of these Saturn V/Apollo facilities. In this planning, two high bays of the VAB will be used for external tank operations, and the remaining two for mating, integration and checkout activities. This project provides only for the modification of two high bays; one for each of these purposes—i.e., one for the receipt, processing and storage of the shuttle external tanks which will arrive from the manufacturing site, Michoud Assembly Facility, LA. Structural modifications will be necessary to provide access and work platforms to service and check out these very large tanks. Major modifications are also necessary in the second "high bay" to support its use in the mating, integration and total checkout of the shuttle in its launch configuration. One of the three existing mobile launchers must also be modified to meet shuttle configuration and weight requirements. For example: the shuttle will require three instead of one major exhaust openings in the mobile launcher deck: two for the solid rocket booster, and one for the orbiter main engines, all of which must fire for launch. The umbilical tower of the existing mobile launcher will be removed and, along with its extensive essential support systems, will be reused to construct a fixed service and access tower at the launch pad. The electrical, environmental control, propellant, pneumatic and other systems must also be modified. The most significant element of this total project involves the modification of Launch Pad 39A.

The major features of this work are: (1) the construction of the fixed service and access tower previously commented on, (2) the construction of a service tower structure, (3) the construction of a new flame deflector, and (4) the modification of support systems such as covered for the mobile launcher with, in this case, the environmental control, fuels and electrical, communications and instrumentation systems being the larger tasks. Considerable detail on this total project is provided in the estimates and for this reason we have now only covered some of the major aspects and highlights. Completion of this FY 1975 modification to LC 39 at KSC will leave consideration of comparable work necessary for the support of higher launch rates, as well as the modification of the launch control center, to subsequent years.

(d) *Modifications for Dynamic Test Facilities, MSFC/Downey, \$3,920,000*

The major portion of this requirement provides for the facility modifications to the Dynamic Test Facility at Marshall Space Flight Center so that ground vibration tests may be conducted on the mated shuttle elements—the orbiter, two solid rocket boosters, and the external tank. During lift-off and throughout the launch profile, the vehicle will be subjected to complex, changing and large dynamic forces. These forces, or dynamic loads, must be evaluated and analyzed by the test program planned on full-scale flight-type hardware. Testing will also be accomplished on the orbiter and external tank, without the boosters, to provide data on the portion of the flight profile which takes place after booster separation. To provide for this, the 360-foot tall test bay must be enlarged, supports and suspensions installed, and a door enlarged to accommodate the orbiter. Access and work platforms must be modified, and utilities extended. Under the present concept, the orbiter will be flown into the Redstone Arsenal airfield and be towed to the test site. This project provides for anticipated airfield and road modifications so this may be done. It also provides for minor work at the NASA Industrial Plant, Downey, CA, for comparable but earlier ¼-scale testing.

(e) *Construction of Orbiter Horizontal Flight Test Facilities, FRC, \$1,940,000*

The horizontal flight testing of the shuttle orbiter will be accomplished at the Air Force Flight Test Center, Edwards Air Force Base, CA. This testing is necessary to verify and qualify the performance of the orbiter in its aircraft mode. This facility is essentially a flight test hangar needed to install test instrumentation on the orbiter, as well as conduct critical inspections, perform maintenance, and “weight-and-balance” activities associated with these test flights. This hangar facility will include lean-to shop space, and supporting pavement and utilities. The project also provides for accommodation of trailers to provide additional temporary space. While this basic facility is a unique shuttle facility requirement and since it is not possible to use other Air Force or NASA facilities for this purpose, it will have follow-on use by Flight Research Center at the conclusion of the shuttle horizontal flight test program.

(f) *Johnson Space Center, \$830,000*

This includes two separate projects: one for the Modifications for Crew Training Facilities, \$420,000, and the other for Modification of the Vibration and Acoustic Test Facility, \$410,000. The first of these provides facility modifications to the Mission Simulation and Training Facility to permit the installation of a Horizontal Flight Simulator and a Shuttle Mission Simulator computer and associated peripheral equipment. This is the first phase of work required to adapt this facility for shuttle crew training purposes. The second project replaces power amplifiers in the Vibration and Acoustic Test Facility to enhance the capabilities and reliability of this facility. This is necessary to insure that shuttle vibro-acoustic testing on components and fuselage sections can be adequately supported.

(g) *Construction of Materials Test Facility, WSTF, \$790,000*

This provides for the construction of a structure housing test cells for both hazardous and non-hazardous materials testing, a test preparation area and test control area at the White Sands Test Facility, NM. While safety of personnel is the main element in the justification of this requirement, it must be coupled with the magnitude of the impending peak in shuttle materials testing which will be carried out here. Existing facilities are very inadequate and substandard, as well as potentially unsafe. In order that these hazardous tests may be carried out in an efficient, reliable and safe manner, this more adequate facility is needed.

(h) *Modifications for Solid Rocket Booster Structural Test Facilities, MSFC, \$2,590,000*

This work, at Marshall Space Flight Center, will modify two facilities: the S-1B Dynamic Test Stand for the water submergence testing of the solid rocket booster, and the Static Test Tower West for other booster tests, including verification, proof and motor-case burst tests. Only a very minimum amount of work is required on the Dynamic Test Stand—mainly the provision of a water loading tank for the submergence testing. The Static Test Tower requires that the flame trench be extended and widened so that it can accommodate a new load frame. A new platform for stacking SRB segments will be provided. The test stand annex will also be refurbished, a new control system will be installed, and utility systems will be modified and extended. All of this work will be necessary to support the capability for full-scale testings of the SRB case and attachments.

(i) *Construction/Modification of Solid Rocket Motor Production and Test Facilities, \$4,000,000*

This provides for the modifications of existing facilities and/or construction of new facilities which are necessary to support production and tests of the solid rocket motors during the Design, Development, Test and Evaluation (DDT&E) phase of the program. The facility requirements for these functions are sensitive to the detailed plans of the solid rocket motor (SRM) contractor selected in November 1973. Award of this contract is being withheld pending resolution of a "protest". Only subsequent to an award can definitive SRM facility needs be delineated. This project is based on the most probable requirements of the selected contractor using earlier analysis and appraisals. This estimate is based on our preproposal discussions with tentative contractors, and is intended to cover the most probable needs.

This completes the shuttle facility projects included in the FY 1975 estimates. These, when coupled with the nonshuttle discrete projects, total \$121.2 million. To complete this total request, there remain: (1) the Rehabilitation and Modification program, (2) the Minor Construction program, and (3) the Facility Planning and Design requirements.

Rehabilitation and Modification of Facilities, Various Locations, \$14,900,000

This is the annual increment of these estimates associated with this type of work estimated to cost less than \$500,000. Included, on a priority basis, are both foreseeable institutional as well as programmatic needs. In keeping with the basic objectives of this centrally-managed program, we have insured that urgent and essential institutional type needs are adequately reflected to best protect the capital value and mission importance represented by our facilities. At the same time, we are sensitive to the need to improve the capabilities and usefulness of these facilities in terms of these mission needs. Since last year we have completed yet another phase of our evaluation of field installations for these rehabilitation and modification type needs. This phase covered the NASA industrial plants and certain component installations such as the White Sands Test Facility. This effort really completes our progressive evaluation in this matter and gives us basic data from which to plan as well as data which we can improve and update, especially as to cost and priorities, on a more-or-less continuing basis.

The submittal this year is distilled by a careful screening of work packages which initially totalled some \$37 million. The thrust of this total program is to overcome the cumulative effects of physical plant wear, deterioration and obsolescence. This year's program gives special emphasis to buildings, and lesser emphasis to utility systems. The work in this request is considered to be of the highest priority on the basis of relative urgency and the expected return on the investment involved. In the formulation of these work packages we have kept in mind the continuing task of preserving and improving our physical plant and, to the extent possible, enhancing its long-term utilization.

Minor Construction of New Facilities and Additions to Existing Facilities, Various Locations—\$4,500,000

This program is intended to provide for minor facility work of the addition or new construction type estimated to cost less than \$250,000. This program was newly incorporated into the CofF estimates in FY 1973 and is necessary to permit the undertaking of those minor new work type projects essential to improving the usefulness of our physical plant. This is achieved by responding to needed adjustments in utilization or minor augmentations of capabilities. Changing technologies and mission needs must be recognized and accommodated. The items of work included in this program and proposed for accomplishment in FY 1975 have been carefully selected from a list totalling about \$9 million. These items, as now presented, involve discrete work packages at specific locations. This year's submittal represents a further improvement over that for FY 1974 and is considered to generally reflect the real needs of this type. As with the rehabilitation and modification program in its inception, this minor construction program is becoming more effective and we are exerting major efforts to further improve its usefulness and overall value. It is also a vital element within the overall facility program.

Facility Planning and Design, \$10,900,000

This request supports into FY 1975 the continuation of the efforts involving master planning for field installations, the preparation of preliminary engineering reports, the accomplishment of facility siting and like investigations, the preparation of special facilities studies and reports, and the accomplishment of final facility design. As has been done for a few years now, this year's request is com-

posed of two elements: (1) regular requirements which mainly relate to our continuing and more general needs, and (2) other requirements which are somewhat special and are generated by exceptionally large and complex pending projects.

The \$3,900,000 requested under regular requirements involves the necessary planning and related work of this general type associated with our recurrent needs. This advance planning, including the preparation and revalidation of cost estimates and schedules, is a most important ingredient in our ability to improve our facility project documentation for budget estimates.

Our installation master plans are updated on the average of every three years. Certain facilities studies and specific engineering support have taken on added importance in recent years and this is reflected in the estimates.

In addition, each year it is necessary to prepare Preliminary Engineering Reports (PERs) and project studies related to proposed future facility projects. It is also necessary to provide for the preparation of designs, plans, drawings and specifications necessary for the accomplishment of future facility projects. In this FY 1975 request, there is \$450,000 included for PERs and \$2,550,000 for final design efforts, both associated with non-space shuttle facility needs.

In FY 1973 we first began, in a substantial way, to become involved in the planning and design work for the then emerging space shuttle facilities program. This program is of such a magnitude and nature as to justify separate consideration and for that reason its planning needs are reflected as special requirements under this Facility Planning and Design. There is a total of \$4.4 million included in this year's request for space shuttle facility planning activities. This includes studies, engineering support, and the preparation of preliminary engineering reports for upcoming projects, and the final design for the pending FY 1976 shuttle facility needs.

In addition, we have three planning efforts scheduled, all of which relate to large aeronautical facilities. These efforts total \$2,600,000 and included:

a. Final design for a High Reynolds Number Transonic Research Wind Tunnel to be located at Langley Research Center. This facility would support aerodynamic research on aircraft over a Mach number range of 0.2 to 1.3 at Reynolds numbers up to at least 50 million. An initial \$400,000 was provided in FY 1974 to undertake engineering and concept studies. An additional \$800,000 is now required for the final design effort.

b. Final design for the Provision of Additional Combustion Air for the Propulsion Systems Laboratory (PSL) at Lewis Research Center. As a major element in the planned future improvements of this PSL, additional combustion air is needed for the testing of future large aircraft engines. This involves large and expensive equipment which must be designed and selected at an early date so that appropriate cost estimates may be made and effective system engineering may be carried out. For this design effort, \$850,000 is included.

c. Final design for Modification of the 40×80-foot Subsonic Wind Tunnel at Ames Research Center. It has been proposed that this existing large tunnel can be greatly improved to meet long-range priority test needs by repowering it and by adding a "non-return" open-end test leg with a larger test section. This would produce higher speeds in the existing test section and provide a larger, lower-speed test section for full scale testing of large aircraft systems. This design is complex, again involves long-lead expensive equipment procurement, and cost is of important concern. For these reasons it is necessary to proceed with this final design effort for which \$950,000 is provided in these estimates.

It is appropriate at this juncture to briefly mention, however, our deep concern relative to the very fluid situation just emerging in overall construction activities. We are, therefore, proposing that the Section 2 authorization language for this year be revised to:

a. Raise the limit to which the cost estimate for an individual item may be increased from 5 to 10%, and

b. Permit this authority to be exercised by the Administrator or his designee as opposed to restricting it solely to the Administrator

Section 2 permits the exercise of this authority "to meet unusual cost variations" provided the total cost of all work, exclusive of facility planning and design, is not exceeded.

The proposed language revision addresses itself to the anticipated severe unknowns stemming from the present energy situation and related factors. It is our intent that the unknown, which can reasonably be based on experience, be adequately covered by our cost estimates as presented. Reasonable and prudent amounts have been included for normal construction contingencies and cost growth based on our experience to date. In all candor, we cannot, however, judge with any degree of accuracy what the future will hold in this regard. Fuels supply

to contractors and deliveries of materials such as steel and cement inherently now reflect much greater uncertainty than in the past. Rather than to further burden each project with an added "pure guess" factor and thus greatly escalate each such estimate, it was adjudged more prudent to increase the Section 2 percentage by a reasonable amount, at least as an initial reaction to this increasingly serious situation. The authority to permit a "designee" of the Administrator to exercise this flexibility is believed to be a sound management principle, in keeping with the magnitude and importance of the decision in relation to all the other demands on the personal time of the Administrator.

In summary, then, these FY 1975 estimates provide for a total of \$151.5 million for Construction of Facilities: \$35.2 million for 15 non-shuttle projects; \$86.0 million for 10 shuttle projects; \$14.9 million for Rehabilitation and Modifications; \$4.5 million for Minor New Construction; and \$10.9 million for Facility Planning and Design.

The documentation in the budget estimates is in considerable detail in keeping with our efforts to achieve full disclosure of all reasonable aspects of each project. Most of these projects are "time sensitive" to some degree. Each project was considered on its individual merits and relative urgency in support of its inclusion in this year's program. We feel that this is a sound and well-balanced program, responding to priority programmatic needs and at the same time including essential institutional requirements.

Mr. Chairman, this completes my prepared statement and I will now address any questions you or members of the Committee may have, or otherwise furnish any additional data or information which may be required.

STATEMENT OF JOSEPH F. MALAGA, ASSISTANT ADMINISTRATOR FOR INSTITUTIONAL MANAGEMENT, NASA

Mr. Chairman and members of the committee; The scientific and benefit-producing research and development programs which have been described to you are planned, directed, and substantially implemented by NASA's in-house workforce of civil service personnel. This workforce is supported by a broad range of services provided by on-site contractors. The pay and support of the civil service complement and the cost of general maintenance of the facilities they use make up the Research and Program Management appropriation, which I will discuss with you today.

With civil service pay and related costs traditionally comprising three-fourths of the R&PM appropriation, we have in recent years subjected the agency's manpower requirements to the most intensive study. In absorbing a personnel cut of one-third since 1967, our capacity to deal with the number and size of projects we once could has naturally been diminished. But we have emerged from successive reductions-in-force with essentially unimpaired capability to meet the major space and aeronautics challenges of the 1970's.

The retention of this capability has not come without severe strain. The combination of a series of reductions-in-force and severely restricted hiring of young people has forced up NASA's average age from 38.6 in June 1967 to 42.7 in December 1973. During the same period, employees under the age of 30 dropped from about 20% of the permanent workforce to less than 10%.

Our concern, however, is not merely for the numbers of our young employees, who represent our future capabilities, but also for their attitudes and motivations. A survey of our young professional employees last year revealed that to them, the most important factors in the NASA work environment were job security, opportunity for achievement of personal goals and creative environment. We believe that the concerns voiced by our junior professionals on these factors are attributable to the retrenchment-oriented mode in which NASA has been operating for several years. We are working to alleviate these apprehensions through a standing subcommittee on young employees. But the most important ingredient will be clear evidence of reasonable stability in our programs and employment levels.

We have worked very hard to gain a full understanding of our institutional manpower needs and how to meet them. We have conducted comprehensive reviews of past manpower trends and analyses of the interrelationships of workload, staffing, and cost. The results of these studies were reported to the Committee in past hearings. During the last year, we continued exhaustive manpower reviews, center by center, directed to future requirements. I believe that a model review was performed at the Marshall Space Flight Center in the course of developing the budget and manpower decisions for the coming year.

This review covered not only manpower but all other facets of institutional support as well: from telephones and office space to highly sophisticated laboratory instruments and technical facilities. Nothing was overlooked and the results are impressive. Significant reductions have been or will be made in the planned inventory of facilities and equipment, office space, manufacturing and assembly areas, warehouse area, vehicle and mobile equipment and telephone lines and telephone instruments. In addition, it was our judgment that a further reduction of 354 civil servants should be made in FY 1975 which together with comparable reductions in support services contracts would bring Marshall's workforce substantially in balance with the approved workload.

We began with the Marshall Space Flight Center because the phase out of major operations with Saturn/Apollo hardware created a more immediate need there. However, we will conduct similar reviews at all other centers within the next six months.

We have learned from our experiences with extended manpower adjustments. We have reached an understanding with the Civil Service Commission on the implementation of the regulations governing the protection of personnel involved in bona fide training and development programs. Although we were forced to discharge large numbers of employees at times when other agencies and private employers were taking similar actions, we have found, through an aggressive out-placement program, productive employment for the overwhelming majority of NASA employees separated involuntarily: over 1200 placements for approximately 2000 separations since 1970. Our placement rate last year, nearly 80%, was the highest and is especially gratifying.

The FY 1974 budget plan for NASA was based on reducing 1,880 permanent civil service positions. The reduction was in two parts: During FY 1975, 382 positions were abolished, with the phase-out of the nuclear propulsion and power program at the Lewis Research Center and the termination of operations at that center's Plum Brook Station. The major portion of the reductions (1,498) is being taken in this fiscal year by completing the closing of the Plum Brook Station (a total of 660 at Lewis for both years), and making planned reductions of 1,220 based on specific programmatic changes at our other installations.

The planned reductions at the Johnson Space Center, Kennedy Space Center, Ames Research Center, Langley Research Center, Goddard Space Flight Center, Wallops Station and NASA Headquarters have already been or should be accomplished through normal attrition. At this time reductions-in-force are planned as follows:

1. At the Marshall Space Flight Center an overall reduction of 650 is planned. At this point, normal attrition has reduced the complement by over 250. The balance of this reduction will be accomplished largely through involuntary separations (RIF), since normal attrition will not be sufficient.

2. At the Lewis Research Center, the phase-out of operations at the Plum Brook Station is continuing and should be completed by June 30, 1974. On this schedule, between 200 and 250 people will be separated. However, there is a possibility that some facilities there will be required to support research and development programs of other agencies. If this is the case, NASA will retain about 50 people to operate the required facilities.

These installations plan to identify the specific positions to be abolished by early spring. Because it is NASA policy to make maximum use of voluntary separations in adjusting our workforce to the desired size and mix, the final decisions on exact numbers of employees to be affected will be delayed as long as possible, but in any case reductions will be accomplished by June 30, 1974.

We believe that following the actions planned for the remainder of FY 1974 and FY 1975, we will have achieved a balance between workload and staff. We would then anticipate a period of employment stability that will enable us to further enhance our capabilities, rejuvenate our work force with a modest but steady infusion of young talent and make our workforce more representative of our population by vigorous recruitment and development of minorities and women.

For FY 1975, we are requesting \$749,624,000 for R&PM. The civil service strength will fall by 354 to 24,616, representing a stable posture everywhere except at the Marshall Space Flight Center. In four of the five functional categories we are requesting less money than in 1974.

Personnel and related costs is expected to decrease by \$3.5 million, primarily because of the savings in FY 1975 resulting from the reduction of 1,880 permanent civil service positions by the end of FY 1974 and the partial year effect of the FY 1975 reduction at MSFC.

Management efforts to reduce travel costs are expected to result in a net reduction of \$800 thousand. The principal savings are to be realized at the Johnson Space Center, where administrative travel will be reduced about \$100,000; at the Kennedy Space Center where motor pool operations will be reduced by almost \$300,000 commensurate with reduced launch activity; and at the Marshall Space Flight Center where there will be a cut of about \$500,000 related to the completion of the Skylab program. There is some rise anticipated for the intensified schedule of meetings with USSR personnel on the Apollo-Soyuz test project.

A substantial increase for facilities services is necessitated by Public Law 92-313, requiring that, effective July 1, 1974, the General Services Administration be reimbursed for space occupied in GSA buildings. The bill for the year will be \$5.2 million. Higher rates for utilities and cost increases for facilities support contract services at Kennedy and Johnson Space Centers bring the total facilities services increase to \$9.4 million.

The end of Skylab operations support at JSC and GSFC helps make possible a cut of \$165,000 in technical services.

Administrative support requirements decline by \$41,000, largely due to the staff decreases at Marshall Space Flight Center and Lewis Research Center.

The R&PM needs of our centers have been outlined in subcommittee hearings. The following table summarizes the distribution of Headquarters requirements and the changes from FY 1974 to 1975:

SUMMARY OF RESOURCES REQUIREMENTS FUNDS

Functions	1973	1974	1975	Change in 1975
Personnel.....	\$42,299,000	\$44,880,000	\$43,914,000	-\$966,000
Travel.....	2,291,000	2,565,000	2,615,000	+50,000
Facilities services.....	470,000	327,000	4,240,000	+3,913,000
Technical services.....	9,951,000	9,988,000	10,647,000	+658,000
Administrative support.....	6,556,000	5,788,000	5,917,000	+129,000
Total, fund requirements.....	61,567,000	63,548,000	67,333,000	+3,785,000

Our largest cost item, personnel, will be down by almost \$1 million as a result of the full year effect of the 1974 staff reductions, lower spending on temporary positions, and a reduced billing from the Labor Department for NASA-wide Workmen's Compensation. The full-year effect of the October 1973 General Schedule pay raise prevents this saving from being even greater.

Headquarters occupies most of the space subject to the aforementioned new statutory provision on reimbursement to GSA. This is almost exclusively responsible for the increase of nearly \$4 million in facilities services, an item which cost us less than 1/2 of a million dollars prior to the new law. Surveys are under way to get us out of as much rental property as possible and thereby minimize this expenditure in future budgets.

An increase in our Scientific and Technical Facility's publications and a realignment of its obligations account for an increase of roughly \$650,000 in technical services. Updating of safety publications, interpreter support, and anticipated equipment and component requirements cause a rise of \$129,000 in administrative services, while the intensification of joint US-USSR meetings on the Apollo-Soyuz Test Project will necessitate an increase of \$50,000 in travel.

Our overall outlook is more optimistic than it has been for some time. We have come a long way in the last year or two in understanding and reducing our institutional resources requirements and we regard this as a continuing challenge.

STATEMENT OF DR. DUDLEY G. MCCONNELL, ASSISTANT ADMINISTRATOR FOR EQUAL OPPORTUNITY PROGRAMS, NASA

Mr. Chairman and Members of the Committee, by way of introduction, my position is that of Assistant Administrator for Equal Opportunity Programs in NASA. As such, I am the senior NASA official regarding EEO policy and programs. I report directly to the Administrator. The position which I hold was created at the time of my appointment, April 16, 1973. Thus, I have been directing this program just under a year. The creation of my position was part of a reorganization which raised the organizational placement of EEO Programs within NASA.

I am pleased to have this opportunity to discuss NASA's Equal Opportunity Program with you this morning.

The goals of the NASA Equal Opportunity Program are:

1. The removal of discrimination in fact and appearance; and
2. The implementation of affirmative action programs ensures the broadest possible participation of women and members of minority groups in NASA programs.

These goals apply to the two principal Equal Employment Opportunity (EEO) functions within NASA:

1. The internal EEO program for NASA's civil service employees; and
2. The Contract Compliance Program for NASA's contractor employees.

There are other NASA programs which contribute to the opportunities which NASA affords minority communities. The full statement I have supplied for the record outlines two of these programs, the NASA Minority Business Enterprise Program and the research program at predominantly minority universities. Both of these programs have made noteworthy progress.

THE MINORITY BUSINESS ENTERPRISE PROGRAM

Considerable achievements are being made in the NASA Minority Business Enterprise Program. During FY 1973 NASA awarded \$8.5 million in contracts set aside for minority enterprises. This represents 3.9 percent of the total of such awards by all Government agencies. In FY 1972 the comparable percentage was 2.1 percent. Since the initial contract awarded in June 1970, NASA has channeled a total of \$13.2 million to minority firms as follows:

Fiscal year	Contract actions	Value
1970.....	3	\$76,909
1971.....	41	1,399,530
1972.....	68	3,222,050
1973.....	105	8,514,542
Total.....	217	13,213,031

NASA's stated goal for 1974 is to award \$11. -million in contracts set aside for minority firms.

Attached as Exhibit 1 is a comparative analysis of minority contracts by civilian agencies of the Federal Government for the period FY 1969 through FY 1973. It indicates that among twenty-five such agencies, NASA ranks fifth in total dollars awarded. My office has worked and continues to work very closely with the Minority Business Office.

RESEARCH PROGRAMS AT PREDOMINANTLY MINORITY COLLEGES

Again in close coordination with my office, the NASA Office of University Affairs has greatly increased its research grants to predominantly minority colleges and universities. This will help to develop a pool of qualified candidates in research from which NASA can recruit. The dollars involved and the number of universities are as follows:

Fiscal year	Amount	Universities
1969.....	\$358,000	7
1970.....	649,000	15
1971.....	829,000	17
1972.....	897,000	20
1973.....	1,378,000	25
1974 (estimate).....	2,000,000	45

I will proceed directly to the formal EEO program and begin with the Contract Compliance Program.

CONTRACT COMPLIANCE PROGRAM

Since 1970 NASA has had responsibility for the EEO compliance of NASA contractors operating on or near NASA Centers. Unlike some other agencies, NASA does not have industry-wide compliance responsibilities.

The organization of NASA's Compliance Program reflects the nature of its compliance responsibility. There is a Contract Compliance group on the EEO staff at each installation to conduct the compliance operation for those contractors on or near the installation. The only exceptions are Flight Research Center, where the contractors are monitored by the Compliance staff at Ames Research Center, and NASA Headquarters where these contractors are monitored by the Compliance staff at the Goddard Space Flight Center.

NASA currently has responsibility for 260 contractors employing some 45,219 employees as of December 31, 1973. The Agency Compliance staff numbers 22 professional positions—including the Compliance Division of the Office of Equal Opportunity Programs (OEOP). Data recently published¹ by the Department of Labor show that NASA expends the most hours-per-contractor employee of any compliance agency. NASA also expends the most staff time per contractor review. This is partly due to the local nature of NASA's compliance responsibility but nevertheless indicates a desire to do thorough, effective compliance reviews—the heart of the compliance function. How well has NASA performed this function to assure participation of minorities and women in the contractor work force?

Uniform and consistent statistics on the contractor work force have been gathered since 1971. This data is summarized in Exhibit II. There has been a continuous increase in the number of minorities employed even though the overall work force has decreased. Minority employment went from 11.8 percent to 15.0 percent of the total (a net increase of 763 positions) while the total number of jobs decreased by over 6,000. There have been notable increases in minority percentages among Officials and Managers (3.4% to 5.4%); Professionals (5.9% to 8.1%); Technicians (10.2% to 15.5%); and other white collar jobs.

The proportion of female employment increased from 15.7 percent to 19.0 percent (a net increase of 560 jobs) despite the overall decrease of 6,000 jobs. Here, too, there were noteworthy increases among Officials and Managers, (2.1% to 3.9%); Professionals, (5.5% to 8.4%); Technicians (8.5% to 11.6%) and other white collar jobs.

The only percentage decreases took place among Unskilled Laborers for women and Service Workers for minorities. These are the two lowest labor categories and, in all candor, we have concentrated our efforts to increase the participation of women and minorities in the higher labor categories. These aggregate statistics show appreciable progress but how do we judge the performance of an individual contractor?

Key to this judgment are the numerical goals and time-tables which the contractor develops and includes in his Affirmative Action Plan.

Government-wide policy on the interpretation and implementation of numerical goals was outlined in a policy statement by Robert Hampton, Chairman, U.S. Civil Service Commission; Stanley Pottinger, Assistant Attorney General; William Brown, Chairman, Equal Employment Opportunity Commission; and Philip Davis, then Acting Director, OFCC. They stated that a goal is a numerical objective fixed realistically in terms of the number of vacancies expected, and the number of qualified applicants available in the relevant job market.

To achieve aggressive goals, we encourage contractors to:

Conduct extensive recruitment drives including the use of recruitment consultants and advertising in media oriented toward women and minority groups.

Offer fully competitive salaries needed to attract necessary qualified persons.

Use the full amount of flexibility within company hiring and retention policies.

Thus, the determination of an individual contractor's compliance is based on a judgment of his good faith efforts. The compliance staff reviews the aggressiveness of the goals in terms of the projected hiring and turnover rates, progression patterns, and so forth. Then there is a judgment of how hard the contractor works to achieve the goals.

In NASA, the Compliance staff on site at each field installation continually monitors the contractors at that installation to insure their compliance. NASA practice is to review each contractor at least twice a year to see that the contractor is living up to the commitments he has made. This continual surveillance is possible because of the local nature of NASA's Compliance responsibility. This practice of continual surveillance is, as far as I know, unique in government.

To summarize, the field compliance staff monitors the contractors at their installation.

¹ "Federal Contract Compliance Planned Program" published by DOL/OFCC November 9, 1973.

The Contract Compliance staff of my office provides expert training, guidance, direction, and coordination to the field staffs. For example, the field staffs attended a four-day training seminar here in Washington this past fall. The purpose was to bring the staff up-to-date on recent Office of Federal Contract Compliance (OFCC) regulations, interpretations and data requirements.

The Department of Labor has recently issued revised data requirements and procedures for conducting compliance reviews. Therefore, it will be necessary to conduct a follow-up training seminar for field compliance staffs—probably at one of NASA's centrally located installations.

In addition to training, the Compliance Division of my office issues day-to-day guidance and direction to the field. For instance, final determinations of compliance are made in the OEOP Compliance Division after review of the on-site reviews and data assessments done locally. Thus, the Compliance staff of my office is ultimately responsible for NASA's Compliance progress.

The year 1974 will see the implementation of a special affirmative action hiring plan for Shuttle construction of facilities at the Kennedy Space Center. Our aim is to assure the utilization of minority employees on the construction work force. To that end, hiring goals have been included in the bid conditions and contractors wishing to participate in the project will have to accept those goals. The goals so far developed apply to the earth-moving portion of the construction. Our task this year will be develop goals for the remaining more complex portions of the project.

This goal development project is being conducted by Mr. Guy Arnett, the most experienced compliance officer in NASA. Mr. Arnett has been in the compliance program since 1963.

In addition to all of the responsibilities mentioned above, all appointments to the field EEO staffs, including the compliance staffs, must have the concurrence of my office. This summarizes NASA Compliance Program. Now to the Internal EEO Program for civil servants.

NASA'S INTERNAL EQUAL OPPORTUNITY PROGRAM

Introduction

NASA currently has the lowest percentage of minorities of all government agencies. The incidence of women in professional categories is also much lower than the rest of the federal government. While it is true that the NASA work force is quite different from the rest of the government; and while it is also true that NASA has been in a reduction mode since 1967 (having decreased our employment from over 34,000 to under 26,000); it is nevertheless true that NASA should be well ahead of its current position.

Let me repeat that NASA must urgently move forward. Let me also place in perspective the challenge which NASA faces as it sets out to move ahead. Engineers and scientists make up about 47% of the NASA work force compared to about 15% government-wide. Blue collar trades are about 6% of NASA's work force compared to 36% government-wide. It should be noted that across the nation about 3.5% of the engineers and scientists are minority and within NASA about 3.4% are minority. Across the nation 3.4% are women, in NASA about 2.5% are women. In both cases NASA is close to the national average but we should still do much more. Certainly, all of our positions are not technical and we must move ahead in the non-technical areas too.

As we review the historical picture, we see that NASA missed golden opportunities to broaden its work force during the period of its growth—during the early sixties. And indeed even before that as the NACA. Since 1967, NASA has been in almost continuing reductions-in-force.

Over the last two years NASA has shown some small progress even though NASA has been in a reducing mode. Of the hires that were made, minority hires well exceeded the current minority percentages. The record of minority hires by fiscal year has been as follows: 10.3% in 1971, 13.2% in 1972, and 16.3% in 1973. As a result of these new hires and with the overall reduction of people, the minority percentage of permanent employees has increased as follows:

	<i>Permanent</i>
June 1972	4.7
June 1973	5.2
December 1973	5.5

It is nevertheless obvious that NASA urgently needs a greater rate of progress. The differences in work force composition between NASA and other agencies should not be seen as obstacles but rather as challenges. These differences point out the directions in which we should move. The challenges become the objectives

of the EEO program. As I have said, these statistics represent an accumulation of past practices. It is the role of the EEO program now to help change those statistics.

Current Programs and Future Plans

Out of a sense of urgency that NASA must drastically speed up its EEO progress, we have elevated our EEO program to the top level of Management Objectives in NASA's management system. This means that progress toward our Equal Opportunity goals is now receiving the same close and continuing attention of NASA top management and the entire NASA management structure as NASA's major technical objectives. I will say more about the involvement of NASA's line management in the EEO program later on. In terms of Agency Management Objectives, specific EEO milestones for calendar year 1974 are:

To achieve at least 6.1% minority employment.

To place at least 80 minorities in professional positions.

To place at least 80 women in professional positions.

To present a Technology Transfer Seminar to minority businesses.

To prepare affirmative action hiring goals for Shuttle construction of facilities in FY' 75 and beyond.

The achievement of these minority and female hiring goals will call for 20% each of expected professional and non-professional hires to be minority and 20% of the professional placements to be women. This should be compared with NASA's hiring performance in FY' 72 when 7% of the professional hires were minority and 10% of the professional hires were women. Thus the goals for CY 1974 will require dramatically increased efforts all across NASA. I will come back to this point when I discuss NASA's recruitment programs.

NASA's aim in presenting the Technology Transfer Seminar is as follows: We in NASA have had a technology transfer program for about ten years to help space technology to find useful applications in the national economy. There is, however, a need to devote more attention in the program toward minority businesses. Thus we have developed an arrangement with the Office of Minority Business Enterprise (OMBE) of the Department of Commerce. Under this arrangement, NASA (and hopefully other government agencies) will display technology developed in various mission programs, and present various methods such as patent waivers, licenses, and so forth by which business persons can gain access to that technology. OMBE will then explain its resources for assisting in financing, market studies, and other product development areas. Our joint aim is to assist minority businesses to make the transition from providing services to manufacturing marketable products.

Now I will describe some of the programs NASA is conducting to assist in achieving the milestones.

Coordinated Recruitment.—The Office of Personnel has developed and is implementing an Agency-wide recruitment program specifically aimed at identification and recruitment of minority and female candidates for professional positions in NASA. A full-time staff in Headquarters will coordinate this effort. Six field centers have regional responsibilities. Teams of recruiters, including minority and female employees, will be involved in contacting potential candidates, counseling them in Government hiring procedures, assisting them to take the steps necessary to establish eligibility, and, of course, selling the candidates on joining NASA.

Cooperative Education (Co-op) Program.—Under this program, students alternate semesters at school and working at a NASA installation. The work experience augments their formal study. The Co-op Program has, for a long time, been a prime source of highly qualified employment candidates for NASA. We see the program as helping to increase the flow of minorities and women into technical fields where there is a current scarcity. Thus NASA has sought to increase minority and female participation in the program. Our enrollment statistics on minorities and women have been as follows:

[In percent]

	June 1972	June 1974 (projected)
Minorities.....	12.2	24.3
Women.....	9.4	16.9

We have increased the number of predominantly minority schools participating in the program from 16 in 1971 to 44 in 1973.

The overall size of the program is increasing like this:

Enrollment:

Fiscal year:

1973.....	719
1974 (projected).....	798
1975 (projected).....	950

Upward Mobility Program.—In addition to recruitment from outside, we also seek to move current employees to higher positions in NASA. NASA has received Civil Service Commission approval of three specific programs—Specialty Training for Entry Professionals (STEP), Growth Opportunities (GO); and CROSSOVER. These programs will allow persons to move out of dead-ended jobs and enter other jobs which have opportunities for career enhancement. Commission approval allows NASA to waive certain experience criteria in selecting people for Upward Mobility positions. The STEP and GO programs have been conducted at NASA Headquarters. During CY 1973, about 8% of Headquarters professional placements were made through Upward Mobility. The Affirmative Action Plans of all of our field installations call for implementing combinations of the programs during 1974.

Identification of Women and Minorities for Management Development.—A special effort is underway to identify persons for management development training. Listings of female and minority employees will be maintained by our Management Development Education Panel. The Panel, the Office of Equal Opportunity Programs, and the Young People's Subcommittee of the Personnel Management Review Committee will all identify training programs and opportunities for persons identified.

Finally, there are two new pilot programs I would like to mention.

The National Aerospace Fellowship Program.—The aim here is to encourage minority and female students to undertake aerospace careers. Thus NASA will award 20 scholarships of \$2,500 per year to Junior and Senior college students. The students will be invited to spend two summers working at a NASA laboratory—again to augment their academic training. This program was just recently approved and we are working out arrangements with several universities right now.

NASA Graduate Internship in Aerospace Technology.—Our Ames Research Center is conducting a small pilot program in conjunction with several nearby universities. Under this program outstanding, graduating, college seniors, specifically including minorities and women, will be selected for two years of graduate study and employment at Ames. During this period they will work in professional science or engineering positions and also earn a Master's Degree. They will spend brief periods at other installations to learn the full range of NASA programs. At the end of the two-year period, successful graduates of the program will then enter a broad range of programs throughout NASA and will have the opportunity to compete for advancement to leadership positions, including astronauts when selections of future astronauts are made.

In addition to these specific programs, we have taken significant steps to prepare NASA's infra-structure for greater EEO progress. We have broadened the composition of several key committees and boards:

The Personnel Management Review Committee now includes a minority and a woman;

The Management Development Education Panel now includes three employee members. The total panel includes two women and two minorities; and

The Incentive Awards Board will include the Federal Women's Program Coordinator and the Assistant Administrator for Equal Opportunity Programs.

Here in Headquarters, we have formed an Employees EEO Advisory Group composed of employee elected representatives to meet periodically with the Administrator to make him directly aware of their views.

Just as importantly, we are involving line management directly in the planning, implementation, and monitoring of the EEO Program. Under NASA's new organizational structure, the Associate Administrator for Center Operations will be responsible for implementing EEO policy and programs for reporting the

results of the programs to the Administrator, and for participating in the assessment of NASA's progress. By this means we aim to get EEO accountability on the shoulders of Agency line management who do the hiring, the promoting, and the expenditure of resources. Consequently, accountability will flow downward from the Associate Administrator for Center Operations to the Installation Directors, Managers and Supervisors.

To further motivate and involve middle level line management, we are implementing a system of Unit Action Plans. Thus, in addition to the formal Agency and Installation Affirmative Action Plans, major organizational units within installations will also develop Action Plans keyed to the hiring, promoting, and training requirements and capabilities of their units. These unit managers will then individually be accountable for EEO progress. Unit managers will thus be motivated to take part in EEO planning and monitoring.

Finally, to close the management loop, we have formed an Agency Equal Opportunity Council to consist of the Deputy Center Directors, the Agency Federal Women's Program Coordinator, four employee representatives and myself. This council will serve to develop and implement EEO policies and programs and to keep Center management informed on the various initiatives.

That is quite a long list of programs. During the remainder of the year, I do not expect any more new initiatives but rather I expect to concentrate on implementing and solidifying our new gains. We have lots of internal areas to work on such as staffing and training which, though not glamorous, are essential to a well-run program. For instance, we will hold an Affirmative Action Plan Development and Implementation Workshop later this spring. Deputy Center Directors will attend and bring the key members of their EEO and Personnel staffs to the workshop. Out of this we hope to build more effective EEO planning, programming and management teams across the Agency.

Again, on building the infra-structure of our program, we must make sure that our initiatives are relevant to the special concerns of women and the Spanish-surnamed—these are special emphasis portions of the NASA EEO Program. Let me outline these areas briefly. Regarding the Federal Women's Program: A Full-time position has been established in my office, in addition to the Federal Women's Program Coordinators at each NASA installation. These Coordinators meet with and counsel the women at their Centers; they participate in the development and implementation of Affirmative Action Plans; they receive discrimination complaints; and in many instances they coordinate Women's Program Advisory Committees in each Center.

Regarding our 16-Point Program: A full-time Spanish speaking Coordinator position has been established in the Office of Equal Opportunity Programs, with Agency-wide scope and responsibility. Coordinators have also been appointed at each of our field installations to assure that all of NASA's EEO programs and policies are relevant to the concerns of Spanish speaking Americans. NASA has conducted training seminars for these coordinators in conjunction with the Civil Service Commission and the League of United Latin American Citizens (LULAC).

Just as importantly, Spanish speaking personnel are joining the professional EEO staffs at NASA field installations in positions not exclusively related to the 16-Point Program. Five Spanish speaking persons entered full-time EEO positions in the last six months. NASA's intention is to conduct a comprehensive, coordinated, and integrated Equal Opportunity Program, rather than separate programs in which various ethnic or cultural minorities would compete for resources and management attention.

NASA has also made a special effort to recruit at universities having significant numbers of Spanish-surnamed students. During 1973, 16-Point Program Coordinators participated in Government Career Information Days at the following universities: New Mexico State, Las Cruces, New Mexico, University of Texas, El Paso, Texas University of New Mexico, Albuquerque, New Mexico Highlands University, Las Vegas, New Mexico.

Mr. Chairman, you will note that NASA has neither excused its performance nor simply promised to do better. We have rather reported on specific programs and initiatives. We in NASA see the current situation as an urgent challenge. Our aim is to increase substantially the participation of women and minorities in all of NASA's programs. That is the basis on which we expect to be evaluated.

Mr. Chairman, this concludes my statement.

EXHIBIT I

SECTION 8(a) MINORITY CONTRACTING—A PERCENTAGE OF TOTAL 8(a) CUMULATIVE AWARDS FOR THE PERIOD
FISCAL YEAR 1969 THROUGH FISCAL YEAR 1973

[Dollar amounts in millions]

Civilian agencies	Total 8(a) awards	Percent of total awards
Agriculture.....	\$5.3	2.3
Atomic Energy Commission.....	.8	.3
Civil Service Commission.....	.2	.1
Commerce.....	7.5	3.2
Equal Employment Opportunity Commission.....	1.0	.4
Executive Office of the President.....	.4	.2
Environmental Protection Agency.....	2.0	.9
General Services Administration.....	82.8	35.2
Health, Education, and Welfare.....	23.7	10.1
Housing and Urban Development.....	1.5	.6
Interior.....	3.2	.4
Internal Revenue Service.....	.02	—
Justice.....	.7	.3
Labor.....	6.5	2.8
National Aeronautics and Space Administration.....	13.2	5.6
National Bureau of Standards.....	.02	—
National Weather Service.....	.05	—
Office of Economic Opportunity.....	6.6	2.8
Post Office.....	5.8	2.5
Redevelopment Land Agency.....	1.5	.6
Small Business Administration.....	1.4	.6
State.....	1.1	.5
Department of Transportation.....	42.3	17.9
Treasury.....	.3	.1
Veterans' Administration.....	27.3	11.6
Total.....	235.19	100.0

Note: This chart presents a comparative analysis of sec. 8(a) contracting as a percent of the total 8(a) cumulative awards for all participating civilian agencies of the Government. It covers the period fiscal year 1969 through 1973, inclusive. It indicates that among 25 participating civilian agencies, NASA ranks 5th in total dollars awarded.

Source: Small Business Administration, status report of 8(a) contracts, dated July 1973.

EXHIBIT II

SUMMARY OF CONTRACTOR WORK FORCE DATA

Total employment:	
Dec. 31, 1971.....	51,275
June 30, 1973.....	47,531
Dec. 31, 1973.....	45,219

EMPLOYMENT OF MINORITIES (IN PERCENT)

	Dec. 31, 1971	June 30, 1973	Dec. 31, 1973
Officials and managers.....	3.4	4.8	5.4
Professionals.....	5.9	7.8	8.1
Technicians.....	10.2	13.6	15.5
Sales workers.....	3.8	6.7	9.0
Office and clerical.....	15.6	19.4	20.9
Skilled crafts.....	8.8	9.6	10.6
Operatives (semiskilled).....	21.4	27.6	28.9
Laborers (unskilled).....	47.5	51.7	62.2
Service workers.....	47.4	46.4	44.0
Total.....	11.8	14.4	15.0

EMPLOYMENT OF WOMEN (IN PERCENT)

	Dec. 31, 1971	June 30, 1973	Dec. 31, 1973
Officials and managers.....	2.1	2.8	3.9
Professionals.....	5.5	7.6	8.4
Technicians.....	8.5	10.6	11.6
Sales workers.....	17.0	13.3	21.0
Office and clerical.....	68.7	70.7	72.3
Skilled crafts.....	3.1	2.7	3.5
Operatives (semiskilled).....	15.2	22.8	29.8
Laborers (unskilled).....	16.0	10.5	13.0
Service workers.....	11.8	14.7	18.0
Total.....	15.7	17.5	19.0

Note: Percentages shown are of the total work force in that job category.

STATEMENT OF CHARLES A. BERRY, M.D., NASA DIRECTOR FOR LIFE SCIENCES,
NASA

Mr. Chairman and Members of the Committee:

It is my privilege to discuss with you today NASA's life sciences activities. They are very broad. These activities cut across almost all of NASA's missions. I would like to quote in part from the National Academy of Sciences 1971 report on *Priorities for Space Research 1971-1980*. I believe it answers clearly the question "Why life sciences in space?" Life sciences, the report notes, is "concerned with life in all its manifestations from molecular mechanisms to the dynamics of large populations, ecosystems, and the entire biosphere. The ultimate aim of the life sciences is to define the universal conditions of life, its origin, and its maintenance. Biological principles are basic to and relevant for application in medicine, population control, and the management of natural resources. In contrast with a field like astronomy which is a science of space and requires space vehicles to bring it closer to its principal objectives, the coupling of biology with space science is less obvious and more selective: as yet life is known only on this planet, and most biologists see as their primary task the investigation of terrestrial life in its natural setting. Yet, with man's venture into space, three new ways of looking at life have been opened to us. We can look outward to ascertain whether there is life on extraterrestrial bodies; we can look back from space to our own planet to observe, from this new vantage point, processes related to life on land and over the oceans; and we can study terrestrial organisms as they enter the space environment and ask how these organisms, including man, survive and perform under the unprecedented conditions of space: an all-pervasive factor—gravity—has been removed, and its role on earth can be fully assessed for the first time. Thus certain areas of the life sciences can contribute to, and benefit from, the space program in major ways."

NASA's life sciences research is not only important to the success of its own missions, but it is important to the Nation as a whole. The National Science Foundation has reported that, in a recent fiscal year, the NASA life sciences research budget accounted for 6.4 percent of the total Federal obligations for such research. While this is a small fraction of the total, it is a significant fraction. The NASA Life Sciences Program applies to the study of life processes the new investigative capabilities made possible by the space program. It takes maximum advantage of the unprecedented opportunity to use weightlessness as a tool for fundamental biological research. And Life Sciences uses this altogether new technology to seek its answers. The information on basic life processes which this approach yields would be otherwise unobtainable.

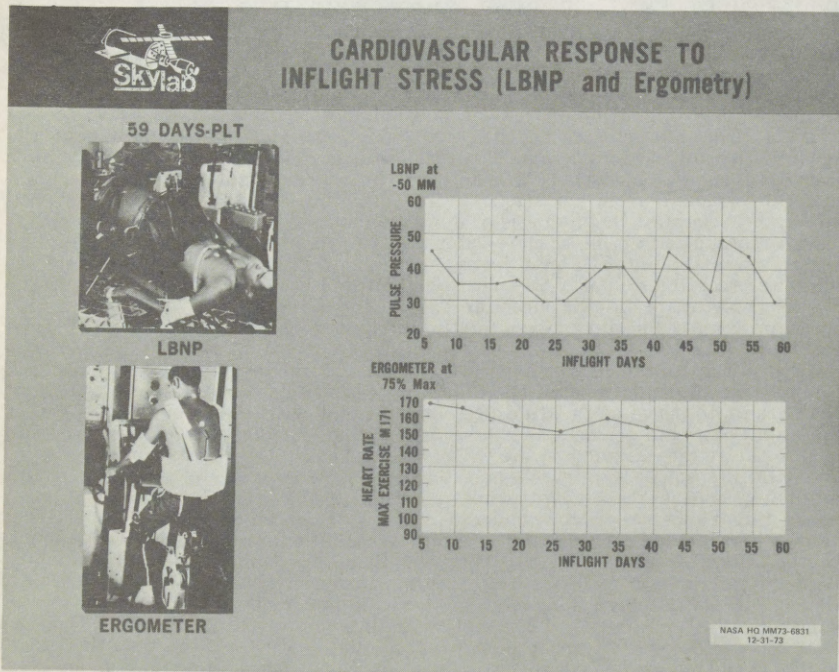
Until 1971, life sciences activities in NASA were dispersed throughout the agency with an element assigned to each substantial activity. This may have satisfied the needs of each NASA activity, but it could not be as effective as a program which derives its strength from the interdependency of an overall integrated program. On the basis of numerous studies and advice from the NAS, NASA reorganized its life sciences efforts in 1971, and a NASA Director for Life Sciences was appointed. The objective of the new Program was to integrate life sciences research for all of NASA, working with the Program Offices involved. The NASA Director for Life Sciences presents to the Administrator each year a proposed program plan and budget for the integrated program. He is also charged with reviewing the entire NASA effort in life sciences and with making periodic reports to the Administrator and to the involved Program Offices. It is his task to make recommendations on the filling of key life sciences positions throughout NASA and to serve as NASA's principal contact with the outside life sciences community on life sciences matters. In addition, he directly manages the life sciences activities assigned to the Office of Manned Space Flight.

NASA life sciences research and technology programs are assigned to and conducted as part of various program management offices. In the Office of Manned Space Flight, the program is called Space Life Sciences. In the Office of Aeronautics and Space Technology, it is called Aeronautical Man-Vehicle Technology. In the Office of Space Sciences, both the Planetary Quarantine and Planetary Biology programs are life sciences programs. In the Office of Applications, an element of the Ecological Sciences program is included as life sciences. In the Office of Industry Affairs and Technology Utilization, we categorize as life sciences those efforts devoted to applying aeronautic and space technology to the broad improvement of medicine and health care on earth. Occupational Medicine and Environmental Health efforts are administered through the Office of Institutional Management. You will hear, in subsequent testimony from the various NASA offices, some of the programmatic details of many of the items I will highlight for you today.

Space Life Sciences is the largest life science effort in NASA; it is located in the Office of Manned Space Flight. In addition to my duties with the overall Life Sciences Program, I have line responsibility for management of this program. Space Life Sciences research provides the understanding and technology necessary to determine man's capabilities and limitations in the space environment. It also develops the technology base for future environmental systems which will permit man to live and work effectively in space for long periods of time. Many of these research and technology efforts also relate very directly to clinical health care on earth.

With Skylab 4, we have just completed the most extensive medical mission ever flown. It represents the most significant medical event in manned space flight of this century. In all three manned Skylab missions, we learned many new things about man in a weightless environment. We now have a tremendous amount of data on man's adaptation to weightlessness and his response on return to earth's gravity. This data base is derived from 16 diverse medical experiments on nine crewmen 21 days preflight, nine crewmen 18 days postflight, and nine for 28 days, six for 60 and three for 84 days in orbit. This was supplemented by special weekly and monthly inflight medical assessments on the status of crewmen. In addition, there were Skylab experiments in basic biology, radiation, habitability, cabin atmospheric particles and maneuvering devices.

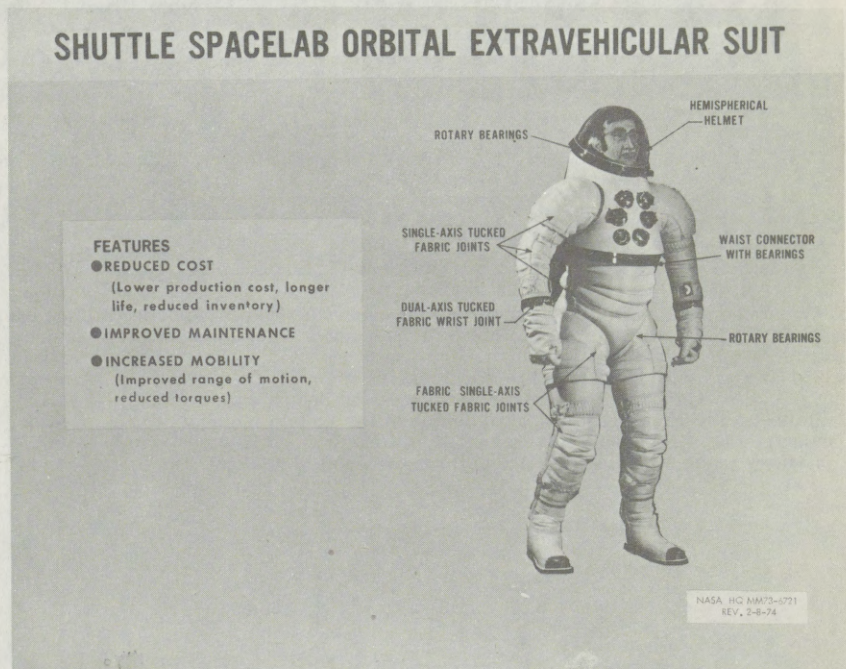
The astronauts' cardiovascular response to an inflight stress of the cardiovascular system was measured using the Lower Body Negative Pressure Device (LBNPD) and the bicycle ergometer. We have observed a cyclic response in the cardiovascular system depicted by the pulse pressure (difference between systolic and diastolic blood pressure) at maximum negative pressure in the Lower Body Negative Pressure Device and heart rate response during exercise stress on the bicycle ergometer (MM73-6831). It is our opinion that cardiovascular adaptation to the zero-G environment occurs for most individuals within the third to fifth week of weightlessness. Had we not exposed man to more than 28 days of space flight, I am convinced we would not have known this important fact about man's physiological response to zero-G, and, more important, we could have drawn the wrong conclusion from the data of only 28 days as the Russians did for 18 days.



From a medical point of view, we are now able to conclude that man can withstand long flight durations, but there will be some adaptive changes. We know now how these changes occur with time, but we do not know in detail what the mechanisms of these changes are. Our Space Life Sciences Program is designed to provide the in-depth understanding of the mechanisms of the adaptive changes. This work will be accomplished in ground laboratories as a prelude to scientific experiments on Shuttle.

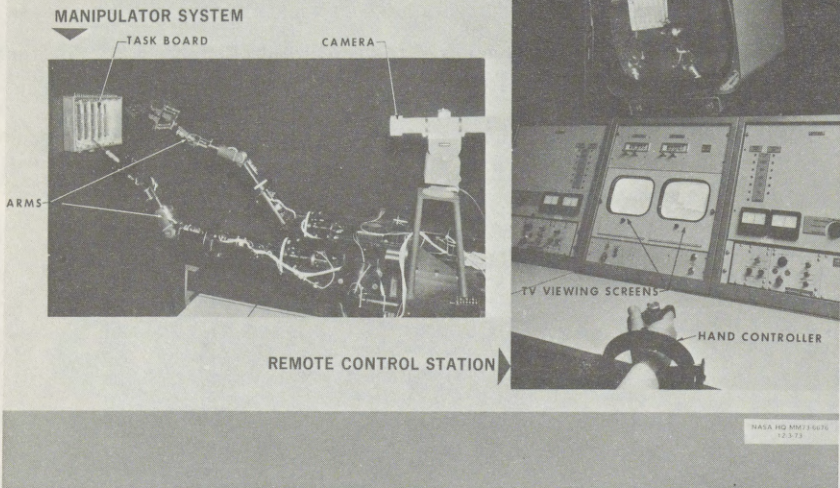
In developing technology to make this possible, we have considerable effort underway in advanced bioinstrumentation, man-machine technology and in life support and protective equipment.

Our efforts related to the protection of the new breed of space traveler on the Shuttle include preliminary studies that will eventually lead to the development of less expensive non-custom-fitted spacesuits. Shuttle passengers will normally launch and land in a shirtsleeve environment. There will be EVA operations requiring a spacesuit with improved performance characteristics. Simple rescue aids are also under study. Shown on this chart (MM73-6721) is a recently completed prototype orbital extravehicular suit.



Another of our efforts in advancing technology will augment man's capabilities in space and in ground operations. It is called "teleoperator systems technology." Our goal in the space program is to provide remote/on-orbit satellite servicing technology. A free-flying remotely controlled spacecraft would extend man's sensory, manipulative and cognitive capabilities in performing replacement and repair tasks on satellites. Illustrated in this chart (MM73-6676) is a manipulator system accomplishing the replacement of a terminal board under the remote control of an operator who is viewing the worksite through a visual system. The operator can be in the Shuttle or in a ground station.

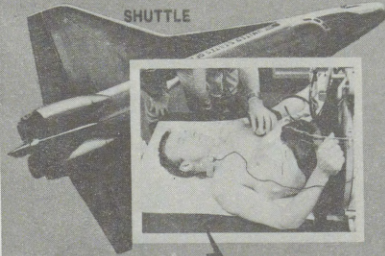
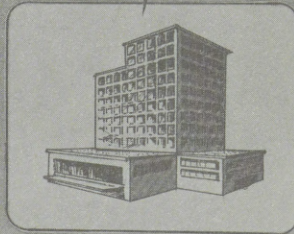
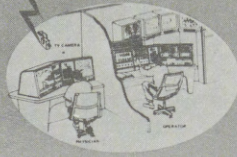
REMOTE ON/ORBIT SATELLITE SERVICING TECHNOLOGY



We are continuing our effort to develop a capability to provide clinical medical care and support to future space crews. It is a form of telemedicine. Taking into consideration the similarities which exist between providing health care to men in space and providing health care to a remote population on earth, a plan was developed to verify the requirements for a space health care delivery system by building and testing a ground-based analog of the system in collaboration with the Department of Health, Education, and Welfare. This chart (MM73-6863) illustrates the similarities of space and remote ground medical support.

IMBLMS**INTEGRATED MEDICAL AND BEHAVIORAL
LABORATORY MEASUREMENT SYSTEM****IMBLMS WILL PROVIDE FOR:**

- SPACEFLIGHT CLINICAL MEDICINE CAPABILITY
- GROUND BASED TELEMEDICINE TECHNOLOGY

GROUND
CONTROL
CENTER

MEDICAL CENTER

NASA HG AM73-6836
REV. 2-8-74

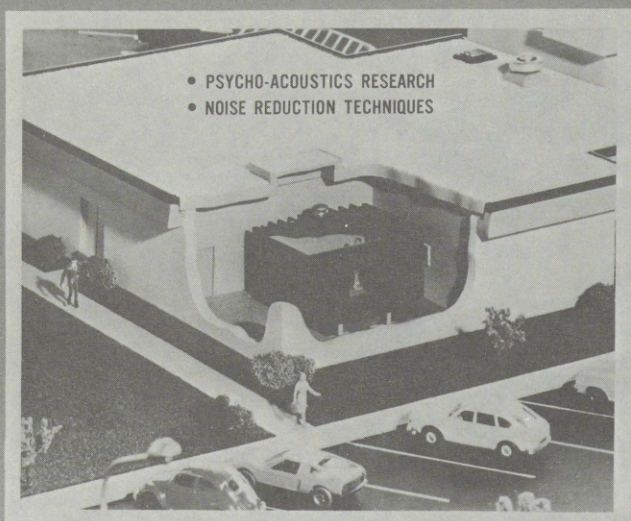
In both circumstances a ground medical data base and the expertise at a large hospital are available to assist by telecommunications in the diagnosis and care of remote patients. The system makes optimum use of advanced medical instrumentation, television, voice, data communications, and modern data processing techniques. With these aids, a specially trained paramedical crewman may examine a patient, transmit medical information from the remote site to a physician in a control center miles away, and consult with a physician who may diagnose the problem and prescribe treatment.

The aeronautical element of our program is located with the rest of NASA's aeronautics efforts in the Office of Aeronautics and Space Technology. It is called Aeronautical Man-Vehicle Technology, and I am pleased to note our growth in this area which is important both domestically and militarily to the Nation.

The Aeronautical Man-Vehicle Technology program provides the research and technology base to solve human problems impeding the growth and the safety of air transportation. The program has four major elements: human response to noise, ride quality, flight management, and simulation technology.

The noise research program looks at the effects of aircraft operations on the human, particularly in the area of sleep interference and annoyance. In mid-1974, the Langley Aircraft Noise Reduction Laboratory will be operational. That facility has laboratories to permit the study of human response to noise (MM74-5231). For example, we will conduct studies on the effects of new takeoff and landing procedures to lessen the annoyance generated by aircraft operations.

NASA AIRCRAFT NOISE REDUCTION LABORATORY

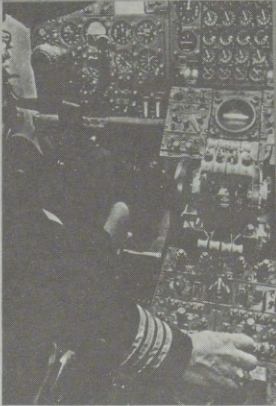


NASA HQ MM74-5231
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The ride quality program provides criteria for assuring passenger acceptance of an aircraft's motion environment. This work is currently focused on advanced short haul air transportation systems.

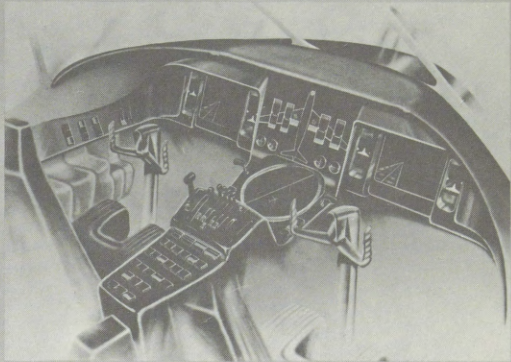
The flight management program provides human factors research to better specify crew roles, flight procedures, pilot training requirements, and control and display requirements for aviation in the next decade. This year the probable air traffic control environment of the 1980's and 1990's will be assessed. A full mission, aircraft/air traffic control simulation will be completed at the Ames Research Center next year. Based on results of these simulations, the acquisition of an integrated cockpit flight management system is planned for FY 1977 (RB73-15013). Flight test and verification of the system will occur at a later date. In addition, a program is being defined for implementation next year that should reduce substantially the number of approach and landing accidents.

COCKPIT CONFIGURATION FOR AUTOMATED SYSTEMS



CURRENT COCKPIT

TECHNICALLY FEASIBLE COCKPIT

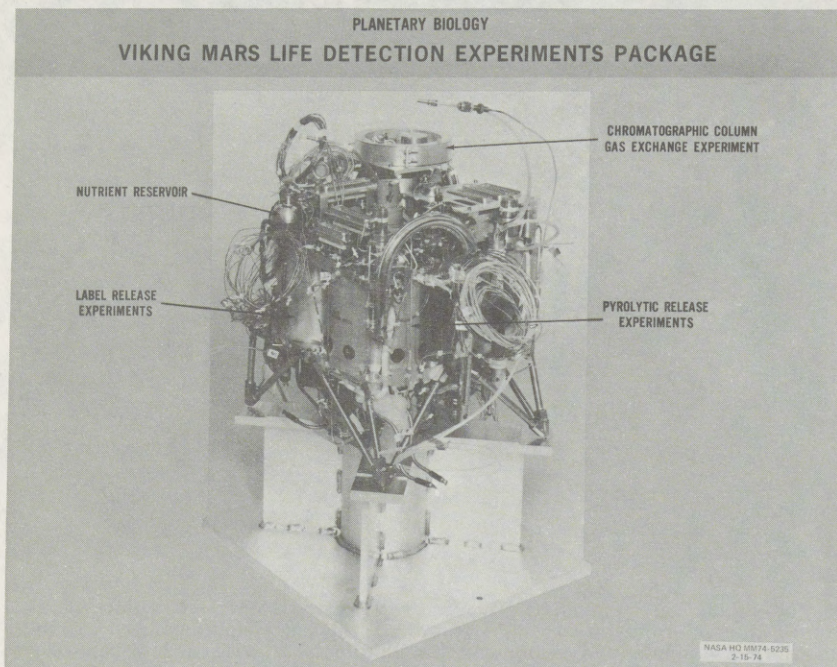


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The simulation technology program works toward effective and economical application of simulators to pilot training, proficiency maintenance, and aeronautical research and development. Simulators have become indispensable to segments of the aviation community for reasons of cost effectiveness and safety. An impetus for even greater application now is the benefit to be derived in fuel conservation from the use of simulators. Wider application is restricted by the unavailability of low cost systems and by limitations in (1) visual scene generation technology, (2) understanding acceleration cue requirements, and (3) measuring pilot performance. In addition, we are doing a comprehensive review of aeronautical life science requirements with the DOD and FAA aimed at sorting out various roles and tasks.

One of our most exciting efforts in NASA is the search for extraterrestrial life and life-related molecules, called Planetary Biology. This program has provided much of the impetus for the unmanned Viking mission which has a molecular analysis experiment in search of organic molecules in the Mars surface. It will land in July 1976 after a flight of nearly a year. Associated with this effort is a related one called Planetary Quarantine. This program attempts to ensure that earth organisms will not be carried to Mars and detected by our searching instruments, giving us false information on life on Mars or alter, in time, the present Martian environment. Both of these activities are in the Office of Space Science.

One major current activity in the Planetary Biology program is concentrated on the preparation of the life detecting experiments assigned for flight on the Viking lander. These experiments are integrated to form a very complex single unit aboard the landing vehicle (MM74-5235).

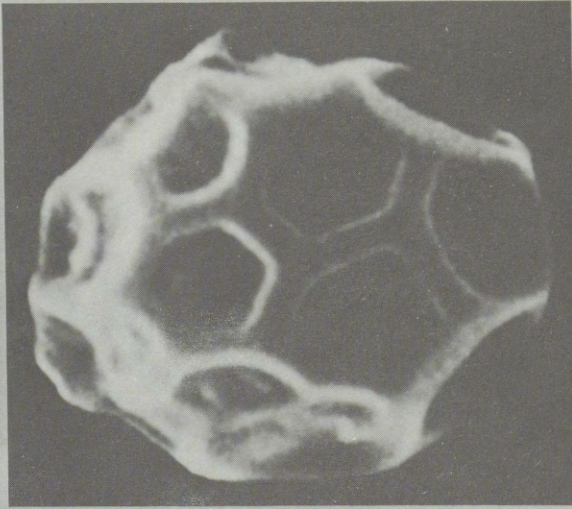


During FY 1974, the initial prototype flight hardware for conducting these experiments was completed and the initial engineering laboratory tests were performed. Although several of the usual early equipment and procedural problems were encountered during these first tests, the results indicated that the design was sound. The extreme complexity of the instrument has produced delays in construction, causing concern in meeting schedule and introducing the possibility of only limited testing in a complete lander system before launch. In FY 1975, the prototype, flight qualification, and flight hardware must be completed to ensure the readiness of the life detection experiments for launch on the Viking flight schedule.

The Planetary Biology program is also currently involved in the analysis of meteorites for evidence of chemical markers of importance to biological or pre-biological activity elsewhere in the solar system, and the analysis of returned samples from the Moon or, hopefully, in the future from other planets for evidence of life or life-related chemical processes. Exploration of the outer planets, e.g., Jupiter, Saturn or the moons of the outer planets also holds considerable promise of data on chemical evolution—that is, those chemical processes which are believed to have preceded the origin of life on earth.

During the past year, research was conducted that further reduced the requirements for sterilization of spacecraft intended to land on planets by evaluating the effects upon viable contamination of the solar wind, proton radiation and other forces encountered during interplanetary cruise. We also identified and began evaluation of a small fraction of spores that are resistant to dry heat sterilization and that may pose a potential threat to the validity of the results from the Viking life detection experiments. (Chart MM74-5230 shows a spore, *Bacillus S.P.*-ATCC 27380, magnified 30,000 times).

PLANETARY QUARANTINE



HIGHLY RESISTANT SPORE
(MAGNIFICATION: 30,000 x)

NASA HQ MM74-5230
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Preliminary tests indicate that these organisms are relatively few in number and have a requirement for more molecular oxygen than exists in the atmosphere of Mars, which would eliminate the problem. Research is underway to confirm these results. However, if there is indeed a hazard to the experiment imposed by those organisms, other steps will be taken to protect the Viking Biology experiment from contamination.

Research on questions basic to the need for quarantine of the outer planets suggests that metabolism can take place in an aerosol; thus the first step in answering two questions concerning the ability of life to exist in the clouds of Venus and Jupiter has been taken. The ability of the organism to reproduce in this environment must still be demonstrated. Study will be continued on the ability of life not only to metabolize but to reproduce in clouds.

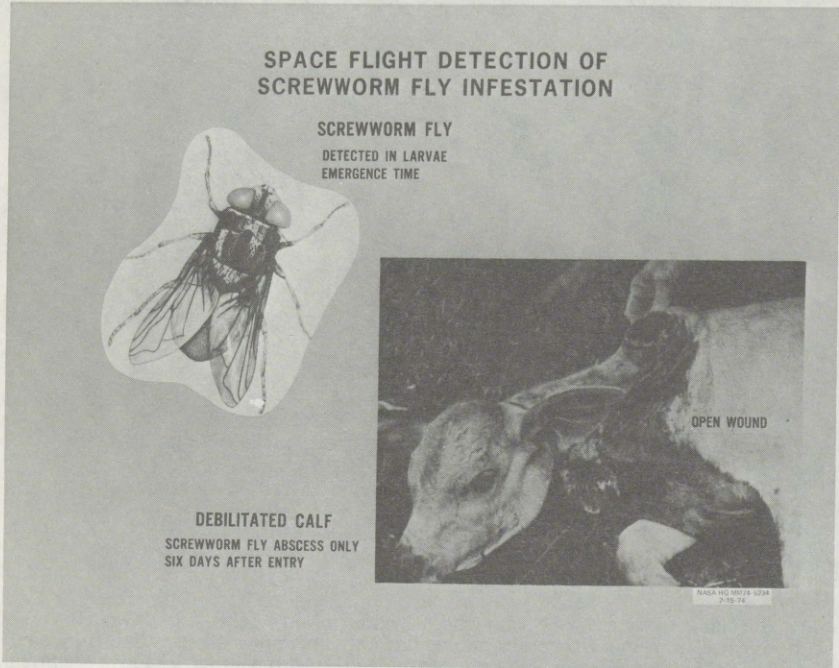
In FY 1975, there will be a continuation of the shift from research on Viking sterilization problems to Viking operational activities. Of prime importance will be final answers on the problem of the hardy organisms, a problem that has a high level of impact on the success of the Viking life detection experiments, the primary purpose of this mission. Work will be initiated on the analysis of risks associated with a Mars sample return.

The Office of Applications focuses on applying aerospace technology to a wide range of life sciences problems here on earth. For example, we are exploring the use of electromagnetic and photosensing technology for remote sensing epidemiological and transmission mechanisms of disease in man, animal, and plants.

Scientists in the health field have emphasized that remote sensing from space or aircraft is not only a highly desirable way of collecting data concerning earth situations but indeed may be the only timely means of acquiring such information. We have been able to determine the habitat of the *Aedes sollicitans* mosquito in a New Orleans site and the ability of near infrared color photography and multi-spectral scanning to identify the breeding habitat of *Biomphalaria glabata*, the snail which serves as the intermediate host for the schistosomal parasite. This parasite affects some 200 million people in the tropics.

We are developing a close liaison with user and regulatory agencies such as the Department of Agriculture in developing pilot eradication and control programs for such disease carriers as the screwworm fly which continually threatens the cattle industry (MM74-5234). The screwworm fly life cycle is dependent upon

certain conditions of temperature and humidity generally found in tropical areas. Reduction of the screwworm fly population is effected by infesting an area with sterile male screwworm flies within the time span of these climatic conditions.

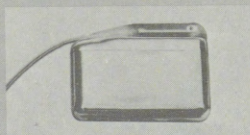


We are currently working out an arrangement with the Mexican Government by which timely satellite weather data may be used to obtain information on the time of screwworm fly larvae emergence so that sterile flies can be released at the proper time. We are also investigating the detection of other disease vectors or reservoirs from aircraft and spacecraft. Our ultimate aim is to detect the progress of infestations so that we can interrupt the chain of events which leads to the movement of destructive disease mechanisms across the earth's surface.

In the area of Technology Utilization, there are many life sciences related activities. These are included in the Biomedical Applications Program. During the past year, a number of projects have been successfully completed. Among these was the implantation in February 1973 of the first fixed-rated rechargeable cardiac pacemaker with a ten to twenty year lifetime.

TECHNOLOGY UTILIZATION

RECHARGEABLE IMPLANTED CARDIAC PACEMAKER



IMPLANTABLE CARDIAC PACEMAKER
WITH INTERNAL BATTERY



BATTERY RECHARGEABLE
UNIT IN PLACE OVER
IMPLANTED PACEMAKER

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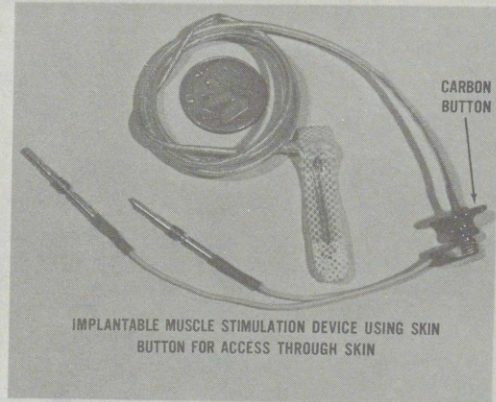
Chart MM74-5233 shows the implant and a patient having the implanted battery recharged. Compared to the conventional cardiac pacemakers which require surgical replacement every two years, this new pacemaker will significantly reduce the risks and costs of surgery for thousands of patients. These pacemakers embody many NASA related technologies, and are now commercially available. The current number of implants is over one hundred.

Some years ago, we spoke of the promise of high purity carbon such as that used in heat shields and rocket engine linings, for devices implanted in the body. Use of the carbon in the devices would result in a minimum of tissue reaction. The feasibility of this concept is now being demonstrated. Electrodes made of the new materials have been used for long term electrical stimulation not only to relieve pain but also to stimulate directly nerves and muscles in order to prevent muscle atrophy and permanent muscle contracture in stroke and trauma patients. These electrodes are shown in Chart MM74-5229.

TECHNOLOGY UTILIZATION

PERMANENTLY IMPLANTED SKIN BUTTON FOR ELECTRICAL DISCONNECT

- UTILIZES HIGH PURITY CARBON FROM SPACECRAFT HEAT SHIELD TECHNOLOGY
- SKIN ADHERES TO SIDES OF BUTTON
- NO SKIN REACTION



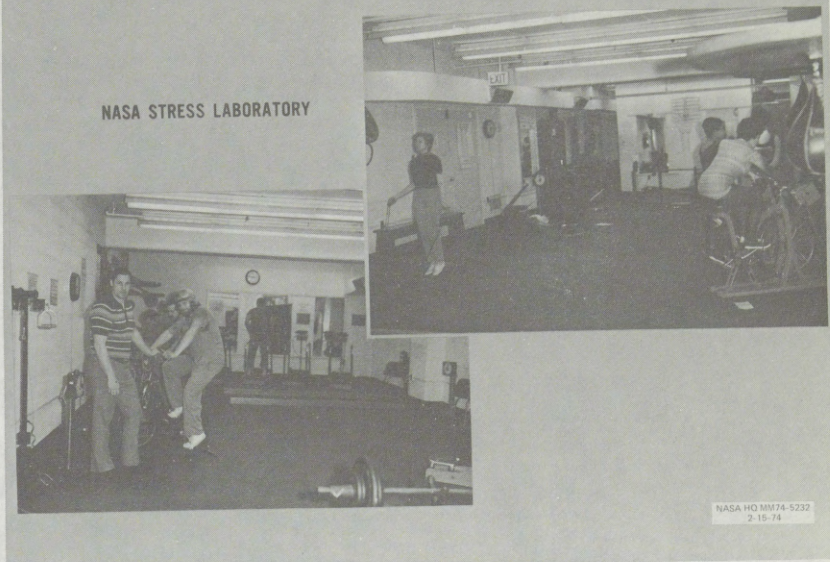
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Effective liaison has been established with the Veterans Administration and a number of promising activities have begun including several projects to provide assistance to patients paralyzed by spinal cord injuries and projects to apply NASA systems analysis experience to the planning of hospital laboratories.

In the Office of Institutional Management, the Director of Occupational Medicine and Environmental Health manages a program which provides medical support for the employees of the various NASA laboratories and facilities. This program aims to ensure efficient performance and to maintain the health fitness of each man or woman employed by NASA—our most precious resource—by utilizing modern medical and environmental health concepts. In so doing, we determine the health status of the individual, prevent illness and promote good health, and appraise any factor in the working environment which could be deleterious to health.

NASA's health program is being used as a model by many other government agencies and industries (Chart MM74-5232). The program includes the use of a stress laboratory where exercise loads are imposed under the control of a prescribing physician. In the facility, controlled physical activity is prescribed for personnel found to have abnormal electrocardiograms, hypertension, obesity, drinking problems, or other conditions expected to be benefited by an individual exercise regimen. By improving physical fitness, we accrue dividends such as increases in work performance, improved feeling of well-being, greater stamina, weight control, and reduced smoking.

EMPLOYEE HEALTH PROGRAM



As the National Academy of Sciences report I mentioned at the beginning of this testimony noted, if the space environment is exploited ambitiously, it represents an inestimable resource in and of itself. An orbital platform gives us the scope in a very literal sense required to solve problems on every conceivable scale, from the microscopic to the vast. From the vantage point of space, we can look back at our own world and, for example, gather more information about a ten-acre field, within a one percent margin of error, than a farmer physically exploring the land could learn from long, careful, on-site observation of that same land. And the volume of information about earth's resources which can be gathered from space is enormous.

Looking out into the universe, the space program on the whole, and the Life Sciences Program as a key part of it, has begun to provide answers to the crucial question, "Are we alone in the universe?" To find the answers to this question, a new specialty, exobiology, is coming of age. Specialists in this field are, understandably, divided on the issue of whether life exists on other planets. The more optimistic of them point out that we are the product of $4\frac{1}{2}$ billion years of evolution and that there is no reason to believe that this evolutionary process has stopped or that man is its climax. A well known astronomer who is sanguine about the possibility of life on other planets has dubbed those who cannot conceive of life without water or oxygen "liquid water chauvinists and oxygen chauvinists." Another exobiologist, on a serious note, points out that we have found life in boiling hot springs and strong acid. Life could well exist in our solar system and if it does not here, there may well be lower or higher forms of life elsewhere in the universe.

Finally, earth orbital zero-G laboratories enable us to study life processes without the confounding variable of gravity. The zero-G environment offers the opportunity to gain basic information in neurophysiology, for example. In weightlessness, it is possible to examine the effects of altered sensory inputs on neurological structures within the vestibular system. A first step in this area was a study of the otolith organ in a frog exposed to six days of zero-G flight.

What have been quantum strides in gaining knowledge of the universe in the last decade and a half have been microsteps along the path of ultimate understanding. But each step was indispensable in bringing us closer to the final goal. There could never have been an Apollo mission without a Gemini mission, and Gemini would have been impossible without Mercury. Without the backlog of experience and technology gained from these, no one would have ventured to expose man to nearly three months of residence in the earth orbiting Skylab vehicle.

Now the first major milestones in space have been achieved. The drama of setting foot on the Moon has come and gone, and some view the 1970's as the end of an era in space. We in life sciences see these accomplishments as just a beginning. Space is becoming for us now an opportunity for the advancement of science as well as exploration. Chart MM74-5262 forecasts those events in space life sciences which we consider to be the major events of the remainder of the decade.

First in order of priority and chronology is a completion of the analysis of the life sciences experiments on the Skylab mission. By the middle of 1975, the prodigious amount of data from those experiments will be processed and the final Principal Investigators' reports released. We are continuing to follow a path of cooperation in space with the Soviet Union. To this end, a Space Biology and Medicine Working Group will complete a data exchange on the Soyuz 12 and 13 missions and the Skylab 3 and 4 missions by the middle of this calendar year. By the end of this year, the "Foundations of Space Biology and Medicine," a three-volume opus which documents the space program in the U.S. and the U.S.S.R., will be published. Finally, our next manned venture into space in mid-1975 will be a joint undertaking with the U.S.S.R.

In July 1976, the Viking project will land on Mars to seek biological or pre-biological activity on that planet. By 1980, we will be ready to launch the first Space Shuttle with Life Sciences definitive experiments.

FORECASTED MAJOR LIFE SCIENCES EVENTS

- COMPLETION OF FACILITY FOR PERFORMING AERONAUTICS LIFE SCIENCES RESEARCH:
 - AIRCRAFT NOISE REDUCTION LABORATORY COMPLETION (PSYCHO-ACOUSTICS RESEARCH) - MID 1974
- COMPLETION OF ANALYSIS OF LIFE SCIENCES EXPERIMENTS ON SKYLAB:
 - MEDICAL EXPERIMENTS SYMPOSIUM ON SKYLAB RESULTS - MID 1974
 - FINAL PRINCIPAL INVESTIGATORS REPORTS ON EXPERIMENTS - MID 1975
- US/USSR JOINT ACTIVITIES:
 - SPACE BIOLOGY & MEDICINE WORKING GROUP (DATA EXCHANGE OF SOYUZ 12, 13/SKYLAB 3-4) MID 1974
 - PUBLICATION OF 3 VOLUMES "FOUNDATIONS OF SPACE BIOLOGY & MEDICINE" - END 1974
 - APOLLO - SOYUZ TEST PROJECT (ASTP) - (LIFE SCIENCES EXPERIMENTS) - MID 1975
- JOINT NASA/HEW FIELD TEST PROGRAM OF REMOTE MEDICAL CARE SYSTEM:
 - INSTALLATION OF SYSTEM COMPLETION ON PAPAGOS INDIAN RESERVATION - END 1974
 - ENGINEERING AND OPERATIONAL TESTS OF SYSTEM CONDUCTED - 1975 - 77
- LIFE DETECTION EXPERIMENTATION ON PROJECT VIKING:
 - 3 EXPERIMENTS TO BE INCLUDED IN LAUNCH - MID 1975
 - LANDING OF EXPERIMENTS ON MARS - MID 1976
- PREPARATION OF LIFE SCIENCES PAYLOADS FOR SHUTTLE ERA:
 - SPACELAB PRESSURE MODULE DESIGN REVIEWS (EUROPEAN SPACE RESEARCH ORGANIZATION) - 1975
 - NASA STUDY GROUPS TO IDENTIFY PAYLOADS - QUARTERLY 1974, 75
 - CONCEPT VERIFICATION TESTING OF UNITS FOR LIFE SCIENCES PAYLOADS (GROUND-BASED) 2/YR, 1974 - 79
 - NATIONAL ACADEMY OF SCIENCES SUMMER STUDY TO IDENTIFY LIFE SCIENCES PAYLOADS - MID 1975
 - TARGET DATES FOR FIRST SHUTTLE LIFE SCIENCES PAYLOADS - 1979, 80

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Finally, turning to earth-oriented applications of life sciences research, in mid-1974, we will see the completion of an aircraft noise reduction laboratory as part of our Aeronautical Life Sciences Program. As just one phase of our efforts to bring space technology to bear on earth-oriented problems, we will install, in conjunction with the Department of Health, Education, and Welfare, a remote medical care system by the end of this year. This field test is aimed at developing the system technology required to provide clinical care in space as well as satisfying the health care needs of a pilot study of a remote population, the Papagos Indians. The system should be fully operational by 1975.

"Why life sciences in space?" Because the space environment offers us an unprecedented and irreplaceable framework within which to study many of the major problems that face man today on earth.

The CHAIRMAN. We now recognize Dr. George Low, and I know you have made a considerable effort to be here. You may now proceed.

Dr. Low. With your permission, Mr. Chairman, we will devote the remainder of today's hearing to a few current examples of how NASA's space activities are leading to tangible applications and benefits. I have a very brief statement concerning the application of NASA technology to down-to-earth problems. We also have four witnesses who will discuss with the committee the specific practical benefits they are deriving from NASA-developed technology.

The CHAIRMAN. Do you want to bring them in while you speak?

Dr. Low. Yes, Mr. Chairman.

Our first presentation will involve a very young lady, 3-year-old Jeni Guarascio, and I would like to proceed because it has been a very long morning for her.

STATEMENT OF DR. GEORGE M. LOW, DEPUTY ADMINISTRATOR, NASA

Dr. Low. Mr. Chairman and members of the committee, with your permission we will devote the remainder of today's hearing to a few current examples of how NASA's space activities are leading to tangible applications and benefits.

In a moment we shall see and hear four brief presentations. The first will describe how the ERTS satellite was used to monitor the Mississippi River flooding in 1973, and how these data may be used to alleviate future disasters of this kind. We will also see how ERTS data are now being used for land irrigation and drainage control in southern Florida.

The second presentation will concern itself with how a battery developed for space use has made possible the development of a rechargeable pacemaker for cardiac patients. Among other benefits, it eliminates the need for repeated surgery for battery replacement.

Third, we will see how technology developed by NASA in work on rocket fuels and propulsion research has been adapted by a private company to provide a new method for separating scarce metals from auto scrap, in a manner that is economical in both cost and energy.

In the fourth presentation, we will learn how fuel cell technology developed for Apollo is being applied by industry and a group of private utility firms to provide new efficient means of supplementing central station electric energy generation.

As we listen to these presentations and look at the additional examples of applied NASA technology around this room, it is important to realize that the work leading to practical applications in our space applications and technology utilization programs is largely made possible by the work we have done in other areas of the NASA program, where the direct benefits often appear to be less tangible and less practical. What we are doing in space applications today is often based on the knowledge of the space environment gained in our space sciences program and by satellite and ground system technology derived from technological advances in all our manned and unmanned space programs.

The technology utilization program likewise draws on all of NASA's programs for new technology which can be transferred to other uses. In a real sense, the space applications and technology utilization programs are where NASA's entire space program meets the world. They make the bridge from space science and technology to tangible applications and benefits.

NASA is, of course, a research and development agency—our job is to develop and experiment with aeronautical and space applications, identify and disseminate new technology, and encourage and facilitate its use. We can and do “push” space technology into applications, but others—the users—must “pull” it through and see that the benefits are realized. So in both our space applications and technology utilization programs we work closely with prospective users who have the responsibilities, resources, and specialized abilities to make proper and productive use of technology NASA has developed.

That is why, Mr. Chairman, we believe it is important for the committee to hear from user witnesses who will provide specific illustrations of how NASA’s work leads to tangible practical applications.

Before introducing the presentations, let me call your attention to the other technology transfer displays you see here in the committee room. The manufacturers, and in some cases the users, of each of these items are here from many parts of the country to explain them to you. I will take time only to identify each of them briefly and hope that you will be able to view the displays at the conclusion of this morning’s hearing or later during the day.

First there are two items where space technology is being used to help the blind, a paper money identifier which enables a blind person to readily identify different paper bill denominations, and an audible light meter which enables a blind person to detect whether it is daylight or dark outside or if overhead lights are on or off. Mrs. Jeanette Wood, personnel manager of District Enterprises for the Blind, Washington, D.C., is here to demonstrate these.

Other products on display and the company officials representing them are:

An emergency lighting system for area and emergency illumination—Mr. John Morton, president of the UDEC Corp., Waltham, Mass.

Telecare—a portable cardiac emergency and resuscitation unit adapted from Skylab medical instrumentation and now being used by crews of ambulances and other emergency rescue vehicles—Mr. Roy Gage, president, SCI Systems, Inc., Houston, Tex.

EPIC—the commercial version of a device for testing psychomotor skills of astronauts. It can be used to test the skills of truck and bus drivers and heavy machinery operators—Mr. Mitchell Davis, vice president for research and development, JWM Corp., Philadelphia, Pa., a minority business.

Streamlite 1 Million—a portable high intensity searchlight developed from rocket combustion technology—Dr. Robert McAlevy, chairman, and Mr. George Regan, president, Streamlite, Inc., Fairfield, N.J.

Sewage Flowmeter—a device for measuring flow in combined sewer systems modified from wind tunnel instrumentation—Mr. Ronald Chandler, Dallas Water Utilities, Dallas, Tex.

Improved Spark Plug—a new resistive spark plug which reduces misfiring and allows ignition noise suppression to be built directly into the spark plug. Mr. Frank Beardslee, research director, the Zeller Corp., Defiance, Ohio.

Finally, we also have on exhibit a representative segment of the solar collector to be used in the solar heating and cooling demonstration project at Marshall Space Flight Center.

At this point we will hear from Mr. Robert E. Fischell of the Johns Hopkins Applied Physics Laboratory. He will present a brief discussion of the development and status of the rechargeable pacemaker. Mr. Robert Frazier and Miss Jeni Guarascio (both pacemaker patients) will also demonstrate its use to us.

The CHAIRMAN. Go ahead, Mr. Fischell.

STATEMENT OF ROBERT E. FISCHELL, JOHNS HOPKINS APPLIED PHYSICS LABORATORY

Mr. FISCHELL. It is a privilege and a pleasure for me to describe to you today a biomedical engineering project which has most successfully utilized space technology in the development of an improved cardiac pacemaker.

You may be aware that cardiac pacemakers are comparatively small, electronic pulse generators which are implanted in patients to increase their slow pulse rate to a typically normal value of 72 beats per minute.

In the past, conventional pacemakers have demonstrated useful lifetimes of as much as only 2 years because their batteries run out of energy in that time. The newest designs for conventional pacemakers hope to extend their average lifetime to as much as 3 years. Before the battery of a conventional pacemaker is completely depleted, the patient must undergo a surgical procedure to have a new unit implanted. The additional surgery every 2 to 3 years exposes the patient to some risk of infection and other surgical complications, and subjects him to considerable discomfort and a substantial cost for the device and its associated medical, surgical, and hospital fees.

Patients using conventional pacemakers also have the psychological problem of knowing in advance that they must undergo surgery at comparatively frequent intervals.

Still, another disadvantage of conventional pacemakers is that, because of the large number of cells they require, these units are quite heavy and large in size, as you can see from this typical pacer that I have in my hand.

At this time, Mr. Robert Frazier, one of our patients from Johns Hopkins, will demonstrate in a moment how he recharges his pacemaker and how this works. Well, he will do this in a moment.

This new rechargeable pacer is about one-third the volume of the conventional device and it is therefore more easily implanted by the surgeon. Its flatness, half the thickness of conventional pacers, allows it to be cosmetically hidden within the patient's body. It has no life-limiting components, so that we believe it will continue to function beyond the lifetime of most cardiac pacemaker patients.

An additional advantage here is that the rechargeable pacer is essentially immune to electrical interference. Conventional pacers have been turned off when in close proximity to sources of electrical interference such as car ignitions, radars and microwave ovens. The Johns Hopkins rechargeable pacemaker is so immune to interference that it would not be turned off even if placed inside a microwave oven.

At this time I would like to introduce Mr. Alfred E. Mann, on my right. In 1969, he was president of both Spectrolab and Heliotek. These companies for many years had been providing high-reliability space hardware for numerous satellites designed by the Applied Physics Laboratory. After attempting without success to interest other companies in this new concept, Johns Hopkins decided to license a new company, Pacesetter Systems, Inc., which was formed by Mr. Mann to manufacture the rechargeable pacemaker. Mr. Mann deserves a great deal of credit of taking the pacemaker out of the lab and making it available to the public.

The results of this program to date have been highly successful. The first human implant was accomplished over 13 months ago in a 76-year old woman at Johns Hopkins Hospital. Since that time over 200 additional units have been implanted in human patients without a single malfunction of any sort in these implanted rechargeable pacemakers.

Now, this new pacemaker would not have been possible without the space technology as developed by NASA. If NASA had not spent many billions of dollars on research and development of space-type, high-reliability, nickel-cadmium cells, the rechargeable pacer would not exist today.

Microminiaturization of electrical components and circuitry, again the result of space technology, was necessary to reduce the size of the rechargeable pacemaker while maintaining a high degree of reliability.

NASA is now sponsoring at the Applied Physics Laboratory a project to further reduce the size of the electronics and improve its reliability by using a hybrid circuit technique that was developed for sophisticated new spacecraft.

I would now like to introduce to you Mr. Robert Frazier and have him say a few words to you and demonstrate how he recharges the heart pacer which is in his chest.

The CHAIRMAN. Please go ahead.

Mr. FRAZIER. I had the original one that Mr. Fischell demonstrated. I am a physically active person. My activities, combined with the bulk of the unit, may work its way through my body. At this point in time the rechargeable pacemaker was available. I had this implanted and have had no difficulties since.

Now, from a cosmetic viewpoint, it is very desirable. The elimination of surgery is another good point.

Mr. HECHLER. How long ago was it implanted?

Mr. FRAZIER. Nearly a year ago. I will demonstrate how it is recharged.

Mr. FISCHELL. Comment on the relative cost also. Well, I will do that. The initial cost was somewhat more than the original pacemaker, roughly \$1,900, compared to \$1,100. When one adds in the cost of surgery and medical fees in replacing this, we have calculated that actually more than \$1 billion could be saved for the country in a 10-year period.

Mr. FRAZIER. There is an audible system letting you know if you are charging. There is no guesswork involved. When I turn this "on" switch, this is audible. When it makes contact, this shuts off. The charging head communicates with the patient and says it is getting exactly the amount or the correct amount of charge into the battery so that it is functioning properly.

Mr. FISCHELL. We recommend 90 minutes a week without charging. If he went for 6 weeks, it would not run out of power, but then it must be recharged again. A patient could go on an extended trip and not have to worry.

Mr. MILFORD. Are there any exposed terminals?

Mr. FISCHELL. This is hidden in a cosmetic way under the skin. The energy goes by magnetic induction through the skin and puts it back into the rechargeable space-type cell.

The last patient we have here is a child. Our pacemaker is particularly well suited because of the small size. It is used for children. I would like now to introduce one such lovely child—Jeni Guarascio and her father, Mike. The father graciously consented to bring her from New York City. Her mother is Katherine. I asked her mother to say a few words on what the pacemaker has meant to her and her daughter.

Mrs. GUARASCIO. It has meant an awful lot to our family. She is two different children now. Before her operation, she was very quiet.

She could not keep up then with other children. After her operation, this is the other extreme. She is now quite active. Having this is a big relief to us to know that she is normal now. She does not have to be operated on every 2 years. We are thankful the pacemaker was available when it was needed. Thank you.

The CHAIRMAN. Thank you very much.

Mr. FREY. Do you intend to continue the microminiaturization of this?

Mr. FISCHELL. Yes. We are very pleased to have the assistance and the financial support of NASA to sponsor a program to further microminiaturize the circuitry. This little box is the circuitry for our next pacemaker. This is being sponsored by NASA, using space technology developed for our most sophisticated spacecraft. We hope to see this implanted in more U.S. patients.

Mr. BELL. What are the future implications of this situation?

Mr. FISCHELL. There are several items we think have considerable potential. A doctor in New York is working on this and work is being done at Johns Hopkins. By stimulating the brain, one can effect a cure for diseases such as epilepsy. Dr. Cooper demonstrated this. We must get the electricity now within the body. At present, those patients that use this brainpacer, they have a large box in the body. This must be carried around and kept in contact with the receiver under the skin. It is put on with adhesive tape.

By using the technique that we have developed, using the space-type cell, we can make a stimulator for the brain which helps cure many brain problems. It also helps cerebral palsy. These results are most interesting. We hope to be able to apply these techniques for other disorders of the human body, as such.

The CHAIRMAN. Does that complete your testimony?

Dr. Low. I understand that Mr. Frazier is also a weightlifter. I won't ask him at this time to demonstrate that, but I think this is a good example of what this technology can do.

I want to thank Jeni for being so patient and bearing up with us. She is a very pleasant little girl.

Mr. FISCHELL. Yes. She says would you like to feel her pacemaker. When she gets to know you she says—"Would you like to feel my pacemaker?"

Dr. Low. She was at NASA Headquarters yesterday and practically all work stopped during her short visit.

The CHAIRMAN. The committee wants to thank you all very much for your efforts in coming. This is the kind of thing that people across the country just don't see. I hope a lot of people will see it today because of television. Thank you all very much.

Dr. Low. I would now like to introduce Dr. Charles J. Robinove of the U.S. Geological Survey, who will discuss the use of ERTS data for flood disaster alleviation and for water resource control.

STATEMENT OF DR. CHARLES J. ROBINOVE, U.S. GEOLOGICAL SURVEY

Dr. ROBINOVE. Thank you. After the demonstration, this is a difficult thing to follow. I will try to bring it into a different field with a different scale. I have three viewgraphs to project.

I will discuss the results of two of the experiments that we are doing with Earth research technology satellites. We are talking about the Department of the Interior program. We are interested in getting results from the use of the satellite.

The graph that you see on the wall at present, this shows pictures taken by the Earth Resources Technology Satellite in 1972 and 1973 along the Mississippi River where we experienced one of the worst floods ever. The picture on the far left is from October 2, 1972. This shows the flood conditions. The river, the dark line coming down the center of the picture. This is because the river is at low flow. The second set of pictures were taken on May 5, 1973. The dark areas along the Mississippi from Cairo to the Arkansas River are in flood. These two pictures, because of the uniformity with which the satellite takes them, and because of the unique characteristics of the pictures, are very simply combined. We combined this one and that one in color. We arrived at this picture. It is a completely false color picture and it bears no relation to the colors on the ground. The yellow areas are areas that were dry at both times of the year. The blue area, the channel of the river, these were areas that were wet at both times of the year. The red areas are those areas that were flooded.

This is a simple technique, the process of making these pictures once we have data from the satellite. This would cost in the order of \$100. What we have is a way of assessing the effects of the floods over extremely large areas. We have not had the capability to do that heretofore by aircraft, although we can collect some of that data. But the cost and time it takes to process it is almost prohibitive. We can combine the images with the maps made of the use of the land and we can say how many acres of crops were inundated and where the plantant may be effective or late. This could also affect any shortage of crops.

The first ability to do this was demonstrated with smaller floods in Iowa. It applies to smaller floods.

Now the second case involves the management of water in southern Florida. In the upper left-hand corner we see an Earth resources satellite of southern Florida. This includes Miami. The Everglades Swamp is shown. There is Lake Okeechobee, which is the basic source of water and several conservations areas where water is stored.

The water moves from the lake to the conservation areas. It is dis-source of water and several conservations areas where water is stored. The water moves from the lake to the conservation areas. It is distributed to agricultural areas and the coastal cities and to the Everglades. There is a competition for water in this area. The only way to solve that problem is to manage it properly so that it can be distributed where needed at the proper time.

What we are trying to do is to learn with the Earth resource technology satellite how to do that. If you look at the conservation area, which is a broad flat area where water is stored, this is reproduced in this lower picture. This is shown so the area of conservation is shown in different colors. Each of these colors relates to a different depth of water. It is deepest at the south end and shallowest at the north end. This was taken March 22, 1973. Eighteen days later this picture was taken. The red color has moved farther south and there is less deep water; 36 days later this picture was taken. There is a larger area of red and a smaller volume of deep water. We find that we can map the volume of water that is available with the satellite. We also use data collection platform which measures within one one-hundredth of a foot the level of the water. This is a platform placed in the conservation area which relays its data through an antenna to the satellite. That relays it back through the NASA facilities to the water management facilities in southern Florida.

The next one shows the situation in the Everglades where you have a flood. You have a large area covered with water. With the satellite we can get water levels within one one-hundredth of a foot by using data collection platforms relaying to the satellite. We can determine the current volume of water in storage. It is that volume and the knowledge of it that is the key to the water management. We, therefore, know how much water is there, and it can be distributed properly.

The model is operated by the U.S. Army Corp of Engineers. They are working with this type of data to see how it fits exactly into their model and exactly how much it improves their practice. We are hopeful there will be significant improvements in the water management processes in southern Florida.

In summary, we have two experiments conducted with the Earth satellite that have very significant potential benefits, not only to the United States but to other countries of the world. These were two out of a multitude of experiments that have been conducted.

Mr. DAVIS. May I ask a question?

The CHAIRMAN. Yes.

Mr. DAVIS. There are certain types of vegetation which cannot survive in acid soil. Others love the acid. There are those such as cedar trees which love limestone in the soil. I wonder if you have given any thought or effort toward analyzing the soil by examining the type of vegetation?

Dr. RIBINOVE. There has been some work done on that. A large amount of this was done by Purdue University. They have worked in teams to try to determine what the soil types are by looking at the soil when the leaves are off the soil or the trees. This has been done by aircraft or satellite data. There has been work done by the Geological Survey. It is in a preliminary stage. It is a very difficult piece of research.

The metals may lead to ore deposits as the trace elements in the soil are taken up by the trees and the characteristics are changed. This can be done in some specific areas. We hope that can be extended further.

Mr. GUNTER. Are you sufficiently far along in the development of technology to share that with water management districts in Florida or not? Are you at the state where they are using this information and input?

Dr. RIBINOVE. Yes. Our work on these experiments is conducted in day-to-day operations with the other Florida water flood control districts and the Corps of Engineers and other agencies in the area. The use of the data is part of our experiment.

Mr. MILFORD. A very vital question that is being asked not only in this country but all over the world is monitoring our food supplies, particularly the agricultural crops that may be growing and being able to spot the drought areas or storm damage areas, et cetera. As a practical matter, do you have the capability for monitoring the wheat crops in the United States and telling, No. 1, the condition of the crop or if it will be poor or fair or good; and No. 2, being able to estimate from that the amount of harvest we might have. Before us is a question of whether or not we have adequate wheat to supply our own needs. That is coupled with what we are exporting. Is this a practical factor or can you practically determine and answer these questions?

Dr. RIBINOVE. Yes. That is not my own particular field, but I think I can speak to it.

There are two steps in answering that. The first is, yes, it is possible with the Earth satellite to determine the acreage planted in wheat.

In terms of determining how many bushels per acre the crop will yield, this is a much more difficult thing to do. This involves more. But putting them together the Department of Agriculture has researched this. It is conducting experiments. I think the answer is yes.

Mr. FREY. Will you yield?

Mr. MILFORD. Yes.

Mr. FREY. They are experimenting in Florida on the young tree decline in the citrus problem. They have worked through the program on trying to pick out the diseased trees from the air. The only present cure is to yank the trees and pull them out so the disease will not spread. I have seen several studies on this and with other types of agriculture crops. They have worked on this and there is a direct application in our State where citrus is a key industry.

The CHAIRMAN. Thank you very much for appearing. We appreciate it.

Dr. Low. Our next witness is Dr. Paul R. Hoffman, vice president of the AVCO Corp. He will discuss and demonstrate the use of ferro-fluids, developed by NASA in rocket fuel research, for auto scrap recovery.

STATEMENT OF DR. PAUL R. HOFFMAN, VICE PRESIDENT, MATERIALS AND CHEMICAL PROCESSES

Dr. HOFFMAN. Mr. Chairman, members of the committee, thank you for the opportunity to describe how the support of the NASA technology utilization program has recently helped commercialize a

development which promises to provide great benefit to the public sector.

The development is a new and improved way of recovering and recycling scrap nonferrous metals—metals such as aluminum, zinc, copper, titanium, and many others. At present, vast domestic resources of these minerals in the form of scrap metals are now being wasted, or at least underutilized, for the lack of efficient recycling techniques.

Now, through the use of magnetic liquids, called ferrofluids, which were pioneered by NASA in the early sixties, these valuable metals can be recovered and recycled economically.

The key effective recycling of nonferrous scrap metals is to separate them from the mixtures in which they occur, into separate groupings—all the zinc together, all the copper together, and so on. Until now, most mixtures of nonferrous scrap metals have been separated manually, or by a series of costly and inefficient processes. Often, the mixtures of metals have been simply discarded, as not being worth the high cost of separation. The AVCO ferrofluid process, for the first time, permits an economical separation of nonferrous metals.

The principle of operation is amazingly simple. When two objects of different density are immersed in a fluid of intermediate density, the less dense object will float, and the more dense one will sink. For instance, if a stone and a block of wood are placed in water, the wood will float and the stone will sink. A sink-float separation has been made because the separation medium—the water—has a density intermediate to that of wood and the stone. In a similar way, the AVCO process makes a sink-float separation of nonferrous metals based on their density differences.

AVCO discovered that ferrofluids in a magnetic field could lift immersed nonmagnetic objects which would sink in the absence of a magnetic field. The lifting ability, or apparent density, of the ferrofluid can be varied by controlling the magnetic field. If two objects of different density are placed in the ferrofluid, the ferrofluid's apparent density can be changed by controlling the current to the magnet so that the less dense metal floats and the more dense metal sinks.

The materials handling system holds the ferrofluid between the poles of a powerful electromagnet. Conveyors carry the mixed metals into the ferrofluid pool, for which the apparent density has been suitably adjusted. The less dense metal floats to the top, and the more dense metal sinks. Two other conveyors remove the separated fractions from the ferrofluid.

I want to go on now to the principle of operation. It is actually amazingly simple and I think I can then get into other matters.

The CHAIRMAN. Then you may please continue.

Dr. HOFFMAN. The principle of operation is amazingly simple. When two objects of different density are immersed in a fluid of intermediate density, the less dense object will float.

This is the separator built under a NASA Technology Utilization Office contract. Conveyors carry the mixed metals in, and the separated metals out. An electromagnet provides the magnetic field, and is easily adjusted to separate a variety of metals of different densities. Later, you may separate mixed scrap metals, yourself, if you wish, on the small demonstrator in the back of the room.

About seven million old automobiles are scrapped each year by being shredded into pieces in giant hammermills. Another 10 to 15 million old hulks are rotting on the landscape of the country because it would cost more to bring them in for recycling than they are worth as scrap metal. Until recently, the 40 or 50 pounds of nonferrous metals in each hulk had been considered a nearly worthless byproduct, with the primary products being magnetic iron and steel. However, with the AVCO ferrofluid process recovering these nonferrous metals economically, the value of each hulk will increase. It will then be profitable to bring into processing centers added millions of junk autos now blighting the countryside.

In other applications, the AVCO process may help reduce the cost of jet aircraft by upgrading the value of scrap titanium and other valuable metals left as byproducts of the manufacture of jet engines and aircraft. Eventually, the separator may help to offset the high costs of proper solid waste disposal, through recovering valuable nonferrous metals from municipal dumps and incinerator residues.

I am sure it is not necessary to detail to you the vital necessity of preserving the mineral resources of this country. For many metals of commerce, we are in, or at least approaching, a critical shortage position domestically. The United States is becoming increasingly dependent upon foreign sources for these minerals, either as ores or as semifinished metals, with harmful effects on the balance of payments and on the Nation's strength in periods of national emergency.

As we look at slide No. 3, we are talking about the overview of NASA machines. Then we will look at slide No. 4 and we will have a closeup of this.

The CHAIRMAN. Yes, please go ahead.

Dr. HOFFMAN. This is the separator built under a NASA technology utilization office contract.

Mr. FREY. What does this mean as to dollars?

Dr. HOFFMAN. These metals, when put together, represent \$27 million.

Full recovery of the nonferrous metals from auto hulks would yield, annually, nearly 400 million pounds of zinc, aluminum, and copper. Mixed together, these metals are of relatively little value, but when properly segregated into their separate metal types they are worth over \$100 million.

The energy to produce a metal from the ore is far greater than the energy required to produce the same metal from scrap. Fully recycling the nearly 400 million pounds of nonferrous metals from auto shredding could replace an equal amount of virgin metal, and thereby save about 1 billion kilowatt hours of electrical energy yearly—enough power to supply a city of 500,000 people. In addition, it would also reduce our dependence on foreign metals and ores and aid the U.S. balance of payments.

How has the NASA technology utilization program helped to bring about the development of an improved way to recycle scrap nonferrous metals? In the early days of the space program, NASA recognized that if a fluid could be made magnetic, it could solve some problems which were present in the development of space vehicles. Magnetic liquids, now called ferrofluids, had been known for some years but initially were technical curiosities, with unknown practical value. In the early sixties, NASA Lewis Research Center

undertook the development of improved ways of making ferrofluids, and of utilizing them for sophisticated applications in space programs. AVCO's Systems Division received several contracts from NASA in the mid-sixties to further develop ferrofluids and their applications to space problems.

Concurrently with the Government-funded efforts, AVCO was investing substantial amounts of its own funds in the investigation of possible commercial uses of ferrofluids. The first application which emerged from the many studied was the separation of scrap non-ferrous metals.

The NASA technology utilization program served a very vital need in the development of this process. Under a \$75,000 contract awarded to AVCO Systems Division, NASA supported the scale-up and construction of the first separator of a size approaching commercial needs—the unit pictured.

NASA has done much more than just support a prototype machine. They have performed an independent assessment of the process. They have given it visibility to an extent greater than AVCO could have accomplished alone.

NASA has been a catalyst—bringing what was first a laboratory model up to the point where the concept has been proven on a nearly full-scale unit and many potential applications have been identified. Private firms can now carry on, with reasonable confidence, to invest the further funds needed to make this process a viable, fully commercial reality.

AVCO's work is not through yet, but the initial commercialization is at last in sight. Soon, this offshoot of NASA space technology will be at work recycling tons of nonferrous metals not now recoverable by other means. Returns to the public, in the form of needed metals, reduced drains on energy and mineral resources, and a better balance of payments, should far exceed this investment by the Government in promoting its development.

Thank you, Mr. Chairman.

Our last presentation was to be by Mr. William H. Podolmy of Pratt and Whitney. He was going to discuss the emerging attractiveness of fuel cells for supplemental electric power generation.

Dr. Low. I would like to put that statement in the record. There are also people here with our other displays. We would like to have them stay this afternoon. Perhaps the members may wish to look at these displays later.

The CHAIRMAN. Any statements you wish may be inserted in the record.

[Statement of Dr. Hoffman follows:]

STATEMENT OF PAUL R. HOFFMAN, VICE PRESIDENT, MATERIALS AND CHEMICAL PROCESSES, AVCO SYSTEMS DIVISION, LOWELL, MASS.

Mr. Chairman and members of the committee, thank you for this opportunity to describe how the support of the NASA Technology Utilization Program has recently helped commercialize a development which promises to provide great benefit to the public sector. The development is a new and improved way of recovering and recycling scrap nonferrous metals—metals such as aluminum, zinc, copper, titanium, and many others. At present, vast domestic resources of these minerals in the form of scrap metals are now being wasted, or at least under-utilized, for the lack of efficient recycling techniques. Now, thorough the use of magnetic liquids, called "ferrofluids", which were pioneered by NASA in the early sixties, these valuable metals can be recovered and recycled economically.

The key to effective recycling of nonferrous scrap metals is to separate them from the mixtures in which they occur, into separate groupings—all the zinc together all the copper together, and so on. Until now, most mixtures of nonferrous scrap metals have been separated manually, or by a series of costly and inefficient processes. Often, the mixtures of metals have been simply discarded, as not being worth the high cost of separation. The AVCO ferrofluid process, for the first time, permits an economical separation of nonferrous metals.

The principle of operation is amazingly simple. When two objects of different density are immersed in a fluid of intermediate density, the less dense object will float, and the more dense one will sink. For instance, if a stone and a block of wood are placed in water, the wood will float and the stone will sink. A sink-float separation has been made because the separation medium—the water—has a density intermediate to that of wood and the stone. In a similar way, the AVCO process makes a sink-float separation of nonferrous metals based on their density differences. (Lights off)

SLIDE 1—FERROFLUID LEVITATION CONCEPT

AVCO discovered that ferrofluids in a magnetic field could lift immersed non-magnetic objects which would sink in the absence of a magnetic field. The lifting ability, or apparent density, of the ferrofluid can be varied by controlling the magnetic field. If two objects of different density are placed in the ferrofluid, the ferrofluid's apparent density can be changed by controlling the current to the magnet so that the less dense metal floats and the more dense metal sinks.

SLIDE 2—THE MATERIALS HANDLING SYSTEM

The materials handling system holds the ferrofluid between the poles of a powerful electromagnet. Conveyors carry the mixed metals into the ferrofluid pool, for which the apparent density has been suitably adjusted. The less dense metal floats to the top, and the more dense metal sinks. Two other conveyors remove the separated fractions from the ferrofluid.

SLIDE 3—OVERVIEW OF NASA MACHINE, THEN SLIDE 4—CLOSE-UP

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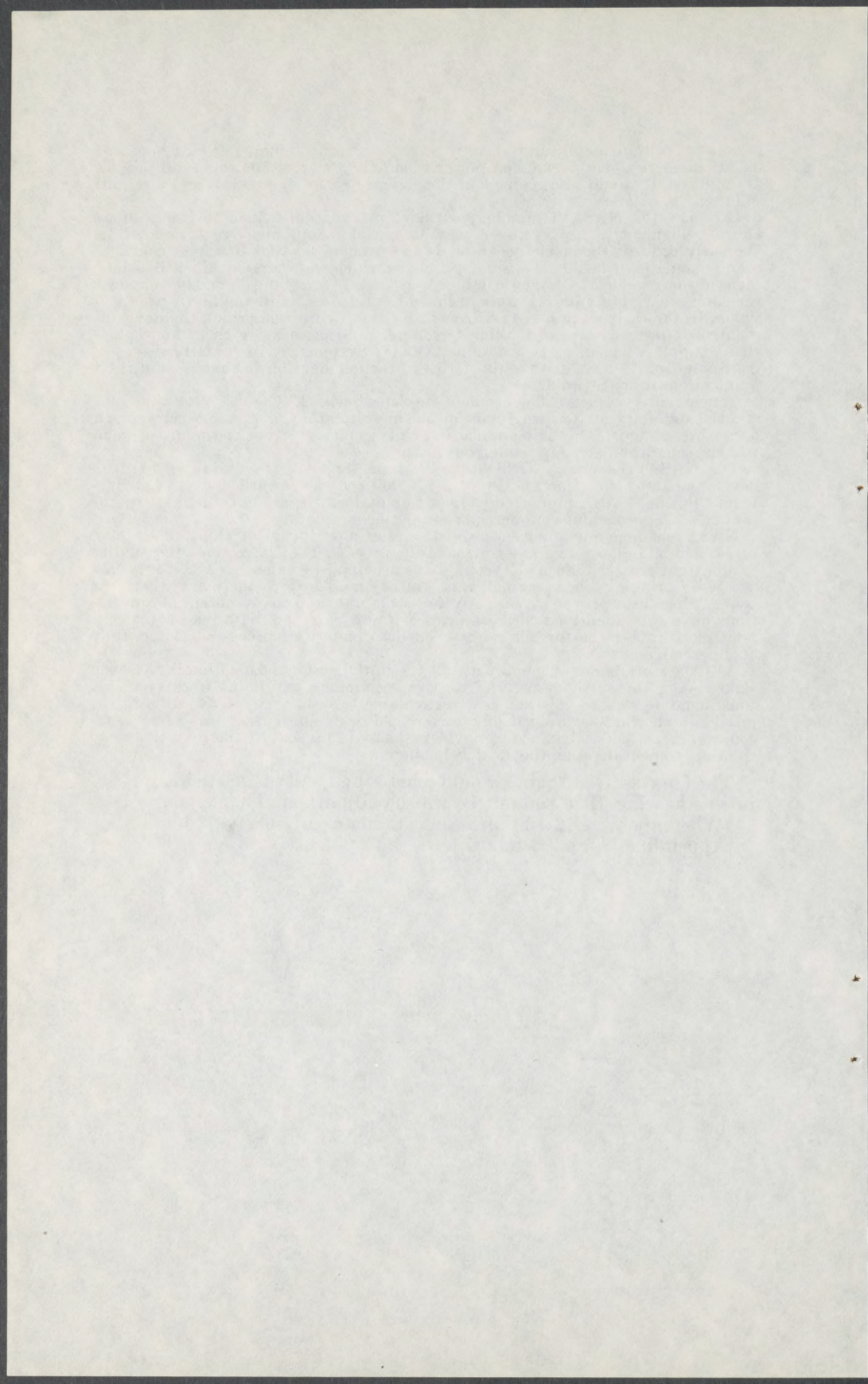
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The CHAIRMAN. Again I would like to thank all the participants in this hearing. The committee will be adjourned. Thank you.

(Whereupon, at 12:10 p.m., the committee adjourned.)

[Appendixes A and B follow:]



APPENDIX A

*National Aeronautics and
Space Administration*

**ANNUAL
PROCUREMENT
REPORT**

FISCAL YEAR 1973



NASA HEADQUARTERS

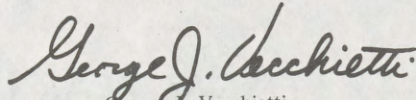
WASHINGTON, D. C. 20546

FOREWORD

Fiscal Year 1973 witnessed the last and most productive of the Apollo flights to the Moon. It also saw the first use of the Skylab space station whose crew photographed more than 4 million square miles of the Earth's surface and observed the Sun through Skylab telescopes for nearly 82 hours. The Skylab I astronauts also demonstrated man's ability to perform valuable services as scientists and engineers for long periods of time in the weightless environment of space. The practical benefits of the Skylab program were augmented by the highly successful flights of two unmanned missions, the first Earth Resources Technology Satellite and the Copernicus Astronomical Observatory. Other unmanned spacecraft launched by NASA in Fiscal Year 1973 included Pioneer 11 which is to follow Pioneer 10 through the Asteroid Belt to Jupiter and beyond. The two manned missions and the 15 unmanned spacecraft launched in Fiscal Year 1973 demonstrate the broad scope of the national space effort and the new goals and opportunities now being stressed. Major contracts for development of the Space Shuttle were awarded during the year and an agreement was reached under which nine European countries are to fund, design and build the manned Spacelab module for use with the Shuttle. Preparation for the Apollo-Soyuz Test Project, a joint effort with the Soviet Union, also progressed smoothly. In aeronautics, efforts to reduce aircraft noise in the vicinity of airports were stressed along with demonstrations of advanced technology to make aircraft safer for both long and short hauls.

Achievement of these goals was made possible by the outstanding scientific and technical competence and dedication of the business firms, educational institutions, private research organizations and other Government agencies that participated in the programs. However, in its selection of these participants and in the implementation of its procurement policies, NASA has been keenly aware of its obligations to look to the future and develop a broad national base of research capability; to promote effective cost-consciousness and management by contractors while maintaining high standards of technical achievement; to seek maximum practicable competition; to encourage small business and minority enterprise participation in the space program; and to advance geographical distribution of its research and development procurements consistent with efficient contract performance.

The statistics in these annual procurement reports are compiled as a source of information for those interested in the procurement aspects and economic impact of the NASA programs.



George J. Vecchieth
Assistant Administrator
for Procurement

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INTRODUCTION

This report presents summary data on all procurement actions accomplished during Fiscal Year 1973 by NASA Headquarters and field procurement offices.

The report also provides detailed data on all actions on each research and development contract and on each contract with and grant to educational and other nonprofit institutions on which the cumulative obligations amount to \$10,000 and over; and on all actions on each other contract on which the cumulative obligations amount to \$25,000 and over. The detailed data include such information as pricing provisions, fees, place of performance and contract descriptions not reported on the smaller contracts or purchases.

The aggregate dollar value of the actions on which detailed data are obtained constituted 95 percent of the total dollar value of all procurements accomplished during Fiscal Year 1973. However, in terms of numbers of actions, these larger contracts and grants accounted for only 8 percent of the total actions.

The term "procurement action" as used in this report means contractual actions to obtain supplies, services or construction which obligate or deobligate funds. A procurement action thus may be a new contract or purchase order, or a debit or credit change such as an amendment, supplemental agreement, change order, cancellation, or termination that changes the total amount of funds obligated. The term "net value of awards" or "net value" refers to the net amount of obligations resulting from debit and credit procurement actions.

The report was prepared by the Information Systems Branch, Staff Operations Division, Office of Procurement, NASA Headquarters. Inquiries and suggestions with reference to the report should be addressed to:

National Aeronautics and Space Administration
Office of Procurement (Code HA)
Washington, D. C. 20546

SUMMARY

NASA's procurements during Fiscal Year 1973 totalled \$2,673 million. This is 2 percent less than was awarded during Fiscal Year 1972 (for further detail see Page 4).

Approximately 77 percent of the net dollar value was placed directly with business firms, 5 percent with educational and other nonprofit institutions or organizations, 8 percent with the California Institute of Technology for operations conducted by or through the Jet Propulsion Laboratory and 9 percent with or through other Government agencies (Page 4).

Ninety percent of the dollar value of procurement requests placed by NASA with other Government agencies resulted in contracts with industry awarded by such other agencies in behalf of NASA. Also, about 61 percent of the funds placed by NASA under the Jet Propulsion Laboratory contracts resulted in subcontracts or purchases with business firms. In short, about 90 percent of NASA's procurement dollars was contracted to private industry (Page 7).

Sixty-two percent of the total direct awards to business firms represented competitive procurements, either through formal advertising or competitive negotiation. Thirty-eight percent constituted noncompetitive procurements. With respect to the competitive procurements, 15 percent of the total awards represented new contracts and 47 percent constituted within scope modifications (incremental funding actions and change orders) to contracts awarded competitively in prior years. Of the noncompetitive procurements, 9 percent of the total awards represented new contracts and 29 percent constituted noncompetitive modifications to contracts awarded in prior years. With further respect to these noncompetitive procurements, 7 percent of the total awards represented follow-on after competition awards to companies that had been previously selected on a competitive basis to perform the original research and development on the applicable projects. In these instances, selection of another source would have required an extensive period of preparation for manufacturing and additional cost to the Government by reason of duplication of investment and preparation. The remaining 31 percent included awards arising from acceptable unsolicited proposals offering new ideas and concepts; awards to contractors having unique capabilities to meet particular requirements of the Government; and awards for sole source items (Page 10).

With respect to contract pricing provisions, awards on incentive contracts amounted to 58 percent of the total awards of \$25,000 and over to business firms. Awards on cost-plus-fixed-fee contracts constituted 28 percent of the total. Firm-fixed-price contracts accounted for 11 percent of the total (Pages 16-17).

Small business firms received \$155 million or 8 percent of NASA's direct awards to business firms. This reflects the fact that most of the awards to business firms were for large continuing research and development contracts for major systems and major items of hardware. These are generally beyond the capability of small business firms on a prime contract basis. However, of the \$489 million of new contracts of \$25,000 and over awarded to business firms during the year, small business received \$75 million or 15 percent (Page 22).

In addition to the direct awards, small business received substantial subcontract awards from 82 of NASA's prime contractors participating in its Small Business Subcontracting Program. Total direct awards plus known subcontract awards to small business aggregated \$254 million or 13 percent of NASA's total awards to business firms during the year (Page 22).

Included in the awards to small business firms were \$12.525 million awarded to minority business enterprises. These procurements comprised \$2.156 million of direct awards, \$7.161 million under Section 8 (a) of the Small Business Act and known subcontract awards of \$3.208 million.

During the year, 48 states and the District of Columbia participated in NASA's prime contract awards of \$25,000 and over. These larger awards went to 1,512 business firms in 42 states and the District of Columbia, to 312 universities and nonprofit organizations in 48 states and the District of Columbia (Page 48). Forty-six percent of the awards was placed in labor surplus areas located in 26 states (Page 56).

Subcontracting effected a further distribution of the prime contract awards. Seventy-four of NASA's prime contractors located in 26 states reported that their larger subcontract awards on NASA effort had gone to 1,027 different subcontractors in 42 states and the District of Columbia. Sixty-five percent of the subcontract dollars crossed state lines (Page 52).

Note: In this report, all tables and charts present data on total procurements of the types specified in the respective sections. Where the data are limited, e.g., to R&D procurements of \$10,000 and over and other procurements of \$25,000 and over, such limitations are indicated by footnotes.

NASA PROCUREMENTS FISCAL YEAR 1973

I. Total Procurements

NASA's procurements in Fiscal Year 1973 totalled \$2,673 million. This is \$65 million or 2 percent less than in Fiscal Year 1972.

The number of procurement actions totalled 233 thousand, which is 12 thousand or 4.9 percent less than in Fiscal Year 1972.

II. Distribution by Type of Contractor

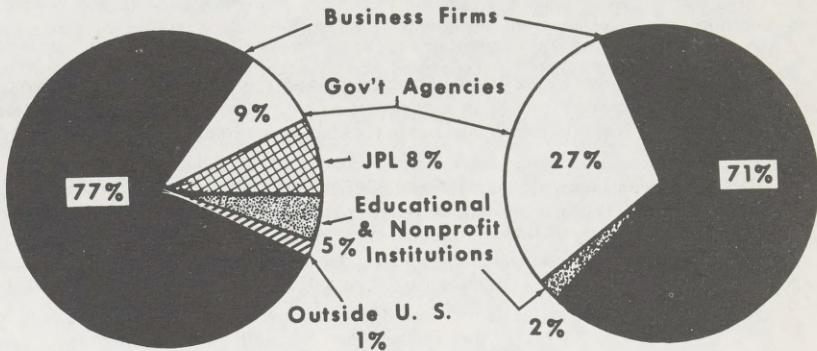
A. **Fiscal Year 1973**—The distribution of NASA's procurements made directly by NASA is shown in Figure 1. Awards to business firms accounted for 77 percent of the total procurements. These awards totalled \$2,064 million which is \$79 million or 4 percent less than in Fiscal Year 1972. Procurements placed through other Government agencies totalled \$235 million, \$27 million or 13 percent more than in Fiscal Year 1972. Awards on contracts with the California Institute of Technology for operations conducted by or through the Government owned Jet Propulsion Laboratory amounted to \$202 million which is \$9 million or 4 percent less than in Fiscal Year 1972. Awards, including grants, to educational and other nonprofit institutions totalled \$138 million, \$9 million or 6 percent less than in Fiscal Year 1972.

In addition to the direct contract awards made by NASA procurement offices, approximately 90 percent of the dollar value of procurement requests placed by NASA with other Government agencies, chiefly the Department of Defense, resulted in contracts awarded to business firms in behalf of NASA. Also, about 61 percent of the funds placed by NASA for programs executed by the Jet Propulsion Laboratory resulted in subcontracts with business firms. Thus, as shown in Figure 2, Page 7, \$2,399 million or 90 percent of NASA's total procurements in Fiscal Year 1973 was ultimately placed with industry. This is \$59 million or 2 percent less than in Fiscal Year 1972.

DISTRIBUTION OF DIRECT NASA PROCUREMENTS FISCAL YEAR 1973

NET VALUE OF AWARDS

NUMBER OF ACTIONS



	(Millions)
<u>Total</u>	<u>\$2,673.4</u>
Business Firms	2,063.8
Educational Institutions	111.7
Nonprofit Organizations	26.4
JPL	202.3
Government Agencies	235.2
Outside United States	34.0

	(Thousands)
<u>Total</u>	<u>233.1</u>
Business Firms	164.4
Educational Institutions	3.2
Nonprofit Organizations	1.6
JPL	0.6
Government Agencies	62.8
Outside United States	0.5

Figure 1

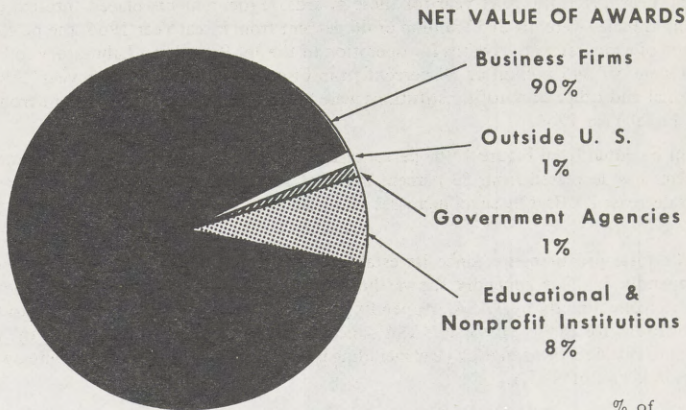
B. **Trend, Fiscal Years 1969 - 1973**—The trend in the distribution of NASA's direct procurements by type of contractor during the 5 year period Fiscal Years 1969 - 1973 is shown in terms of dollars in Figure 3, Page 8 and in terms of percentages of total annual procurements in Figure 4, Page 9. In each of these years, total procurements have been less than in the previous year.

Awards to business firms in Fiscal Year 1973 were down \$2,078 million or 50 percent from Fiscal Year 1965, the peak year for these awards. Procurements placed through other Government agencies were off \$457 million or 66 percent from Fiscal Year 1964, the peak year for this type of procurement. Awards for operation of the Jet Propulsion Laboratory in Fiscal Year 1973 were off \$45 million or 18 percent from Fiscal Year 1965, the peak year. Awards to educational and other nonprofit institutions were down \$40 million or 22 percent from the peak year, Fiscal Year 1966.

As will be noted from Figure 4, the percentage of NASA's total procurements awarded to business firms has decreased from 83 percent in Fiscal Year 1969 to 77 percent in Fiscal Year 1973. This decrease is offset by small increases in the share of the awards to each other type of contractor.

NASA's total procurements since its establishment on October 1, 1958, are shown by year in Appendix I. This appendix shows the distribution of the procurements by type of contractor, as made directly by NASA. Appendix II compares procurement obligations to total agency obligations for each year since NASA's inception. This appendix also shows the total dollars going to business firms in each year including both direct awards from NASA and awards from others in behalf of NASA.

DISTRIBUTION OF NASA PROCUREMENTS BY NASA AND BY OTHERS IN BEHALF OF NASA FISCAL YEAR 1973

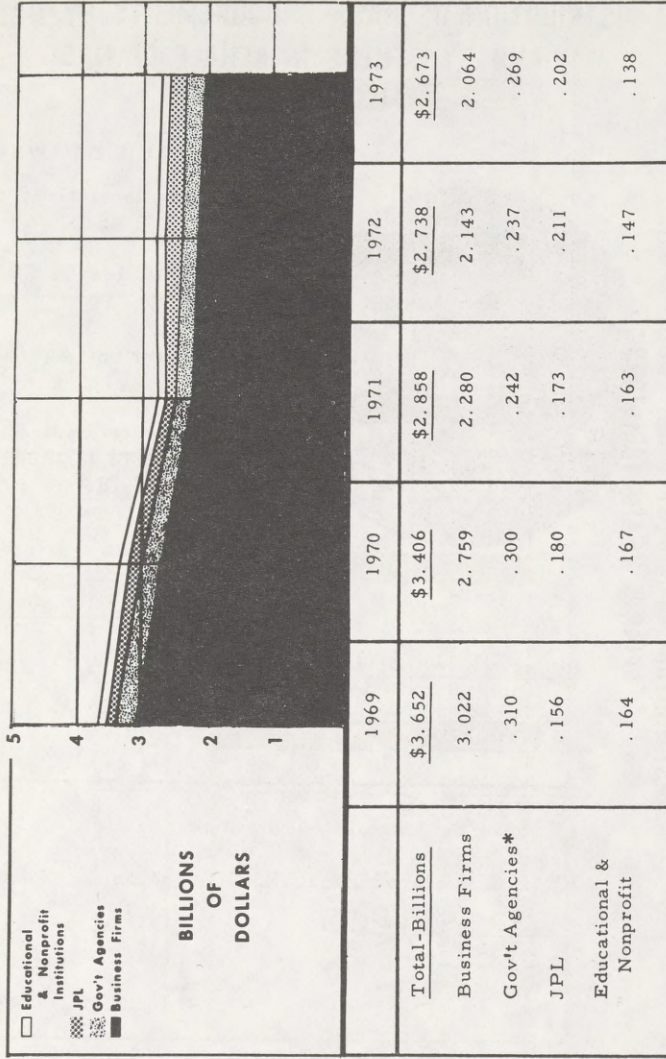


	(Millions)	% of Total
<u>Total</u>	<u>\$2,673.4</u>	<u>100</u>
<u>Business Firms - Total</u>	<u>2,399.2</u>	<u>90</u>
Direct from NASA	2,063.8	77
Thru Other Gov't Agencies	211.7*	8
Thru JPL	123.7*	5
<u>Educational & Nonprofit - Total</u>	<u>216.7</u>	<u>8</u>
JPL (In-House)	78.6	3
Other Educational & Nonprofit	138.1	5
<u>Other Gov't Agencies (In-House)</u>	<u>23.5</u>	<u>1</u>
<u>Outside United States</u>	<u>34.0</u>	<u>1</u>

* Estimated

Figure 2

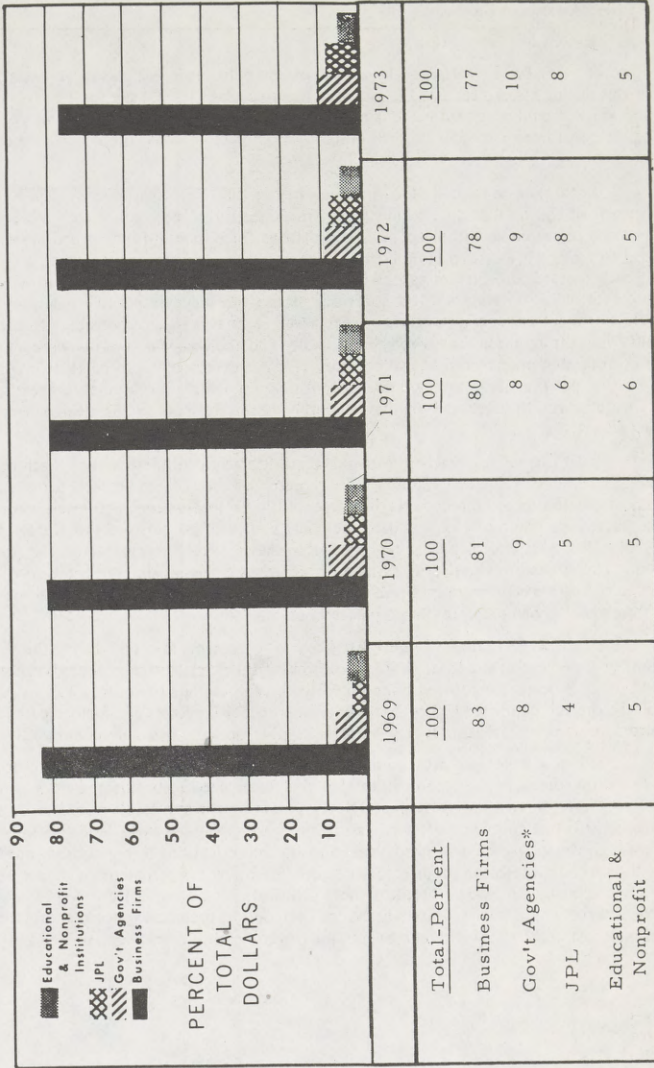
DISTRIBUTION OF DIRECT NASA PROCUREMENTS **FISCAL YEARS 1969-1973**



* Includes awards placed outside U.S.

Figure 3

DISTRIBUTION OF DIRECT NASA PROCUREMENTS FISCAL YEARS 1969-1973



* Includes awards placed outside U.S.

Figure 4

III. Direct Awards to Business Firms

A. Extent of Competition

1. *Fiscal Year 1973*—The extent of competition in NASA's direct awards to business firms during Fiscal Year 1973 is shown in Figure 5, Page 11. Of the total awards of \$2,064 million, \$1,276 million or 62 percent represented competitive procurements, as compared to 61 percent in Fiscal Year 1972; \$788 million or 38 percent constituted noncompetitive procurements.

With respect to the \$1,276 million of competitive procurements, \$308 million, or 15 percent of the total awards to business firms, constituted new contracts; \$968 million or 47 percent represented within scope modifications (incremental funding actions and change orders) to contracts awarded competitively in prior years. In the tabulation in Figure 5, the competitive awards are further categorized to show the amounts placed on contracts awarded through formal advertising and on contracts placed through competitive negotiation. With respect to the latter contracts, offers were received from at least 2 responsible offerors capable of satisfying the requirements wholly or partially and the award or awards were made on the basis of price, design or technical competition. NASA's extensive use of negotiation procedures reflects the fact that its awards are primarily for experimental, development or research work. Specifications for these procurements can rarely be established to the degree necessary for formal advertising.

With further respect to the awards placed through competitive negotiation, approximately 84 percent of their total dollar value represented awards on contracts for which formal source evaluation board procedures had been utilized in the contractor selection process. These boards are composed of qualified technical and business personnel of the field installations and Headquarters, including representatives having key assignments on the projects involved. The procedures under which the boards operate assure implementation of NASA's policy to obtain maximum competition among those sources that possess the qualifications and resources necessary to perform the proposed work.

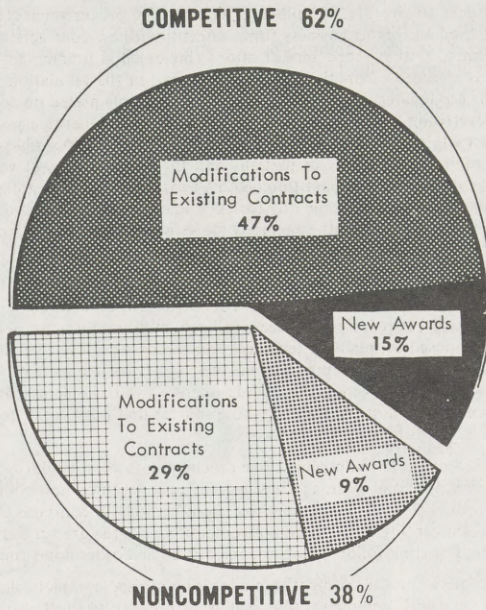
Of the \$788 million of noncompetitive procurements awarded during the year, \$181 million, or 9 percent of the total awards to business firms, constituted new contracts and \$607 million or 29 percent constituted noncompetitive modifications to contracts awarded in prior years. In the tabulation in Figure 5, these noncompetitive awards are further categorized to show the amount representing follow-on after competition and other non-competitive awards.

The new follow-on after competition awards comprised contracts placed noncompetitively during the year with companies that had been previously selected on a competitive basis to perform the original research and development on the applicable projects. The modifications constituting follow-on after competition awards included both modifications to these follow-on contracts awarded in prior years and also modifications to previously awarded competitive contracts where the modifications represented new procurements, e.g., acquisition of additional items of hardware. In all of these follow-on after competition awards, selection of another source would have required an extensive period of preparation for manufacturing, and additional cost to the Government by reason of duplication of investment and preparation.

COMPETITION IN NASA AWARDS TO BUSINESS FIRMS FISCAL YEAR 1973

NET VALUE OF AWARDS

TOTAL \$2,063.8 MILLION



	(Millions)		(Millions)
<u>Competitive-Total</u>	<u>\$1,275.6</u>	<u>Noncompetitive-Total</u>	<u>\$ 788.2</u>
<u>New Awards</u>	<u>308.1</u>	<u>New Awards</u>	<u>181.4</u>
Advertised	28.5	Follow-on After Competition	0.3
Negotiated	279.6	Other Noncompetitive	181.1
<u>Modifications</u>	<u>967.5</u>	<u>Modifications</u>	<u>606.8</u>
Advertised	13.1	Follow-on After Competition	156.8
Negotiated	954.4	Other Noncompetitive	450.0

Figure 5

The "other noncompetitive" awards included both new contracts and modifications to contracts arising from acceptable unsolicited proposals offering new ideas and concepts; awards to contractors having unique capabilities to meet particular requirements of the Government; and procurements of sole source items.

Except for purchases through or from another Government agency, utilities services available only from one source, architect-engineer services, purchases of \$250 or less, procurements of industrial facilities required in support of related procurement contracts, and procurements of scientific experiments based on unsolicited proposals, all single source procurements require detailed written justification. Each such justification for noncompetitive procurement is subjected to detailed review and approval by succeeding higher management levels, dependent upon the dollar amount involved.

When the estimated cost of the single source procurement plus the aggregate amount of follow-on contracts under the same program is expected to equal or exceed the contract approval authority limitation of the respective installation, as set forth in the following tabulation, final approval is reserved to the Administrator (except where approval is delegated to the Head of the installation under the Master Buy Plan Procedure described in the next paragraph).

Contract Approval Limitations

Ames Research Center	\$2,500,000
Kennedy Space Center	
Langley Research Center	
Lewis Research Center	
Goddard Space Flight Center	
Johnson Space Center	
Marshall Space Flight Center	
Headquarters Contracts Division	\$1,000,000
NASA Pasadena Office	
Flight Research Center*	\$ 500,000
Wallops Station**	

*Limitation changed to \$2.5 million in October 1973.

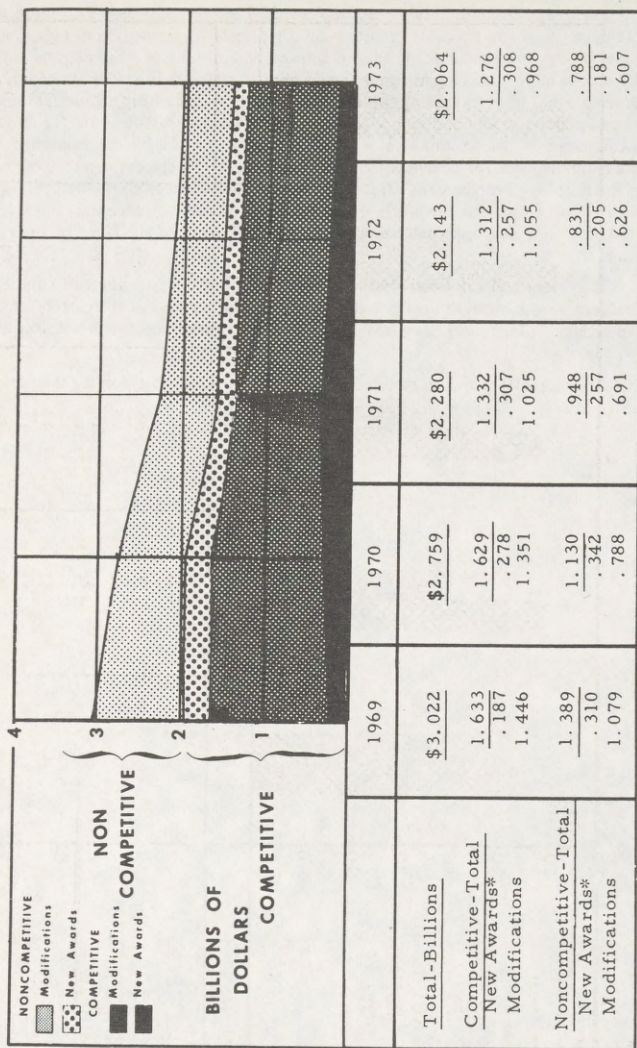
**Limitation changed to \$1.0 million in October 1973.

These approval limitations are subject to a Master Buy Plan Procedure designed to enable management to focus its attention on a representative selection of high dollar value and otherwise sensitive procurement actions without compromise of Headquarters visibility or control over essential management functions. Under this Master Buy Plan Procedure, certain procurements equal to or exceeding the dollar value limitations set forth above are selected to receive Headquarters review and approval including approval of justifications for noncompetitive procurements by the Administrator. The selection is made by the cognizant Program Associate Administrator for Organization and Management with the concurrence of the Assistant Administrator for Procurement. Justifications for noncompetitive procurements which are expected to equal or exceed the above dollar value limitations but which are not selected for Headquarters review and approval are subject to the approval of the Head of the respective installation.

2. *Trend, Fiscal Years 1969 - 1973*—The trend in the extent of competition in NASA's direct awards to business firms during the 5 year period Fiscal Years 1969 - 1973 is shown in terms of dollars in Figure 6, Page 14, and in terms of percentages of total awards in Figure 7, Page 15.

Appendix III provides detailed data on extent of competition for the period Fiscal Years 1961 - 1973.

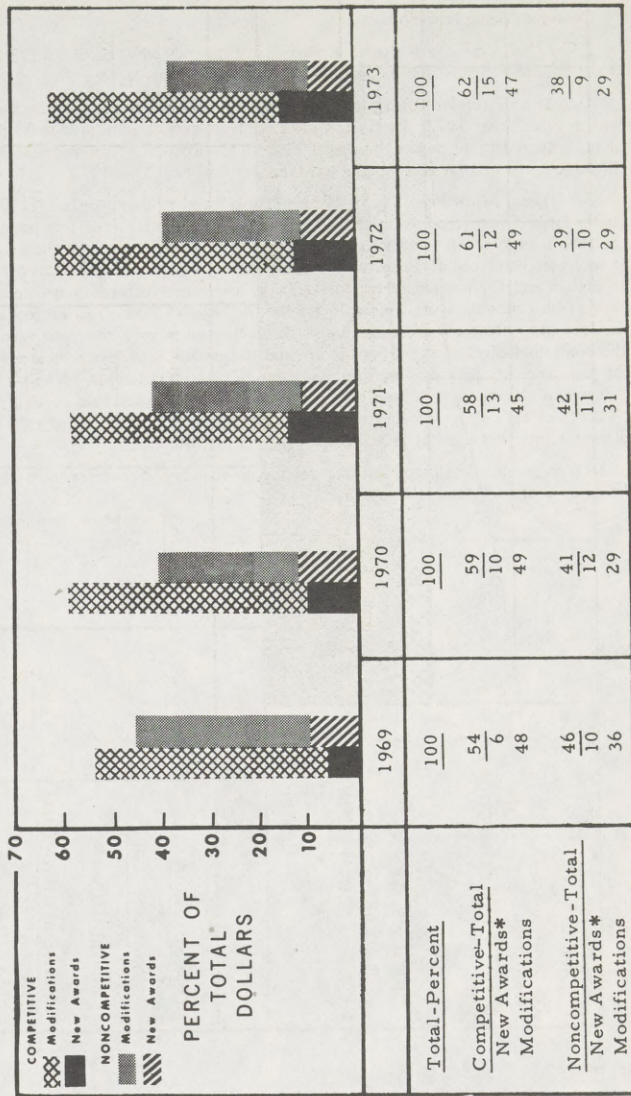
COMPETITION IN NASA AWARDS TO BUSINESS FIRMS FISCAL YEARS 1969-1973



* Data on new contracts are restricted to R&D contracts of \$10,000 and over and all other contracts of \$25,000 and over.

Figure 6

COMPETITION IN NASA AWARDS TO BUSINESS FIRMS FISCAL YEARS 1969-1973



* Data on new contracts are restricted to R&D contracts of \$10,000 and over and all other contracts of \$25,000 and over.

Figure 7

B. Contract Pricing Provisions

1. *Fiscal Year 1973*—Figure 8, Page 17, categorizes Fiscal Year 1973 awards of \$25,000 and over to business firms in terms of contract pricing provisions.

Awards on incentive contracts accounted for 58 percent of the total as compared to 44 percent in Fiscal Year 1972. Firm-fixed-price contract awards amounted to 11 percent of the total as compared to 14 percent in Fiscal Year 1972. Cost-plus-fixed-fee contracts represented 28 percent of the total as compared to 40 percent in Fiscal Year 1972.

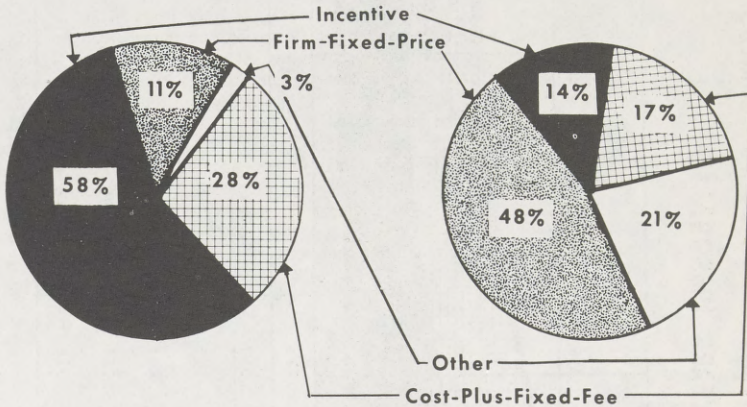
2. *Trend, Fiscal Years 1969 - 1973*—Figures 9 and 10 on Pages 18 and 19 show respectively the latest 5 year trend in dollars and in percentages of total annual procurements with respect to the major types of contract pricing provisions. As will be noted, there was a considerable increase in the use of incentive provisions during Fiscal Year 1973, with respect to both the dollars and the percent of total data. This increase, which resulted from incentive provisions in major procurements for the Space Shuttle, Apollo-Soyuz Test Project and Delta programs, does not reflect any increased emphasis on the use of incentive contracts. It does reflect the continued exercise of particular care and judgement in each of several review steps for major procurements to assure appropriate selection of contract types. NASA recognizes that the degree of effectiveness of incentive arrangements will always remain dependent on the extent of contract definition, the relative precision possible in price analysis, and the factor of technical uncertainty that must be faced during contract performance.

Data in greater detail as to contract pricing provisions and covering the period Fiscal Years 1961 - 1973 are provided in Appendix IV.

**PROCUREMENTS BY CONTRACT PRICING PROVISION
DIRECT AWARDS TO BUSINESS FIRMS *
FISCAL YEAR 1973**

NET VALUE OF AWARDS

NUMBER OF ACTIONS



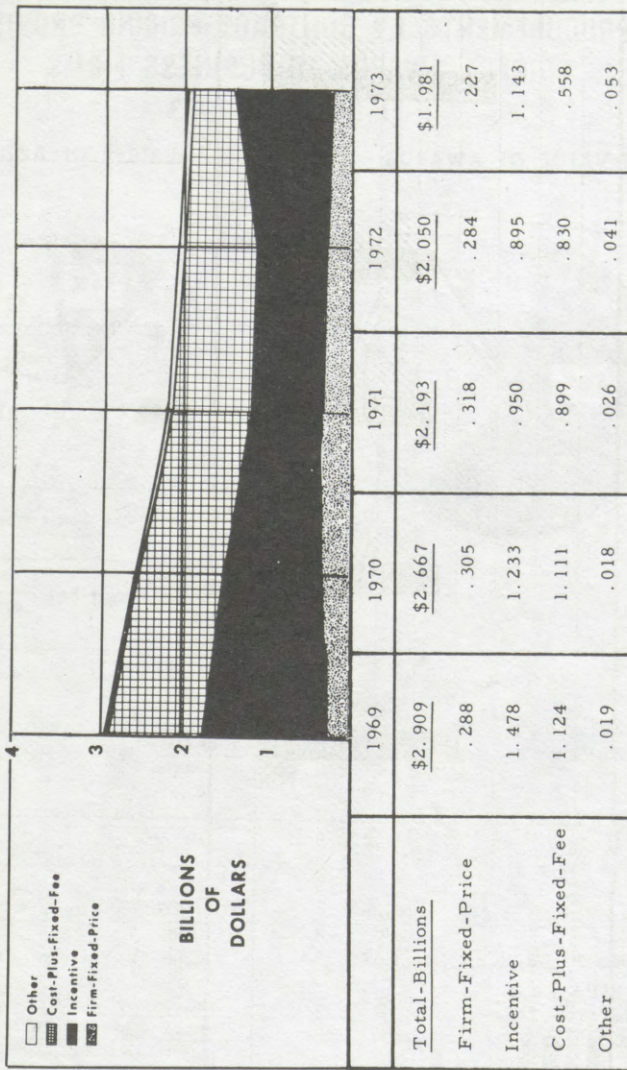
	(Millions)		Actions
<u>Total</u>	<u>\$1,981.3</u>	<u>Total</u>	<u>13,703</u>
<u>Incentive</u>	<u>1,143.0</u>	<u>Incentive</u>	<u>1,969</u>
Fixed Price	133.3	Fixed Price	128
Cost**	1,009.7	Cost	1,841
<u>Other Fixed Price</u>	<u>228.3</u>	<u>Other Fixed Price</u>	<u>6,519</u>
Firm	226.9	Firm	6,510
Redeterminable	1.0	Redeterminable	5
Escalation	0.4	Escalation	4
<u>Other Cost Reimbursable</u>	<u>601.4</u>	<u>Other Cost Reimbursable</u>	<u>2,412</u>
Cost	37.8	Cost	99
Cost-Plus-Fixed-Fee	558.3	Cost-Plus-Fixed-Fee	2,284
Cost Sharing	5.3	Cost Sharing	29
<u>Labor Hour</u>	<u>2.8</u>	<u>Labor Hour</u>	<u>995</u>
<u>Time and Materials</u>	<u>5.8</u>	<u>Time and Materials</u>	<u>1,808</u>

*Includes awards on R&D contracts of \$10,000 and over and on all other contracts of \$25,000 and over.

**Incentive fee and/or award fee. Also includes \$336 million where incentive or award fees are combined with fixed fee provisions.

Figure 8

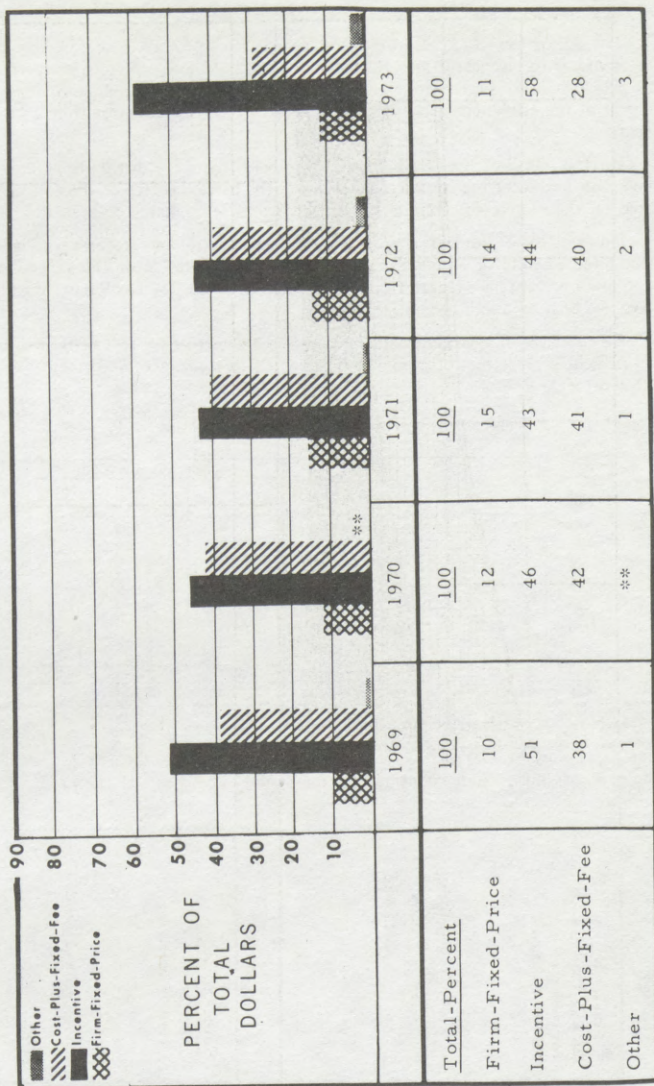
NASA CONTRACT PRICING PROVISIONS-AWARDS TO BUSINESS FIRMS * FISCAL YEARS 1969-1973



* Awards on R&D contracts of \$10,000 and over and on all other contracts of \$25,000 and over.

Figure 9

NASA CONTRACT PRICING PROVISIONS-AWARDS TO BUSINESS FIRMS * FISCAL YEARS 1969-1973



* Awards on R&D contracts of \$10,000 and over and on all other contracts of \$25,000 and over.
 ** Less than 0.5 percent.

Figure 10

C. Negotiated Fees on New Cost-Plus-Fixed-Fee Contracts

1. *Fiscal Year 1973*—During Fiscal Year 1973, NASA awarded 455 new cost-plus-fixed-fee contracts to business firms. The estimated costs of these contracts, exclusive of fees, aggregate \$67.5 million. Fees negotiated on the contracts total \$4.6 million, or an average of 6.82 percent of the estimated costs. On individual contracts, the fees range from 1.45 percent to 8.89 percent.

Parts A and B of Figure 11, Page 21, present frequency distributions showing the percentage distribution of the contracts according to the percentage fee on the contracts. Part A is based on the number of contracts and Part B on the estimated costs of the contracts.

On the basis of number of contracts, the most typical fees are between 7 and 8 percent. One hundred sixty or 35 percent of the contracts provide fees in this range. An additional 156 or 34 percent have fees of from 6 to 7 percent. Thus, 316 or 69 percent of the contracts have fees of from 6 to 8 percent.

On the basis of aggregate estimated costs, 43 percent have fees of from 6 to 7 percent; 33 percent provide fees of from 7 to 8 percent. Thus, a total of 76 percent have fees of from 6 to 8 percent.

Figure 11 is based on the following tabulation:

Percentage Fee	Contracts*			Fee (Thousands)	Estimated Contract Costs			Average Percentage Fee
	Number	Percent of Total	Cumulative Percent		Amount (Thousands)	Percent of Total	Cumulative Percent	
1.00 - 1.99	1	0.2	0.2	\$ 1	\$ 69	0.1	0.1	1,449
2.00 - 2.99	—	—	—	—	—	—	—	—
3.00 - 3.99	4	0.9	1.1	23	742	1.1	1.2	3,099
4.00 - 4.99	14	3.1	4.2	147	3,128	4.6	5.8	4,699
5.00 - 5.99	40	8.8	13.0	393	7,129	10.6	16.4	5,512
6.00 - 6.99	156	34.3	47.3	1,964	29,353	43.4	59.8	6,690
7.00 - 7.99	160	35.1	82.4	1,670	22,266	33.0	92.8	7,500
8.00 - 8.99	80	17.6	100.0	411	4,853	7.2	100.0	8,468
Total	455	100.0		\$4,609	\$67,540	100.0		6,824

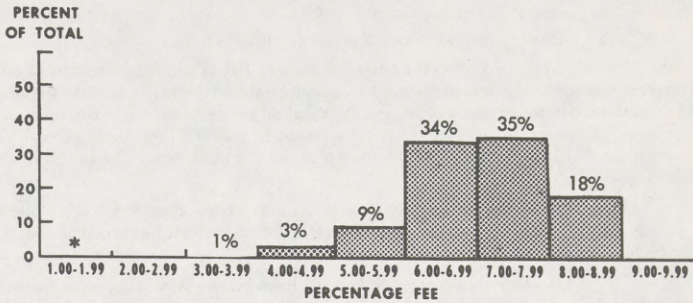
*R&D contracts of \$10,000 and over and all other contracts of \$25,000 and over.

2. *Trend, Fiscal Years 1961 - 1973*—Appendix V shows the average fees and range in fees on new cost-plus-fixed-fee contracts for the period Fiscal Years 1961 - 1973.

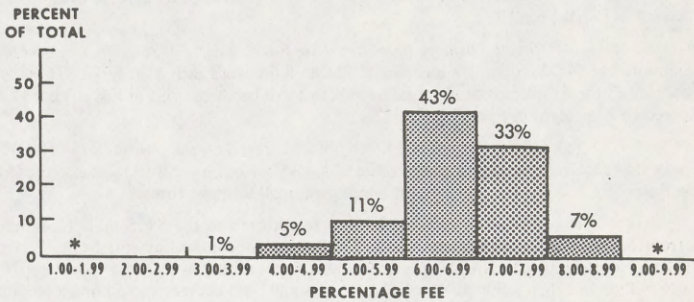
**NEGOTIATED FEES ON NEW COST-PLUS-FIXED-FEE
CONTRACTS AWARDED TO BUSINESS FIRMS****

FISCAL YEAR 1973

A. NUMBER OF CONTRACTS (TOTAL 455)



B. AGGREGATE ESTIMATED COST OF CONTRACTS (\$67.5 MILLION)



* Less than 0.5 percent.

** Includes R&D contracts of \$10,000 and over and all other contracts of \$25,000 and over.

Figure 11

D. Small Business Participation in NASA Procurements

1. Fiscal Year 1973

a. *Participation in Prime Contract Awards*—During Fiscal Year 1973, NASA direct awards to small business firms amounted to \$155.3 million. These awards constituted 8 percent of the total awards to business firms, the same as in Fiscal Year 1972.

The dollar awards to small business firms in Fiscal Year 1973 resulted from 101 thousand procurement actions or 61 percent of the total number of actions placed with business firms.

b. Effort to Increase Small Business Participation

(1) *Share of New Contracts*—Most of NASA's direct awards to business firms involve large continuing research and development contracts for major systems and major items of hardware. These are generally beyond the capability of small business firms on a prime contract basis. However, of the new contracts awarded to business firms during Fiscal Year 1973, which totalled \$489 million, small business received \$75 million or 15 percent, the same as in Fiscal Year 1972.

(2) *Share of Smaller Awards*—Awards of less than \$25,000 to business firms during Fiscal Year 1973 totalled \$83 million. Of these smaller awards, small business firms received \$37 million or 44 percent.

(3) *Extent of Maximum Possible Participation in New Awards*—Assuming that the smaller awards represented new purchases and contracts, the total amount of new awards in which small business could have participated was \$572 million, consisting of the \$489 million of new awards of \$25,000 and over and the \$83 million of awards of less than \$25,000. Of this \$572 million, small business received \$112 million or 20 percent as compared to 21 percent in Fiscal Year 1972.

(4) *Small Business Set-Asides*—In Fiscal Year 1973, small business set-asides amounted to \$47.3 million, an increase of \$2.2 million over Fiscal Year 1972. These set-asides accounted for 31 percent of the total awards to small business firms in Fiscal Year 1973 as compared to 28 percent in Fiscal Year 1972.

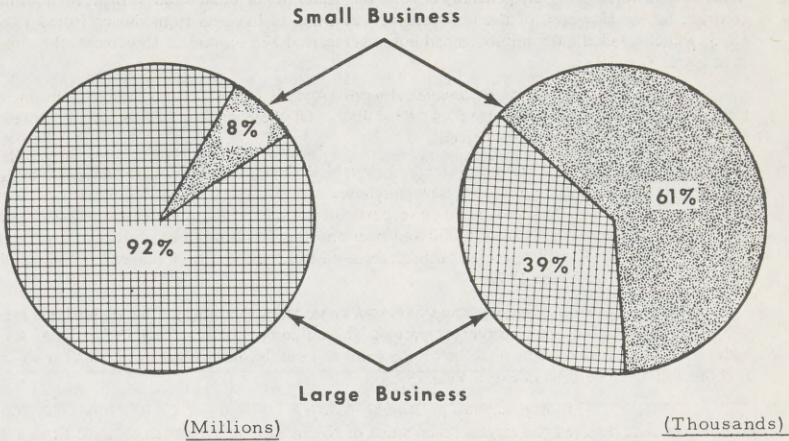
(5) *Representation Among NASA's 100 Largest Contractors*—The 100 contractors that received the largest dollar value of NASA's direct awards to business firms are listed on Pages 30 - 35. Twelve of these contractors are small business firms.

(6) *Impact of Subcontracting*—In addition to the \$155 million of direct awards from NASA, small business received \$99 million in subcontract awards from 82 large business firms participating in NASA's Small Business Subcontracting Program (see Page 26). This is \$26 million less than in Fiscal Year 1972. Thus, small business received a known amount of \$254 million of NASA's dollars plus an undetermined amount from other NASA prime contractors and from other Government agencies including the Department of Defense in behalf of NASA. The \$254 million constituted 13 percent of NASA's total awards to business firms in Fiscal Year 1973 as compared to \$286 million or 13 percent in Fiscal Year 1972.

SMALL BUSINESS PARTICIPATION IN NASA PROCUREMENTS FISCAL YEAR 1973

NET VALUE OF AWARDS

NUMBER OF ACTIONS



Note: Not included are \$7.161 million awarded to small minority firms through the Small Business Administration Section 8 (a) Program (see Page 26).

Figure 12

c. *Analysis of Awards to Large & Small Business Firms*—Figure 13, Page 25, provides information as to why small business did not obtain the contracts of \$25,000 and over that were awarded to large business firms.

As will be noted, small business firms were solicited on \$652 million or 33 percent of the larger awards. This is 1 percentage point higher than in Fiscal Year 1972 and is also higher than in any other year including 1961, the first year information on this item was compiled. Of the awards on which they bid, small business was successful to the extent of 41 percent as compared to 38 percent in Fiscal Year 1972.

Of the \$1,329 million on which small business was not solicited, \$796 million or 60 percent represented awards for which there were no known small business sources. An additional \$525 million or 39 percent are categorized as "other reasons not solicited." A significant amount of these awards represent follow-on contracts with large business firms where small business had not bid on or had not been responsive to the solicitations for the prior contracts. In both these instances, the contracts are primarily for major systems and major items of hardware or services requiring resources generally beyond the capability of small business firms on a prime contract basis.

As is also shown in Figure 13, small business was successful in obtaining \$37 million or 44 percent of the awards of under \$25,000.

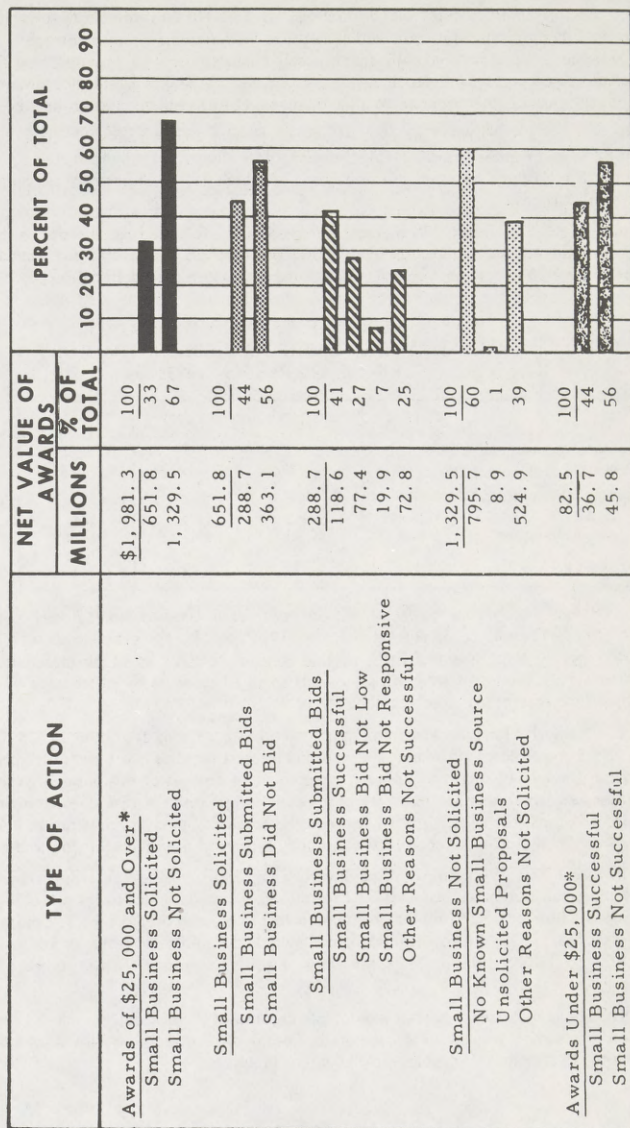
2. *Trend, Fiscal Years 1969 - 1973*—Table I below shows the extent of small business participation in NASA's procurements for the period Fiscal Years 1969 - 1973. Appendix VI provides data for the period Fiscal Years 1960 - 1973. Appendix VII provides historical data with respect to the information shown in Figure 13.

TABLE I—SMALL BUSINESS PARTICIPATION IN NASA PROCUREMENTS
FISCAL YEARS 1969 - 1973

	FY 1969	FY 1970	FY 1971	FY 1972	FY 1973
Net Value of Awards (Millions)					
Total Business	\$3,022.3	\$2,759.2	\$2,279.5	\$2,143.3	\$2,063.8
Small Business Total	162.8	161.2	178.1	160.9	155.3
Set-Asides	31.4	35.7	41.1	45.1	47.3
Other	131.4	125.5	137.0	115.8	108.0
Large Business	2,859.5	2,598.0	2,101.4	1,982.4	1,908.5
Percent of Total					
Total Business	100	100	100	100	100
Small Business Total	5	6	8	8	8
Set-Asides	1	1	2	2	2
Other	4	5	6	6	6
Large Business	95	94	92	92	92

ANALYSIS OF AWARDS TO LARGE AND SMALL BUSINESS FIRMS

FISCAL YEAR 1973



* R&D awards of \$10,000 and over are included in awards of \$25,000 and over.

Figure 13

3. *Small Business Subcontracting Program*—The Government has established a small business subcontracting program which requires Government prime contractors to establish and conduct a program that will enable small business firms to be considered fairly as subcontractors and suppliers under their prime contracts. NASA has established a reporting system in connection with this program so that the extent of its implementation may be determined.

a. *Fiscal Year 1973*—Reports covering Fiscal Year 1973 have been received from 82 large business firms. During the year, these companies subcontracted \$376 million of their NASA business to other business firms of which \$99 million or 26 percent was placed with small business.

b. *Trend, Fiscal Years 1969 - 1973*—Table II, Page 26 shows the extent of subcontracting to small business by NASA large business contractors for the period Fiscal Years 1969 - 1973. (See Appendix VIII for data for the period Fiscal Years 1961 - 1973.)

TABLE II—SMALL BUSINESS SHARE OF SUBCONTRACTS
AWARDED BY NASA LARGE BUSINESS CONTRACTORS
FISCAL YEARS 1969 - 1973

	FY 1969	FY 1970	FY 1971	FY 1972	FY 1973
Number of Reporting Companies	86	83	82	84	82
Subcontracted-Millions					
Total	\$618.8	\$405.5	\$472.1	\$486.3	\$376.0
Small Business Share	\$164.8	\$109.1	\$116.1	\$124.7	\$ 98.6
% to Small Business	27%	27%	25%	26%	26%

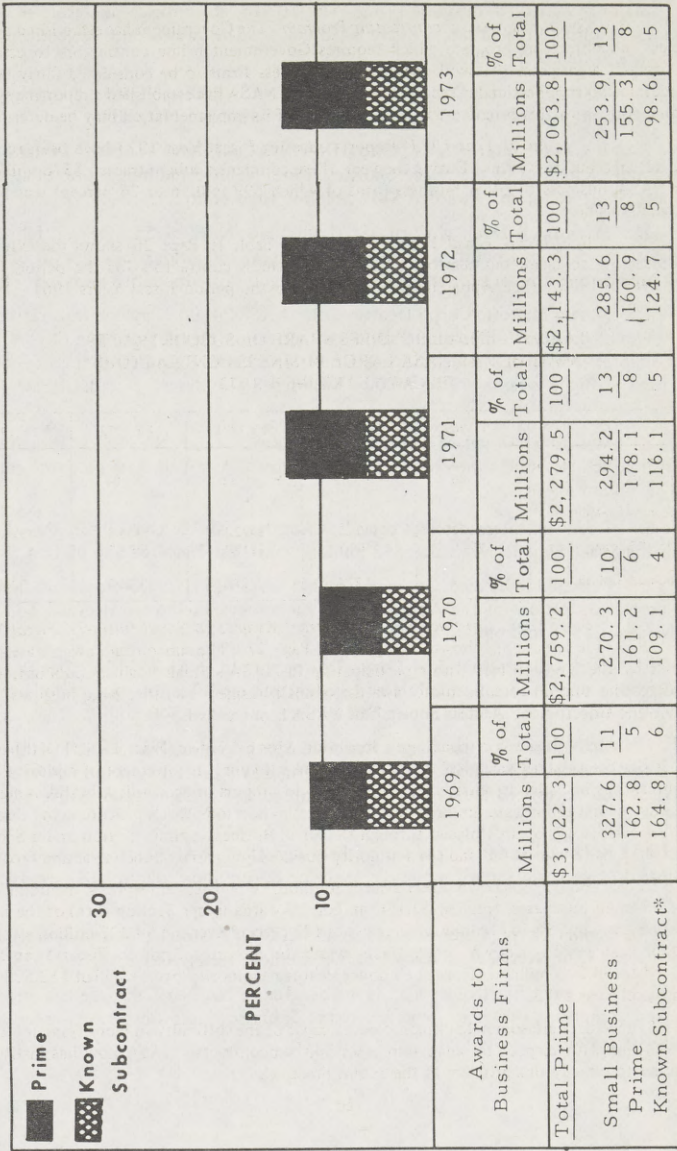
4. *Total Prime Contract and Subcontract Awards to Small Business, Fiscal Years 1969 - 1973*—These data are shown in Figure 14, Page 27. The subcontract awards are those reported by the large business firms participating in NASA's Small Business Subcontracting Program. The amount of subcontract awards to small business by other large business firms and by other Government agencies in behalf of NASA is not known.

E. *Minority Business Program*—In connection with Executive Order 11625, October 13, 1971, it has been determined that the national interest requires involvement of minority business enterprises in Federal procurement programs. In support of this policy, NASA is making continuing efforts to increase minority business participation in NASA's procurements through (1) direct awards, (2) awards placed through the Small Business Administration under Section 8 (a) of the Small Business Act and (3) a minority Business Enterprises Subcontracting Program.

In Fiscal Year 1973, known direct awards to minority business enterprises, including contracts and small purchases, totalled \$2.156 million. Awards under Section 8 (a) of the Small Business Act totalled \$7.161 million, an increase of 122 percent over the \$3.222 million awarded in Fiscal Year 1972. Known subcontract awards to minority firms in Fiscal Year 1973 amounted to \$3.208 million. Thus, the known awards to minority firms totalled \$12.525 million in Fiscal Year 1973.

The above data are somewhat incomplete because of the difficulty in identifying minority business firms with respect to small purchases and subcontracts. NASA now has instituted procedures to remedy this problem to the extent practical.

TOTAL NASA PRIME CONTRACT AND SUBCONTRACT AWARDS TO SMALL BUSINESS FISCAL YEARS 1969-1973



* As reported by NASA large business contractors participating in NASA Small Business Subcontracting Program.

Figure 14

F. **Major Awards To Business Firms**—The 20 largest contracts in terms of aggregate value of awards during Fiscal Year 1973 are listed below. The awards on these contracts during the period aggregated \$927 million.

1. Martin Marietta Corp., Denver, Colo. NAS1-9000. Viking Lander System and project integration. Awarded \$126 million; cumulative awards \$290 million.
2. Rockwell International Corp., Downey, Calif. NAS9-14000. Design, development, test and evaluation of the Space Shuttle Orbiter Vehicle and integration of all elements of the Space Shuttle System. Awarded \$118 million; (new contract).
3. McDonnell Douglas Corp., St. Louis, Mo. NAS9-6555. Design, fabricate and deliver orbital workshops (modified Saturn S-IVB stages) and airlock modules for Skylab Program and provide operational support. Awarded \$111 million; cumulative awards \$688 million.
4. Martin Marietta Corp., Denver, Colo. NAS8-24000. Payload integration for the Skylab Program, program support operation and activation planning for the Skylab Multiple Docking Adapter (MDA) at Kennedy Space Center and Earth Resources Experiment Package (EREP) for the flight version of the MDA. Awarded \$60 million; cumulative awards \$343 million.
5. McDonnell Douglas Corp., Huntington Beach, Calif. NAS7-811. Procurement of Delta research vehicles plus two-year launch capability. Awarded \$56 million; cumulative awards \$73 million.
6. Rockwell International Corp., Los Angeles, Calif. NAS8-27980. Design of main engine for the Space Shuttle. Awarded \$53 million; cumulative awards \$66 million.
7. Fairchild Industries, Germantown, Md. NAS5-21100. Development, fabrication, test and project operations of the Applications Technology Satellites. Awarded \$43 million; cumulative awards \$99 million.
8. Rockwell International Corp., Downey, Calif. NAS9-13100. Design, development and testing of the docking module and system and modification of an Apollo command and service module for the Apollo-Soyuz Test Project. Awarded \$40 million; (new contract).
9. McDonnell Douglas Corp., Kennedy Space Center, Fla. NAS10-7100. Mission launch support services at Kennedy Space Center for S-IVB orbital workshop, airlock module dock services and Saturn IB launch vehicles. Awarded \$38 million; cumulative awards \$84 million.
10. Rockwell International Corp., Downey, Calif. NAS9-150. Design, develop and test Apollo command and service module. Awarded \$36 million; cumulative awards \$3,972 million.
11. Bendix Corp., Columbia, Md. NAS5-23000. Maintenance and operation of the Manned Space Flight Network. Awarded \$33 million; cumulative awards \$73 million.
12. Lockheed Electronics Co., Houston, Texas. NAS9-12200. General electronics, scientific and computing center support services at Johnson Space Center. Awarded \$27 million; cumulative awards \$50 million.

13. International Business Machines Corp., Huntsville, Ala. NAS8-14000. Fabrication of instrument units for Saturn vehicles and related sustaining engineering and flight and launch control computer programming in support of Apollo and Skylab missions. Awarded \$25 million; cumulative awards \$437 million.

14. Bendix Corp., Kennedy Space Center, Fla. NAS10-1600. Apollo launch support services at Kennedy Space Center. Awarded \$25 million; cumulative awards \$218 million.

15. Boeing Company, Kennedy Space Center, Fla. NAS10-7444. Provide installation and technical support services at the Kennedy Space Center. Awarded \$25 million; cumulative awards \$59 million.

16. McDonnell Douglas Corp., Santa Monica, Calif. NAS7-101. Design, develop and fabricate the S-IVB stage of the Saturn V vehicle and associated ground support equipment and provide launch support services. Awarded \$24 million; cumulative awards \$1,216 million.

17. Philco-Ford Corp., Houston, Texas. NAS9-1261. Equipment and construction of facilities for integrated mission control center at the Johnson Space Center. Awarded \$23 million; cumulative awards \$219 million.

18. McDonnell Douglas Corp., Huntington Beach, Calif. NAS7-818. Procurement of Delta first stage boosters and related equipment. Awarded \$23 million; (new contract).

19. General Dynamics Corp., San Diego, Calif. NAS3-13502 Procurement of Centaur long lead hardware requirements for additional Centaur space vehicles. Awarded \$21 million; cumulative awards \$35 million.

20. Federal Electric Corp., Kennedy Space Center, Fla. NAS10-4967. Provide communications, instrumentation and computer operations support services for Kennedy Space Center facilities. Awarded \$20 million; cumulative awards \$113 million.

G. **One Hundred Principal Contractors (Business Firms)**—The one hundred contractors that received the largest dollar value of NASA direct awards to business firms during Fiscal Year 1973 are shown in Table III, Pages 30-35.

The awards to these contractors accounted for 89 percent of the direct awards to business firms during the year. The smallest aggregate award to any contractor was in excess of \$1.2 million.

Twenty-two of these contractors did not appear among the 100 principal contractors during Fiscal Year 1972. Eight of these 22 are small business firms. An additional 4 are small business firms that did appear in the prior list. Thus, 12 of NASA's 100 principal contractors during the year were small business firms.

During Fiscal Years 1962 - 1973, a total of 258 different contractors have appeared on this annual list of NASA's 100 principal contractors. The smallest aggregate annual award to any such contractor was \$700 thousand.

TABLE III—ONE HUNDRED CONTRACTORS (BUSINESS FIRMS) LISTED
ACCORDING TO NET VALUE OF DIRECT AWARDS**
FISCAL YEAR 1973

Contractor & Place of Contract Performance	Rank FY 1972	Net Value of Awards	
		Thousands	% of Total
<i>Total Awards to Business Firms</i>		\$2,063,797	100.00
1. Rockwell International Corp. *Downey, Calif.	3	317,756	15.40
2. McDonnell Douglas Corp. *St. Louis, Mo.	1	272,364	13.20
3. Martin Marietta Corp. *Denver, Colo.	2	191,987	9.30
4. General Electric Company *King of Prussia, Pa.	4	86,856	4.21
5. General Dynamics Corp. *San Diego, Calif.	8	80,422	3.90
6. Bendix Corp. *Columbia, Md.	6	79,054	3.83
7. Boeing Company *Kennedy Space Center, Fla.	5	75,535	3.66
8. Int'l. Business Machines Corp. *Huntsville, Ala.	7	61,307	2.97
9. Fairchild Industries *Germantown, Md.	10	43,724	2.12
10. RCA Corporation *Princeton, N.J.	9	38,227	1.85
11. Philco-Ford Corp. *Houston, Texas	11	37,521	1.82
12. Lockheed Electronics Co. *Houston, Texas	16	29,339	1.42
13. TRW, Inc. *Redondo Beach, Calif.	13	28,223	1.37
14. Chrysler Corp. *New Orleans, La.	17	27,693	1.34
15. Sperry Rand Corp. *Huntsville, Ala.	12	26,558	1.29
16. Computer Sciences Corp. *Silver Spring, Md.	19	25,103	1.22
17. United Aircraft Corp. *East Hartford, Conn.	24	24,986	1.21
18. Federal Electric Corp. *Kennedy Space Center, Fla.	18	24,833	1.20
19. Hughes Aircraft Co. *El Segundo, Calif.	20	20,941	1.01

TABLE III—ONE HUNDRED CONTRACTORS (BUSINESS FIRMS) LISTED
 ACCORDING TO NET VALUE OF DIRECT AWARDS** (Continued)
 FISCAL YEAR 1973

Contractor & Place of Contract Performance	Rank FY 1972	Net Value of Awards	
		Thousands	% of Total
20. LTV Aerospace Corp. *Dallas, Texas	21	\$19,878	.96
21. Northrop Services, Inc. *Houston, Texas	46	16,522	.80
22. Lockheed Missiles & Space Co., Inc. *Sunnyvale, Calif.	22	14,717	.71
23. Kentron Hawaii Ltd. *Houston, Texas	—	12,956	.63
24. Honeywell, Inc. *St. Petersburg, Fla.	27	12,419	.60
25. Grumman Aerospace Corp. Bethpage, N.Y.	14	11,998	.58
26. Litton Systems, Inc. *Los Angeles, Calif.	42	11,235	.54
27. Computing & Software, Inc. *Greenbelt, Md.	28	9,815	.48
28. Teledyne Industries, Inc. *Northridge, Calif.	41	9,759	.47
29. American Science & Engrg., Inc. (S) Cambridge, Mass.	35	8,877	.43
30. Brown Engineering Co., Inc. *Huntsville, Ala.	26	8,617	.42
31. General Motors Corp. *Goleta, Calif.	39	8,124	.39
32. Hayes International Corp. *Huntsville, Ala.	44	7,848	.38
33. Westinghouse Electric Corp. *Friendship Airport, Md.	33	7,450	.36
34. Singer Company *Houston, Texas	29	7,277	.35
35. Garrett Corporation *Torrance, Calif.	36	6,900	.33
36. Lockheed Aircraft Corp. *Marietta, Ga.	43	6,752	.33
37. Global Associates Bay St. Louis, Miss.	32	6,472	.31
38. Raytheon Service Co. *Halethorpe, Md.	(a)	5,896	.29
39. Xerox Corporation *El Segundo, Calif.	34	5,655	.27

TABLE III—ONE HUNDRED CONTRACTORS (BUSINESS FIRMS) LISTED
 ACCORDING TO NET VALUE OF DIRECT AWARDS** (Continued)
 FISCAL YEAR 1973

Contractor & Place of Contract Performance	Rank FY 1972	Net Value of Awards	
		Thousands	% of Total
40. Dynallectron Corp. *Houston, Texas	37	\$ 5,418	.26
41. Mason-Rust New Orleans, La.	40	5,301	.26
42. Morrison-Knudsen Co. Kennedy Space Center, Fla.	—	4,780	.23
43. Pan American World Airways, Inc. *Kennedy Space Center, Fla.	79	4,628	.22
44. Control Data Corp. *Minneapolis, Minn.	31	4,594	.22
45. Chesapeake & Potomac Tel. Co. *Greenbelt, Md.	52	4,442	.22
46. Thiokol Chemical Corp. *Huntsville, Ala.	57	4,187	.20
47. Management Services, Inc. Huntsville, Ala.	61	4,160	.20
48. American Tel. & Tel. Co. *Greenbelt, Md.	56	4,067	.20
49. Aerojet-General Corp. *El Monte, Calif.	15	3,910	.19
50. ILC Industries, Inc. Dover, Del.	30	3,902	.19
51. Informatics Tisco, Inc. College Park, Md.	48	3,844	.19
52. ITT World Communications, Inc. *New York, N.Y.	55	3,743	.18
53. Alpha Building Corp. (S) Houston, Texas	—	3,623	.18
54. Santa Barbara Research Center Goleta, Calif.	47	3,308	.16
55. Textron, Inc. *Fort Worth, Texas	45	3,185	.15
56. Int'l. Tel. & Tel. Corp. *Fort Wayne, Ind.	72	3,017	.15
57. Ampex Corporation *Redwood City, Calif.	89	2,988	.15
58. Aydin Corporation *Fort Washington, Pa.	97	2,898	.14
59. Southern Bell Tel. Co. *Kennedy Space Center, Fla.	60	2,825	.14

TABLE III—ONE HUNDRED CONTRACTORS (BUSINESS FIRMS) LISTED
ACCORDING TO NET VALUE OF DIRECT AWARDS** (Continued)
FISCAL YEAR 1973

Contractor & Place of Contract Performance	Rank FY 1972	Net Value of Awards	
		Thousands	% of Total
60. Serv-Air, Inc. *Edwards, Calif.	92	\$ 2,489	.12
61. Virginia Electric Power Co. *Hampton, Va.	68	2,456	.12
62. Cleveland Elec. Illuminating Co. Cleveland, Ohio	71	2,451	.12
63. Wyle Laboratories Hampton, Virginia	58	2,385	.12
64. Klate Holt Co. (S) *Hampton, Va.	59	2,373	.11
65. Computer Sciences Corp./Technicolor Graphics DP Assoc. (JV) Greenbelt, Md.	—	2,347	.11
66. Collins Radio Company *Addison, Texas	—	2,244	.11
67. Technicolor Graphic Service, Inc. Houston, Texas	66	2,156	.10
68. Woerfel Corp. & Towne Realty Co. (JV) Cape Kennedy, Fla.	—	2,124	.10
69. McGregor & Werner, Inc. (S) Kennedy Space Center, Fla.	74	2,086	.10
70. Ball Brothers Research Corp. Boulder, Colo.	51	2,063	.10
71. Lathrop F.P. Construction Co. Mountain View, Calif.	—	2,030	.10
72. Planning Research Corp. *Huntsville, Ala.	81	2,027	.10
73. Eastman Kodak Co. *Rochester, N.Y.	91	1,995	.10
74. Wackenhut Services, Inc. *Houston, Texas	62	1,917	.09
75. United Air Lines, Inc. San Francisco, Calif.	—	1,913	.09
76. Aero Spacelines, Inc. (S) *Los Angeles, Calif.	—	1,891	.09
77. Wolf Research & Develop. Corp. *Riverdale, Md.	83	1,865	.09
78. Air Products & Chemicals, Inc. *Long Beach, Calif.	54	1,850	.09
79. Lawrence, J. H. Co. (S) Greenbelt, Md.	82	1,831	.09

TABLE III—ONE HUNDRED CONTRACTORS (BUSINESS FIRMS) LISTED
 ACCORDING TO NET VALUE OF DIRECT AWARDS** (Continued)
 FISCAL YEAR 1973

Contractor & Place of Contract Performance	Rank FY 1972	Net Value of Awards	
		Thousands	% of Total
80. S & Q Construction Co. (S) *Mountain View, Calif.	—	\$ 1,819	.09
81. Texas Instruments, Inc. *Dallas, Texas	—	1,785	.09
82. Mechanical Projects, Inc. (S) Hampton, Va.	—	1,782	.09
83. Programming Methods, Inc. *Mountain View, Calif.	75	1,756	.09
84. Electronic Associates, Inc. *Hampton, Va.	70	1,744	.08
85. Perkin-Elmer Corp. *Norwalk, Conn.	65	1,717	.08
86. Taft Broadcasting Co. (S) Houston, Texas	—	1,712	.08
87. Systems Technology Associates, Inc. (S) Falls Church, Va.	—	1,628	.08
88. Potomac Electric Power Co. Greenbelt, Md.	87	1,574	.08
89. R&W Machine Co. (S) Hampton, Va.	—	1,465	.07
90. Honeywell Information Systems, Inc. *Kennedy Space Center, Fla.	85	1,381	.07
91. Jacob Transfer, Inc. Greenbelt, Md.	—	1,355	.07
92. Pacific Gas & Electric Company *Mountain View, Calif.	—	1,348	.07
93. Hewlett-Packard Company *Palo Alto, Calif.	—	1,340	.06
94. Weston Instruments, Inc. *College Park, Md.	64	1,292	.06
95. Western Union International, Inc. New York, N.Y.	—	1,288	.06
96. Systems Engineering Labs, Inc. *Houston, Texas	—	1,265	.06
97. Southwestern Bell Telephone Co. Houston, Texas	100	1,257	.06
98. Raytheon Co. *Sudbury, Mass.	80	1,234	.06

TABLE III—ONE HUNDRED CONTRACTORS (BUSINESS FIRMS) LISTED
ACCORDING TO NET VALUE OF DIRECT AWARDS** (Continued)
FISCAL YEAR 1973

Contractor & Place of Contract Performance	Rank FY 1972	Net Value of Awards	
		Thousands	% of Total
99. Peoples Construction Co. (S) Mountain View, Calif.	—	\$ 1,167	.06
100. Owens-Illinois, Inc. *Pittsburgh, Pa.	67	1,160	.06
Other		219,819	10.65

* Awards during year represent awards on several contracts which have different principal places of performance. The place shown is that which has the largest amount of the awards.

** Data for individual companies include awards on R&D contracts of \$10,000 and over and on all other contracts of \$25,000 and over.

(S) Indicates small business concerns.

(a) Formerly a division of Raytheon Co.

IV. Awards to Educational and Other Nonprofit Institutions*

A. **Distribution by Type of Institution and Award**—During Fiscal Year 1973, \$138 million was awarded to educational and other nonprofit institutions or organizations. Of this amount, \$112 million was awarded to educational institutions and \$26 million to other nonprofit organizations. A breakout of these awards between contracts and grants is shown below:

Type of Award	Total (Millions)	Educational Institutions (Millions)	Nonprofit Organizations (Millions)
<i>Total</i>	<i>\$138.1</i>	<i>\$111.7</i>	<i>\$26.4</i>
Contracts	81.5	59.5	22.0
Grants	56.6	52.2	4.4

With respect to research contracts of \$10,000 and over, approximately 82 percent of the dollars represented actions on cost (no-fee) contracts and 10 percent represented actions on cost-plus-fixed-fee contracts. Actions on the cost-plus-fixed-fee contracts involve 56 new contracts. Fees on these contracts vary from 3.57 percent to 7.69 percent of their estimated cost. The average fee on these contracts is 5.51 percent.

B. **Major Awards**—The awards to educational and other nonprofit institutions during the period included 14 of over \$1 million. These were as follows:

1. Massachusetts Institute of Technology, Cambridge, Mass. NAS9-4065. Design of the guidance and navigation system for the Lunar Module of the Apollo Spacecraft. Awarded \$5.3 million; cumulative awards \$114.0 million.
2. Harvard University, Cambridge, Mass. NAS5-3949. Study and experiment for a high resolution ultra violet telescope and spectrometer system. Awarded \$4.0 million; cumulative awards \$30.6 million.
3. National Academy of Sciences, Washington, D. C. NSR9-12087. Administration of NASA's resident research associateship program. Awarded \$3.0 million; cumulative awards \$13.7 million.
4. University of Illinois-Urbana, Urbana, Ill. AF306-24144. Illiac IV experimentation in parallel computation. Awarded \$3.0 million; cumulative awards \$3.4 million.
5. Smithsonian Institute, Washington, D. C. NGR9-15002. Conduct an optical satellite tracking program. Awarded \$2.7 million; cumulative awards \$50.2 million.
6. University of Iowa, Iowa City, Iowa. NAS1-11257. Design, development, fabrication, testing and launch support of the Injun F Spacecraft. Awarded \$2.3 million; cumulative awards \$2.9 million.
7. Massachusetts Institute of Technology, Cambridge, Mass. NAS5-11450. Experiment to perform X-ray astronomy on the Small Astronomy Satellite-C Spacecraft. Awarded \$2.1 million; cumulative awards \$4.8 million.
8. University Corporation for Atmospheric Research, Boulder, Colo. NAS5-3950. White light coronagraph for Advanced Orbiting Solar Observatories. Awarded \$1.7 million; cumulative awards \$14.4 million.

*Excludes JPL.

9. Aerospace Corporation, Los Angeles, Calif. NASW-2472. Advanced space programs studies. Awarded \$1.6 million; (new contract).

10. Purdue University, Lafayette, Ind. NGL15-5112. Expansion of the Earth Resources Program. Awarded \$1.4 million; cumulative awards \$5.3 million.

11. University of Colorado-Boulder, Colo. NAS5-11363. Orbiting Solar Observatories pointed experiment hardware. Awarded \$1.4 million; cumulative awards \$3.0 million.

12. American Institute of Aeronautics and Astronautics, New York, N. Y. NASW-2422. Abstracting, indexing publications and dissemination of scientific and technical information in the international aerospace abstracts. Awarded \$1.4 million; (new contract).

13. University of California-San Diego, San Diego, Calif. NAS8-27974. Design and development of the million electron volt gamma ray telescope experiment under the High Energy Astronomy Observatory program. Awarded \$1.0 million; cumulative awards \$2.7 million.

14. New Mexico State University-Las Cruces, Las Cruces, N. M. NAS5-23001. Telemetry engineering, analytical and field support services for Sounding Rocket program. Awarded \$1.0 million; cumulative awards \$2.1 million.

C. One Hundred Principal Institutions*—The one hundred educational and nonprofit institutions that received the largest dollar value of NASA awards during Fiscal Year 1973 are shown in Table IV, Pages 38-43.

The awards to these institutions accounted for 91 percent of the total awards to educational and nonprofit institutions during the period. The smallest aggregate award was \$170 thousand.

Eighty-four of the top 100 were educational institutions; 16 were nonprofit institutions.

*Excludes JPL.

TABLE IV—ONE HUNDRED EDUCATIONAL AND NONPROFIT INSTITUTIONS
LISTED ACCORDING TO NET VALUE OF DIRECT AWARDS*
FISCAL YEAR 1973

Institution and Address	Rank FY 1972	Net Value of Awards	
		Thousands	% of Total
<i>Total Awards to Educational & Nonprofit Institutions</i>		<i>\$138,109</i>	<i>100.00</i>
1. Massachusetts Institute of Technology Cambridge, Mass.	1	14,163	10.26
2. Harvard University Cambridge, Mass.	5	4,801	3.48
3. Smithsonian Institution (N) Washington, D. C.	7	4,550	3.29
4. Stanford University Stanford, Calif.	8	4,176	3.02
5. University of California—Berkeley Berkeley, Calif.	6	4,062	2.94
6. University of Illinois—Urbana Urbana, Ill.	34	3,806	2.76
7. National Academy of Sciences (N) Washington, D. C.	3	3,399	2.46
8. University of Iowa Iowa City, Iowa	24	3,381	2.45
9. California Institute of Technology Pasadena, Calif.	9	3,308	2.40
10. University of California—San Diego San Diego, Calif.	4	2,821	2.04
11. Aerospace Corporation (N) El Segundo, Calif.	10	2,814	2.04
12. University of Wisconsin—Madison Madison, Wisc.	18	2,752	1.99
13. University of Colorado—Boulder Boulder, Colo.	15	2,691	1.95
14. Purdue University Lafayette, Ind.	29	2,688	1.95
15. Environmental Research Institute of Mich. (N) Ann Arbor, Mich.	(a)	2,403	1.74
16. University of Minnesota—Minneapolis-St. Paul Minneapolis, Minn.	17	2,384	1.73
17. Princeton University Princeton, N. J.	11	2,342	1.70
18. Columbia University New York, N. Y.	16	2,264	1.64

TABLE IV—ONE HUNDRED EDUCATIONAL AND NONPROFIT INSTITUTIONS
LISTED ACCORDING TO NET VALUE OF DIRECT AWARDS* (Continued)
FISCAL YEAR 1973

Institution and Address	Rank FY 1972	Net Value of Awards	
		Thousands	% of Total
19. University of Chicago Chicago, Ill.	13	\$ 2,237	1.62
20. University of Maryland—College Park College Park, Md.	19	2,157	1.56
21. University of Texas—Dallas Dallas, Texas	21	2,090	1.51
22. Battelle Memorial Institute (N) Columbus, Ohio	14	2,076	1.50
23. University of Michigan—Ann Arbor Ann Arbor, Mich.	2	1,933	1.40
24. University of Arizona Tucson, Ariz.	23	1,680	1.22
25. New Mexico State University—Las Cruces University, N. M.	26	1,680	1.22
26. University Corporation for Atmospheric Research (N) Boulder, Colo.	22	1,659	1.20
27. Cornell University Ithaca, N. Y.	39	1,537	1.11
28. University of Hawaii Honolulu, Hawaii	20	1,504	1.09
29. Johns Hopkins University Baltimore, Md.	12	1,484	1.08
30. University of California—Los Angeles Los Angeles, Calif.	25	1,453	1.05
31. American Institute of Aeronautics and Astronautics (N) New York, N. Y.	28	1,348	.98
32. George Washington University Washington, D. C.	40	1,256	.91
33. Dudley Observatory Albany, N. Y.	38	1,251	.91
34. University of Alaska—College College, Alaska	49	1,239	.90
35. University of Kansas Lawrence, Kansas	44	1,216	.88
36. University of Texas—Austin Austin, Texas	31	1,178	.85
37. Old Dominion University Norfolk, Va.	42	1,048	.76

TABLE IV—ONE HUNDRED EDUCATIONAL AND NONPROFIT INSTITUTIONS
LISTED ACCORDING TO NET VALUE OF DIRECT AWARDS* (Continued)
FISCAL YEAR 1973

Institution and Address	Rank FY 1972	Net Value of Awards	
		Thousands	% of Total
38. University of Houston Houston, Texas	32	\$ 1,004	.73
39. Rice University Houston, Texas	36	911	.66
40. Stanford Research Institute (N) Menlo Park, Calif.	30	876	.63
41. Oklahoma State University Stillwater, Okla.	45	859	.62
42. IIT Research Institute (N) Chicago, Ill.	27	806	.58
43. Pennsylvania State University University Park, Pa.	48	775	.56
44. Texas A & M University College Station, Texas	47	737	.53
45. University of Pittsburgh Pittsburgh, Pa.	58	714	.52
46. New York University New York, N. Y.	54	709	.51
47. University of Utah Salt Lake City, Utah	35	700	.51
48. Rensselaer Polytechnic Institute—N. Y. Troy, N. Y.	64	672	.49
49. University of Washington Seattle, Wash.	37	640	.46
50. Virginia Polytechnic Institute Blacksburg, Va.	63	598	.43
51. University of Tennessee—Knoxville Knoxville, Tenn.	87	592	.43
52. Washington University St. Louis, Mo.	43	587	.43
53. University of New Hampshire Durham, N. H.	61	576	.42
54. Oregon State University Corvallis, Ore.	81	576	.42
55. Research Triangle Institute (N) Durham, N. C.	55	528	.38
56. Southwest Research Institute (N) San Antonio, Texas	56	524	.38

TABLE IV—ONE HUNDRED EDUCATIONAL AND NONPROFIT INSTITUTIONS
LISTED ACCORDING TO NET VALUE OF DIRECT AWARDS* (Continued)
FISCAL YEAR 1973

Institution and Address	Rank FY 1972	Net Value of Awards	
		Thousands	% of Total
57. University of New Mexico Albuquerque, N. M.	62	\$ 515	.37
58. University of Alabama—Huntsville Huntsville, Ala.	41	495	.36
59. Colorado State University Ft. Collins, Colo.	50	476	.35
60. University of Virginia Charlottesville, Va.	67	455	.33
61. Baylor University Medical College Houston, Texas	72	445	.32
62. Lowell Observatory (N) Flagstaff, Ariz.	69	433	.31
63. Indiana University—Bloomington Bloomington, Ind.	66	430	.31
64. Georgia Institute of Technology Atlanta, Ga.	53	428	.31
65. College of William and Mary Williamsburg, Va.	51	424	.31
66. Ohio State University Columbus, Ohio	65	416	.30
67. University of Alabama—Tuscaloosa Tuscaloosa, Ala.	—	415	.30
68. Universities Space Research Association (N) Washington, D. C.	33	401	.29
69. State University of New York—Stony Brook Stony Brook, N. Y.	57	397	.29
70. University of Texas—Galveston Galveston, Texas	100	388	.28
71. University of Florida Gainesville, Fla.	70	376	.27
72. Case Western Reserve University Cleveland, Ohio	52	375	.27
73. University of Southern California Los Angeles, Calif.	46	373	.27
74. Michigan State University East Lansing, Mich.	75	357	.26
75. South Dakota State University Brookings, S. D.	—	335	.24

TABLE IV—ONE HUNDRED EDUCATIONAL AND NONPROFIT INSTITUTIONS
LISTED ACCORDING TO NET VALUE OF DIRECT AWARDS* (Continued)
FISCAL YEAR 1973

Institution and Address	Rank FY 1972	Net Value of Awards	
		Thousands	% of Total
76. University of Denver Denver, Colo.	60	\$ 322	.23
77. Fairleigh-Dickinson University St. Croix, Virgin Islands	—	307	.22
78. Dallas County Hospital District (N) Dallas, Texas	—	295	.21
79. Lehigh University Bethlehem, Pa.	89	290	.21
80. University of Santa Clara Santa Clara, Calif.	79	284	.21
81. Colorado School of Mines Golden, Colo.	—	255	.18
82. University of California-Davis Davis, Calif.	—	241	.17
83. Mitre Corporation (N) Bedford, Mass.	—	230	.17
84. Brown University Providence, R. I.	—	225	.16
85. University of Miami Coral Gables, Fla.	88	224	.16
86. University of Wyoming Laramie, Wyo.	—	218	.16
87. Catholic University of America Washington, D. C.	—	213	.15
88. Yale University New Haven, Conn.	94	205	.15
89. Auburn University-Auburn Auburn, Ala.	59	202	.15
90. University of Georgia Athens, Ga.	—	200	.14
91. University of Massachusetts-Amherst Amherst, Mass.	80	196	.14
92. State of Ohio (N) Columbus, Ohio	—	196	.14
93. State University of New York-Buffalo Buffalo, N. Y.	—	194	.14
94. University of Connecticut Storrs, Conn.	90	192	.14

TABLE IV—ONE HUNDRED EDUCATIONAL AND NONPROFIT INSTITUTIONS
LISTED ACCORDING TO NET VALUE OF DIRECT AWARDS* (Continued)
FISCAL YEAR 1973

Institution and Address	Rank FY 1972	Net Value of Awards	
		Thousands	% of Total
95. North Carolina State University Raleigh, N. C.	83	\$ 187	.14
96. Louisiana State University—Baton Rouge Baton Rouge, La.	73	185	.13
97. University of Nebraska—Lincoln Lincoln, Neb.	97	185	.13
98. Howard University Washington, D. C.	96	181	.13
99. California State University—San Jose San Jose, Calif.	—	174	.13
100. University of Delaware Newark, Del.	—	170	.12
Other		12,389	8.97

* Includes awards on research grants and contracts of \$10,000 and over; excludes awards to California Institute of Technology for operation of the Jet Propulsion Laboratory.

(N) Indicates nonprofit institution.

(a) Formerly a part of University of Michigan.

V. Contract With California Institute of Technology For Operation of Jet Propulsion Laboratory

The Jet Propulsion Laboratory (JPL) is a Government-owned research and development facility, operated for NASA by the California Institute of Technology. The Laboratory carries out research programs and flight projects and conceives and executes advanced development and experimental engineering investigations to further the technology required for the Nation's space program. The primary emphasis of the Laboratory's effort is on the carrying out of unmanned lunar, planetary and deep-space scientific missions.

Net awards during Fiscal Year 1973 totalled \$202 million. Of this amount, \$123 million was placed through subcontracts or purchases with business firms; \$79 million constituted in-house effort.

VI. Negotiation Authority

A. **Fiscal Year 1973**—The circumstances under which NASA's procurements were accomplished by negotiation are shown in Figure 15, Page 45. The data include all direct awards to business firms, contracts with educational institutions and nonprofit organizations, and awards on the JPL contracts.

Of the \$2,344 million negotiated during the period, 49 percent was obligated on contracts negotiated under Authority (11), Experimental, Development or Research Work. Eleven percent of the dollars represented R&D contracts negotiated under Authority (5), Services of Educational Institutions. Of the \$261 million negotiated under this authority, \$202 million represented awards on the JPL contracts. Thus, in terms of dollars, procurements on contracts negotiated under the two authorities cited above, pertaining primarily to research and development effort, accounted for 60 percent of the negotiated procurements during the period.

In terms of number of negotiated procurement actions in the year, 74 percent was negotiated under Authority (3), Contracts or Purchases of \$2,500 or less. The dollar value of these actions, however, amounted to only 1 percent of the total amount negotiated. Negotiation procedures are utilized for the small actions because administrative costs of formal advertising would be excessive in relation to the value of the procurements.

B. **Trend, Fiscal Years 1961 - 1973**—Appendix IX provides historical data on the use of negotiation authority for the period Fiscal Years 1961 - 1973.

NEGOTIATION AUTHORITY - ALL DIRECT ACTIONS

FISCAL YEAR 1973

AUTHORITY 10 U S C 2304(a)	THOUSANDS	% OF TOTAL	PERCENT OF TOTAL									
			10	20	30	40	50	60	70	80	90	
<u>Total</u>	<u>\$2,344,301</u>	<u>100</u>										
(11) Research & Development	1,151,760	49										
(10) Advertising Impracticable	738,167	32										
(5) Educational Institutions	261,422	11										
(17) Otherwise Authorized by Law	80,048	3										
(1) National Emergency	39,562	2										
(6) Outside U.S. and Possessions	33,993	2										
(3) \$2,500 or Less	32,800	1										
(4) Personal or Professional Services	6,080	*										
(2) Public Exigency	1,003	*										
(7) Medicines or Medical Supplies	83	*										
(13) Technical Equipment Requiring Standardization	30	*										
(9) Perishable/Non-perishable Subsistence Supplies	3	*										
(14) Substantial Initial Investment Required	(650)	*										

* Less than 0.5 percent.

Figure 15

VII. Purchases and Contracts Placed With or Through Other Government Agencies

A. **Fiscal Year 1973, Distribution by Agency**—Data for Fiscal Year 1973 are shown in Figure 16, Page 47.

The extensive procurements through the Department of Defense reflect NASA's policy to avoid duplication of effort and to achieve the most effective and economic utilization of DoD and NASA resources. NASA procures through DoD those items which the military departments, because of their own programs, can most economically contract from industry.

B. **Major Placements**—Examples of major procurements placed through other Government agencies are as follows:

Air Force

Vehicles and services in support of Titan Program—\$38.1 million.

Atlas vehicles for Atlas-Centaur Program—\$17.3 million.

Support services at Cape Kennedy—\$14.4 million.

Propellants for launch vehicles and engine development programs—\$10.8 million.

Maintain, operate, test, modify and repair aircraft—\$6.0 million.

Navy

Recovery operations in support of Apollo and Skylab Programs—\$5.9 million.

Spectroheliograph solar physics experiment—\$5.6 million.

Geological Environmental Optical System Spacecraft—\$5.5 million.

Army

Construction services at various NASA facilities—\$12.7 million.

Interior

Geological planetary surface exploration studies and lunar sample analysis research—\$6.7 million.

Commerce

Supporting research and technology in the fields of meteorology, earth observations, communications and technical applications—\$6.7 million.

PURCHASES AND CONTRACTS PLACED WITH OR THROUGH OTHER GOVERNMENT AGENCIES

FISCAL YEAR 1973

AGENCY	MILLIONS	% OF TOTAL	PERCENT OF TOTAL				
			10	20	30	40	50
<u>Total</u>	<u>\$235.2</u>	<u>100</u>					
<u>\$25,000 and Over</u>	<u>189.4</u>	<u>81</u>					
Air Force	96.1	41					
Navy	26.3	11					
Army	19.9	9					
Interior Department	9.7	4					
Commerce Department	8.6	4					
Atomic Energy Commission	7.8	3					
General Services Administration	6.7	3					
Miscellaneous	14.3	6					
<u>Under \$25,000</u>	<u>45.8</u>	<u>19</u>					

Figure 16

C. Trend, Fiscal Years 1961 - 1973 - Historical data on procurements placed with or through other Government agencies for the period Fiscal Years 1961 - 1973 are shown in Appendix X.

VIII. U. S. Geographical Distribution of NASA Procurements

A. Prime Contract Awards

1. *Fiscal Year 1973*—In Fiscal Year 1973, 48 states and the District of Columbia participated in NASA's direct R&D awards of \$10,000 and over and other direct awards of \$25,000 and over, (Table V, Page 49). These larger awards were distributed among 7,360 contracts and went to 1,824 different organizations in 732 different cities. Of the 1,824 organizations, 1,512 are business firms located in 608 cities in 42 states and the District of Columbia; 312 are educational & nonprofit institutions located in 218 cities in 48 states and the District of Columbia.

Thirty-five states received awards of more than \$1 million; 7 states received awards of more than \$50 million. The 10 states receiving the largest share are listed below. The large proportion placed in California reflects the heavy concentration in that State of firms in the aerospace and electronic industries.

State	Amount (Millions)	Percent of Total
<i>Total</i>	<i>\$2,116</i>	<i>100</i>
California	696	33
Florida	215	10
Colorado	194	9
Maryland	182	9
Texas	180	9
Missouri	112	5
Alabama	106	5
Louisiana	50	2
Massachusetts	47	2
Pennsylvania	47	2
Other	287	14

The categorization of NASA procurements by state is based on the location where the items are to be produced or supplied from stock, where the services will be performed; or with respect to construction contracts, the construction site.

2. *Trend, Fiscal Years 1969 - 1973*—NASA's awards for the period Fiscal Years 1969 through 1973 are shown by region in the table and map on Pages 50 and 51. The regional grouping of states is that employed by the Department of Commerce in their publication "Survey of Current Business," and is depicted in the map on Page 51. Appendix XI shows the state by state distribution of the prime contract awards for the period Fiscal Years 1961 - 1973.

It is emphasized that these data reflect only placements with prime contractors. The impact of subcontracting on the geographical distribution of NASA's procurement dollars is discussed in the following section.

TABLE V—U. S. GEOGRAPHICAL DISTRIBUTION OF
NASA PRIME CONTRACT AWARDS
FISCAL YEAR 1973

State	Total		Business		Educational & Nonprofit	
	Thousands	Percent of Total	Thousands	Percent of Total	Thousands	Percent of Total
<i>Total</i>	<i>\$2,115,644</i>	<i>100.0</i>	<i>\$1,979,566</i>	<i>100.0</i>	<i>\$136,078</i>	<i>100.0</i>
Alabama	106,042	5.0	104,692	5.3	1,350	1.0
Alaska	1,718	0.1	479	*	1,239	1.0
Arizona	6,956	0.3	4,767	0.2	2,189	1.6
Arkansas	87	*	—	—	87	0.1
California	696,005	32.9	674,189	34.1	21,816	16.0
Colorado	194,400	9.2	189,011	9.5	5,389	4.0
Connecticut	21,711	1.0	21,275	1.1	436	0.3
Delaware	4,300	0.2	4,075	0.2	225	0.2
District of Columbia	11,671	0.6	5,484	0.3	6,187	4.5
Florida	215,112	10.2	213,486	10.8	1,626	1.2
Georgia	5,206	0.2	4,400	0.2	806	0.6
Hawaii	2,100	0.1	596	*	1,504	1.1
Idaho	34	*	—	—	34	*
Illinois	8,357	0.4	1,284	0.1	7,073	5.2
Indiana	5,601	0.3	2,449	0.1	3,152	2.3
Iowa	4,072	0.2	682	*	3,390	2.5
Kansas	1,600	0.1	295	*	1,305	1.0
Kentucky	147	*	—	—	147	0.1
Louisiana	49,812	2.4	49,347	2.5	465	0.3
Maine	(21)	*	—	—	(21)	*
Maryland	181,801	8.6	177,738	9.0	4,063	3.0
Massachusetts	47,164	2.2	23,245	1.2	23,919	17.6
Michigan	10,483	0.5	5,628	0.3	4,855	3.6
Minnesota	10,578	0.5	8,066	0.4	2,512	1.8
Mississippi	13,230	0.6	12,835	0.6	395	0.3
Missouri	111,855	5.3	111,016	5.6	839	0.6
Montana	104	*	—	—	104	0.1
Nebraska	286	*	101	*	185	0.1
Nevada	578	*	437	*	141	0.1
New Hampshire	979	*	242	*	737	0.5
New Jersey	36,065	1.7	33,635	1.7	2,430	1.8
New Mexico	4,260	0.2	2,513	0.1	1,747	1.3
New York	45,193	2.1	35,831	1.8	9,362	6.9
North Carolina	1,637	0.1	697	*	940	0.7
Ohio	21,278	1.0	18,085	0.9	3,193	2.3
Oklahoma	997	*	12	*	985	0.7
Oregon	1,107	0.1	369	*	738	0.5
Pennsylvania	46,926	2.2	44,647	2.3	2,279	1.7
Rhode Island	312	*	87	*	225	0.2
South Carolina	316	*	172	*	144	0.1
South Dakota	335	*	—	—	335	0.2
Tennessee	1,708	0.1	932	*	776	0.6
Texas	180,376	8.5	172,316	8.7	8,060	5.9
Utah	1,259	0.1	538	*	721	0.5
Vermont	153	*	105	*	48	*
Virginia	44,213	2.1	40,374	2.0	3,839	2.8
Washington	13,322	0.6	12,341	0.6	981	0.7
West Virginia	147	*	53	*	94	0.1
Wisconsin	3,854	0.2	1,040	0.1	2,814	2.1
Wyoming	218	*	—	—	218	0.2

*Less than .05 percent.

Note: Includes awards on R&D contracts and awards to educational and nonprofit institutions of \$10,000 and over and on all other contracts of \$25,000 and over; excludes awards placed through other Government agencies, awards outside the U.S., and actions on the JPL contracts.

TABLE VI—U. S. GEOGRAPHICAL DISTRIBUTION OF
NASA PRIME CONTRACT AWARDS—BY REGION

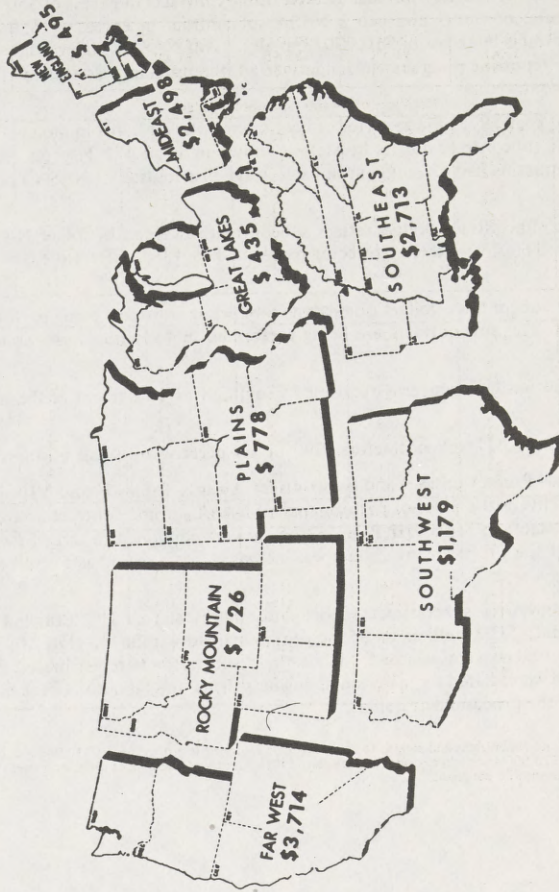
FISCAL YEARS 1969-1973

REGION	FISCAL YEAR 1969	FISCAL YEAR 1970	FISCAL YEAR 1971	FISCAL YEAR 1972	FISCAL YEAR 1973	TOTAL FISCAL YEARS 1969-1973
Net Value of Awards (Millions of Dollars)						
<i>Total</i>	<i>\$3,066</i>	<i>\$2,831</i>	<i>\$2,352</i>	<i>\$2,195</i>	<i>\$2,116</i>	<i>\$12,560</i>
New England	118	118	106	83	70	495
Mideast	694	583	516	379	326	2,498
Southeast	717	600	504	455	437	2,713
Great Lakes	95	101	118	71	50	435
Plains	47	139	218	245	129	778
Southwest	263	284	229	210	193	1,179
Rocky Mountain	72	121	121	216	196	726
Far West	1,055	881	535	532	711	3,714
Alaska & Hawaii	5	4	5	4	4	22
Percent of Total						
<i>Total</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>	<i>100</i>
New England	4	4	5	4	3	4
Mideast	23	21	22	17	16	20
Southeast	23	21	21	21	21	22
Great Lakes	3	4	5	3	2	3
Plains	2	5	9	11	6	6
Southwest	9	10	10	10	9	9
Rocky Mountain	2	4	5	10	9	6
Far West	34	31	23	24	34	30
Alaska & Hawaii	*	*	*	*	*	*
Percent Increase Over Previous Year						
<i>Total</i>	<i>(12)</i>	<i>(8)</i>	<i>(17)</i>	<i>(7)</i>	<i>(4)</i>	
New England	2	—	(10)	(22)	(16)	
Mideast	(11)	(16)	(11)	(27)	(14)	
Southeast	(12)	(16)	(16)	(10)	(4)	
Great Lakes	(17)	6	17	(40)	(30)	
Plains	15	196	57	12	(47)	
Southwest	3	8	(19)	(8)	(8)	
Rocky Mountain	95	68	—	79	(9)	
Far West	(21)	(16)	(39)	(1)	34	
Alaska & Hawaii	67	(20)	25	(20)	—	

*Less than 0.5 percent.

Note: Includes awards on R&D contracts and awards to educational and nonprofit institutions of \$10,000 and over and on all other contracts of \$25,000 and over; excludes awards placed through other Government agencies, awards outside the U.S., and actions on the JPL contracts.

U. S. GEOGRAPHICAL DISTRIBUTION OF NASA PRIME CONTRACT AWARDS*
TOTAL - FISCAL YEARS 1969 THROUGH 1973
 (Millions of Dollars)



* Includes awards on R&D contracts and awards to educational and nonprofit institutions of \$10,000 and over and on all other contracts of \$25,000 and over; excludes awards placed through other Government agencies, awards outside the U.S., and actions on the JPL contracts.

Figure 17

B. Subcontract Awards—In August 1962, NASA instituted a subcontract reporting program, the primary purpose of which is to obtain additional data on the geographical distribution of NASA's procurement dollars. Under this program, NASA's prime contractors report first-tier subcontracts in excess of \$10,000 on each of their prime contracts in excess of \$500,000. Each of the first-tier subcontractors awarded a NASA subcontract in excess of \$50,000 reports second-tier subcontracts in excess of \$10,000. Initially, 12 of NASA's major prime contractors participated in the reporting program. In January 1964, the program was extended to cover all of NASA's prime contractors.

During Fiscal Year 1973, the reported subcontracts totalled \$348 million. The place of performance of the subcontract dollars by state is shown in Table VII, Page 53. As indicated below, the subcontracting had a significant impact on the distribution of NASA's procurement dollars.

1. The subcontract dollars reflect subcontracts awarded by 74 of NASA's major prime contractors. The subcontracts are being performed by 1,027 different first and second-tier subcontractors.
2. The subcontract dollars originated from prime contracts being performed in 69 cities in 26 states. The subcontracts are being performed in 455 cities in 42 states and the District of Columbia.
3. Small business concerns received \$57 million or 16 percent of the subcontract dollars.
4. Of the 1,027 subcontractors, 699 or 68 percent are small business concerns.

C. Net Total—Prime Contract and Subcontract Awards—Tables V and VII on Pages 49 and 53 show respectively the place of performance of NASA's prime contract awards and subcontract awards by state. In Table VIII, Page 55, the data are combined to show to what extent each state's share of the procurement dollars was increased or decreased as a result of the subcontracting.

As indicated above, the subcontracts reported during Fiscal Year 1973 totalled \$348 million. Of this amount, \$122 million or 35 percent remained within the states to which the respective prime contracts were awarded. While these subcontracts redistributed the dollars within the states and were shared by many small business firms, they did not affect the state by state distribution of the procurement dollars.

TABLE VII—U. S. GEOGRAPHICAL DISTRIBUTION
OF FIRST AND SECOND-TIER SUBCONTRACTS
ON NASA'S MAJOR PRIME CONTRACTS

FISCAL YEAR 1973

State	Amount (Thousands)	% of Total	State	Amount (Thousands)	% of Total
Alabama	\$ 3,130	0.9	Nebraska	\$ 136	*
Alaska	102	*	Nevada	46	*
Arizona	13,445	3.9	New Hampshire	223	0.1
Arkansas	14	*	New Jersey	5,762	1.7
California	162,900	46.8	New Mexico	396	0.1
Colorado	16,295	4.7	New York	16,043	4.6
Connecticut	9,193	2.6	North Carolina	178	0.1
Delaware	33	*	Ohio	2,493	0.7
Washington, D.C.	11	*	Oklahoma	231	0.1
Florida	18,690	5.4	Oregon	191	0.1
Georgia	52	*	Pennsylvania	8,730	2.5
Illinois	850	0.2	Rhode Island	50	*
Indiana	256	0.1	South Carolina	214	0.1
Iowa	133	*	Tennessee	18	*
Kansas	29	*	Texas	10,917	3.1
Louisiana	463	0.1	Utah	2,332	0.7
Maryland	15,868	4.6	Vermont	162	*
Massachusetts	16,163	4.6	Virginia	1,363	0.4
Michigan	2,506	0.7	Washington	18,217	5.2
Minnesota	9,116	2.6	West Virginia	13	*
Mississippi	2,136	0.6	Wisconsin	824	0.2
Missouri	8,237	2.4	TOTAL	\$348,161	100.0

*Less than .05 percent.

However, \$226 million or 65 percent of the subcontract dollars did cross state lines and, as shown in Table VIII, effected a significant redistribution of the procurement dollars among the states. As may be noted from column (f) of the table, 32 states and the District of Columbia show an increase in their share of the procurements as a result of the subcontracting. Seven states show an increase of more than \$5 million. These, in order of magnitude of the amount of increase together with their share of the prime contract dollars and total share of the procurement dollars including subcontracts, are shown below:

State	Share of Prime Contract Dollars (Percent)	Increase Due to Subcontracting (Thousands)	Total Share of Procurement Dollars (Percent)
	(c)*	(f)*	(h)*
Washington	0.6	18,217	1.5
Massachusetts	2.2	14,788	2.9
Florida	10.2	13,717	10.8
Arizona	0.3	13,309	1.0
New York	2.1	12,788	2.7
Minnesota	0.5	8,942	0.9
Connecticut	1.0	8,298	1.4

*Columns of Table VIII from which data were obtained.

For 10 states, their total share of the procurement dollars is less than their share of the prime contracts as a result of the subcontracting. Four states show a decrease of more than \$5 million. These, in order of magnitude of the amount of decrease in their share of the procurement dollars, are as follows:

State	Share of Prime Contract Dollars (Percent)	Decrease Due to Subcontracting (Thousands)	Total Share of Procurement Dollars (Percent)
	(c)	(f)	(h)
California	32.9	\$35,404	31.2
Colorado	9.2	29,885	7.8
Maryland	8.6	26,553	7.3
Missouri	5.3	6,891	5.0

TABLE VIII—U. S. GEOGRAPHICAL DISTRIBUTION
OF NASA PRIME CONTRACT AND SUBCONTRACT AWARDS
FISCAL YEAR 1973

(Thousands of Dollars)

State	Prime Contract Awards to State		Subcontract Awards			Net Total - Prime Contract & Subcontract Awards	
	Amount	% of Total	Received From Other States	Awarded To Other States	Net Total**	Amount***	% of Total
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
TOTAL	\$2,115,644	100.0	\$226,252	\$226,252	\$ -	\$2,115,644	100.0
Alabama	106,042	5.0	2,557	3,945	(1,388)	104,654	4.9
Alaska	1,718	0.1	102	-	102	1,820	0.1
Arizona	6,956	0.3	13,861	552	13,309	20,265	1.0
Arkansas	87	*	14	-	14	101	*
California	696,005	32.9	57,208	92,612	(35,404)	660,601	31.2
Colorado	194,400	9.2	9,179	39,064	(29,885)	164,515	7.8
Connecticut	21,711	1.0	10,134	1,836	8,298	30,009	1.4
Delaware	4,300	0.2	33	31	2	4,302	0.2
District of Columbia	11,671	0.6	11	-	11	11,682	0.6
Florida	215,112	10.2	15,858	2,141	13,717	228,829	10.8
Georgia	5,206	0.2	52	-	52	5,258	0.2
Hawaii	2,100	0.1	-	-	-	2,100	0.1
Idaho	34	*	-	-	-	34	*
Illinois	8,357	0.4	850	-	850	9,207	0.4
Indiana	5,601	0.3	243	608	(365)	5,236	0.2
Iowa	4,072	0.2	133	554	(421)	3,651	0.2
Kansas	1,600	0.1	29	-	29	1,629	0.1
Kentucky	147	*	-	-	-	147	*
Louisiana	49,812	2.4	172	93	79	49,891	2.4
Maine	(21)	*	-	-	-	(21)	*
Maryland	181,801	8.6	3,464	30,017	(26,553)	155,248	7.3
Massachusetts	47,164	2.2	16,271	1,483	14,788	61,952	2.9
Michigan	10,483	0.5	3,170	1,478	1,692	12,175	0.6
Minnesota	10,578	0.5	8,981	39	8,942	19,520	0.9
Mississippi	13,230	0.6	243	1,218	(975)	12,255	0.6
Missouri	111,855	5.3	7,855	14,746	(6,891)	104,964	5.0
Montana	104	*	-	-	-	104	*
Nebraska	286	*	136	-	136	422	*
Nevada	578	*	34	-	34	612	*
New Hampshire	979	*	223	-	223	1,202	0.1
New Jersey	36,065	1.7	12,943	14,529	(1,586)	34,479	1.6
New Mexico	4,260	0.2	396	-	396	4,656	0.2
New York	45,193	2.1	15,999	3,211	12,788	57,981	2.7
North Carolina	1,637	0.1	178	-	178	1,815	0.1
Ohio	21,278	1.0	2,327	316	2,011	23,289	1.1
Oklahoma	997	*	231	-	231	1,228	0.1
Oregon	1,107	0.1	191	-	191	1,298	0.1
Pennsylvania	46,926	2.2	9,075	4,137	4,938	51,864	2.5
Rhode Island	312	*	51	-	51	363	*
South Carolina	316	*	214	-	214	530	*
South Dakota	335	*	-	-	-	335	*
Tennessee	1,708	0.1	18	-	18	1,726	0.1
Texas	180,376	8.5	8,930	6,306	2,624	183,000	8.6
Utah	1,259	0.1	2,465	831	1,634	2,893	0.1
Vermont	153	*	162	-	162	315	*
Virginia	44,213	2.1	833	3,627	(2,794)	41,419	2.0
Washington	13,322	0.6	20,589	2,372	18,217	31,539	1.5
West Virginia	147	*	13	-	13	160	*
Wisconsin	3,854	0.2	824	506	318	4,172	0.2
Wyoming	218	*	-	-	-	218	*

Note: Prime contract awards include awards on R&D contracts and awards to educational and nonprofit institutions of \$10,000 and over and on all other contracts of \$25,000 and over; exclude awards placed through other Government agencies, awards outside the U.S., and actions on the JPL contracts. Subcontract awards include those of \$10,000 and over on prime contracts of \$500,000 and over.

* Less than .05 percent.

** Parentheses indicate that the awards to other states exceed the awards from other states.

*** Column (b) plus or minus column (f).

The states that received more than \$1 million from 1 or more of these 4 states are shown in the following tabulation as an illustration of the widespread redistribution of the procurement dollars effected through subcontracting. For example, California awarded subcontracts totalling \$1 million or more to 13 states and distributed the subcontracts among a total of 32 states. Corresponding data for Colorado are 6 and 24; for Maryland, 3 and 17; and for Missouri, 4 and 14.

Recipient State	Awarding State and Amount (Thousands)			
	California	Colorado	Maryland	Missouri
Arizona	\$10,248	\$ -	\$ -	\$ -
California	-	18,679	16,305	5,195
Colorado	7,506	-	-	-
Connecticut	4,463	-	-	3,596
Florida	2,379	1,408	8,998	-
Massachusetts	4,310	8,594	-	-
Minnesota	7,928	-	-	-
Missouri	6,664	-	-	-
New Jersey	4,519	2,639	-	1,934
New York	11,246	-	-	1,220
Ohio	1,118	-	-	-
Pennsylvania	6,877	1,060	-	-
Texas	4,467	3,452	-	-
Washington	17,200	-	2,727	-
Other States	3,687	3,232	1,987	2,801
Total	\$92,612	\$39,064	\$30,017	\$14,746
Total Number of States to which subcontracts were awarded	32	24	17	14

Appendix XII provides data on the geographical distribution of the net total of prime contract and subcontract awards for the period Fiscal Years 1962 - 1973.

IX. NASA Prime Contract Awards Placed In Labor Surplus Areas*

Of NASA's direct awards of \$2,116 million to U. S. business firms, educational institutions and nonprofit organizations during Fiscal Year 1973, \$981 million or 46 percent was placed in areas which were designated by the Department of Labor as substantial labor surplus areas at the time of the awards. The labor surplus areas receiving awards included 232 cities located in 26 states. The 5 labor surplus area cities receiving the largest share of such awards were Downey, California; Los Angeles, California; Kennedy Space Center, Florida; St. Louis, Missouri; and Huntington Beach, California ranked in that order. Awards by labor surplus area city within each state are shown in Table IX on Pages 57-60.

* Awards on R&D contracts and awards to educational and nonprofit institutions of \$10,000 and over and on all other contracts of \$25,000 and over.

TABLE IX—NASA PRIME CONTRACT AWARDS
PLACED IN LABOR SURPLUS AREAS*
FISCAL YEAR 1973

State-City	Thousands	State-City	Thousands
<i>Total</i>	<i>\$981,121</i>	<i>California (Cont'd)</i>	
<i>Alaska</i>	<i>1,718</i>	Huntington Beach	\$ 81,643
Anchorage	31	Huntington Park	36
College	757	Irvine	679
Fairbanks	930	Lancaster	18
<i>Arkansas</i>	<i>45</i>	Lawndale	46
Searcy	45	Long Beach	6,177
<i>California</i>	<i>607,680</i>	Los Angeles	120,717
Alhambra	120	Madera	13
Anaheim	1,226	Malibu	1,459
Arcadia	48	Marina	22
Azusa	219	Marina Del Rey	178
Barstow	408	Merced	17
Big Bear City	42	Monrovia	241
Buena Park	74	Montebello	19
Burbank	1,333	Monterey	23
Calabasas	105	Monterey Park	8
Camarillo	272	Newport Beach	104
Chico	14	Oakland	142
Chula Vista	71	Ontario	90
City of Industry	150	Orange	22
Claremont	11	Oxnard	98
Compton	739	Palmdale	56
Costa Mesa	169	Pasadena	4,350
Covina	22	(exclusive of JPL)	
Culver City	194	Pomona	270
Dominguez	40	Redlands	268
Downey	212,341	Redondo Beach	26,510
Duarte	165	Riverside	135
Edwards	4,075	Rolling Hills Estates	181
El Cajon	33	San Diego	73,414
El Monte	3,252	San Fernando	122
El Segundo	20,830	Santa Ana	294
Eureka	70	Santa Cruz	794
Fullerton	432	Santa Fe Springs	90
Gardena	107	Santa Monica	34,806
Glendale	41	Saugus	29
Hawthorne	759	Seal Beach	17
		Solana Beach	50
		South El Monte	268
		South Gate	117

TABLE IX—NASA PRIME CONTRACT AWARDS
PLACED IN LABOR SURPLUS AREAS* (Continued)
FISCAL YEAR 1973

State-City	Thousands	State-City	Thousands
<i>California (Cont'd)</i>		<i>Maryland</i>	\$ 139
South Pasadena	\$ 265	Frostburg	13
Stockton	77	Pocomoke City	90
Thousand Oaks	100	Princess Anne	36
Torrance	6,141		
Valencia	127	<i>Massachusetts</i>	45,438
Whittier	70	Acton	58
Yorba Linda	15	Ashland	25
		Attleboro	24
<i>Connecticut</i>	12,365	Bedford	408
Bethel	55	Boston	1,010
Bridgeport	34	Brockton	14
East Hartford	5,918	Brookline	97
Fairfield	10	Burlington	1,005
Farmington	96	Cambridge	32,492
Greenwich	26	Canton	16
Manchester	31	Chelmsford	192
Meriden	25	Concord	716
Middlebury	10	Dedham	111
Middletown	138	Hingham	31
New Haven	132	Lexington	4,438
Norwalk	899	Lowell	354
Portland	254	Lynn	763
Stamford	154	Maynard	643
Stratford	952	Medford	25
Trumbull	33	Methuen	14
Wilton	303	Needham	94
Windsor Locks	3,295	Newton	46
		Norwood	74
<i>Florida</i>	138,213	Pittsfield	24
Cape Canaveral	18,515	Reading	30
Kennedy Space Center	119,182	Salem	26
Melbourne	295	Somerville	20
Merritt Island	36	Sturbridge	96
Palm Bay	146	Sudbury	646
Titusville	39	Tewksbury	19
		Wakefield	14
<i>Louisiana</i>	23,413	Waltham	891
Baton Rouge	114	Watertown	54
New Orleans	22,496	Westfield	15
Slidell	803	Westminster	206

TABLE IX—NASA PRIME CONTRACT AWARDS
PLACED IN LABOR SURPLUS AREAS* (Continued)
FISCAL YEAR 1973

State-City	Thousands	State-City	Thousands
<i>Massachusetts (Cont'd)</i>		<i>New Jersey (Cont'd)</i>	
Wilmington	\$ 693	Nutley	\$ 20
Woburn	16	Oakland	45
Worcester	38	Paramus	83
		Paterson	94
<i>Michigan</i>	8,064	Plainfield	33
Ann Arbor	6,898	Ridgefield	98
Birmingham	13	Somerville	130
Detroit	81	Teaneck	17
Montague	199	Teterboro	3,620
Southfield	80	Union	160
St. Clair	14	West Long Branch	635
St. Joseph	672	Westwood	7
Troy	90	Wood Ridge	150
Warren	17		
<i>Minnesota</i>	70	<i>New Mexico</i>	3,657
Northfield	70	Las Cruces	3,583
		Socorro	74
<i>Mississippi</i>	5,575	<i>New York</i>	2,300
Bay St. Louis	5,575	Amherst	76
		Batavia	12
<i>Missouri</i>	90,632	Buffalo	1,180
St. Louis	90,632	East Aurora	303
		Holcomb	35
<i>New Jersey</i>	6,597	Horseheads	215
Bayonne	26	Jamestown	44
Belleville	13	Lancaster	127
Clifton	31	Niagara Falls	44
East Paterson	17	North Tonawanda	180
Englewood	95	Norwich	37
Fairfield	83	Silver Creek	47
Franklin Lakes	14		
Freehold	269	<i>Ohio</i>	10,468
Linden	126	Cleveland	10,425
Little Falls	650	Delphos	43
Murray Hill	46		
Newark	118	<i>Oklahoma</i>	55
North Bergen	17	Durant	55

TABLE IX—NASA PRIME CONTRACT AWARDS
PLACED IN LABOR SURPLUS AREAS* (Continued)
FISCAL YEAR 1973

State-City	Thousands	State-City	Thousands
<i>Oregon</i>	\$ 162	<i>Vermont</i>	\$ 97
Eugene	155	Springfield	97
McMinnville	7		
<i>Pennsylvania</i>	2,374	<i>Virginia</i>	6,814
Hazleton	24	Chincoteague	6,792
Jefferson	7	Painter	22
Kittanning	12		
Lock Haven	34	<i>Washington</i>	13,294
Pittsburgh	2,297	Bellevue	55
<i>Rhode Island</i>	292	Kent	47
Lincoln	27	Mountlake Terrace	97
Providence	265	Redmont	426
<i>Texas</i>	1,285	Renton	453
Addison	1,028	Richland	381
Galveston	257	Seattle	11,791
		Tacoma	44
<i>Utah</i>	328		
Brigham City	14	<i>Wisconsin</i>	46
Logan	10	Amery	13
Ogden	284	Green Bay	17
Provo	20	West Salem	16

* Awards on R&D contracts and awards to educational and nonprofit institutions of \$10,000 and over and on all other contracts of \$25,000 and over.

X. Awards Placed Outside the United States

During Fiscal Year 1973, NASA placed \$35.6 million of awards that are being performed outside the United States.

As indicated in the following tabulation, \$34.9 million represented direct NASA awards; \$667 thousand constituted awards placed through other Federal agencies. The awards are being performed in 19 Countries.

Place of Performance	Total (Thousands)	Business Firms (Thousands)	Educational & Nonprofit (Thousands)	Foreign Govts. (Thousands)
<i>Total</i>	<i>\$35,551*</i>			
<i>Direct NASA Awards</i>	<i>\$34,884</i>	<i>\$ 5,712</i>	<i>\$12,647</i>	<i>\$16,525</i>
Ascension Island	1,189	1,189		
Australia	16,361			16,361
Bermuda	1,214	1,214		
Canada	825	808	17	
Chile	3,106	276	2,830	
Ecuador	50		50	
England	326	24	252	50
France	269	133		136
Germany	49	49		
Italy	598		598	
Jamaica	(6)		(6)	
Japan	4	4		
Peru	95		95	
South Africa	3,567		3,567	
Spain	7,038	1,984	5,054	
Sweden	24	31	15	(22)
Virgin Islands	175		175	
<i>Placed Through Other Federal Agencies</i>	<i>\$ 667</i>			
Bermuda	280			
Canada	(14)			
England	2			
Guam	92			
Madagascar	315			
Spain	(8)			

*Awards on R & D contracts of \$10,000 and over and on all other procurements of \$25,000 and over.

XI. Procurement Activity by Installation

Most of NASA's purchases and contracts are made by the procurement offices of its field installations. During Fiscal Year 1973, these offices accounted for 96 percent of the procurement dollars.

In terms of dollars, the Marshall Space Flight, Johnson Space and Goddard Space Flight Centers accomplished the highest placements. As shown in the following tabulation, these installations accounted for 54 percent of the total procurements.

Installation	Net Value of Awards—Fiscal Year 1973	
	Millions	Percent of Total
<i>Total</i>	<i>\$2,673.4</i>	<i>100.0</i>
Marshall Space Flight Center	536.0	20.1
Johnson Space Center	492.4	18.4
Goddard Space Flight Center	405.1	15.2
NASA Pasadena Office	302.4	11.3
Langley Research Center	248.2	9.3
Lewis Research Center	231.9	8.7
Kennedy Space Center	217.7	8.1
Headquarters	110.5	4.1
Ames Research Center	88.8	3.3
Wallops Station	20.2	0.8
Flight Research Center	14.7	0.5
Space Nuclear Systems Office	5.5	0.2

GLOSSARY

The data contained in this publication were compiled on the basis of the definitions given below:

1. *Advertised*—Procurement actions resulting from acceptance of bids made by contractors in response to formal advertising.
2. *Award*—See procurement action.
3. *Direct Actions (Direct Awards)*—Procurement actions placed directly with business firms and nonprofit institutions or organizations. The term excludes procurement actions placed with or through other Federal agencies.
4. *Intragovernmental*—Procurement actions placed with or through other Federal agencies.
5. *Modification*—Any written alteration in the specifications, delivery point, rate of delivery, contract period, price, quantity, or other contract provision of an existing contract, whether accomplished by unilateral action in accordance with a contract provision or by mutual action of the parties to the contract. It includes (a) bilateral actions, such as supplemental agreements, and (b) unilateral actions such as change orders, notices of termination, and notices of the exercise of an option.
6. *Negotiated*—Procurement actions resulting from negotiation procedures authorized under Title 10 U. S. C. 2304(a).
7. *Negotiated Competitive*—Procurements where offers were received from at least two responsible offerors capable of satisfying the Government's requirements wholly or partially, and the award or awards were made on the basis of price, design or technical competition.
8. *Negotiated Noncompetitive*—Procurements where an offer was received from only one responsible offeror capable of satisfying the Government's requirements wholly or partially. (Includes contracts for architect-engineer services and contracts resulting from unsolicited proposals.)
9. *Net Value*—Net amount of obligations resulting from debit and credit procurement actions.
10. *Procurement Action (Award)*—Any transaction of the following type which obligates or deobligates funds:
 - a. Letter contracts or other preliminary notices of negotiated awards.
 - b. Definitive contracts, including purchase orders.
 - c. Orders against indefinite delivery type contracts.
 - d. Modifications.
11. *Small Business*—A concern that meets the pertinent criteria established by the Small Business Administration and set forth in Paragraph 1.701 of the NASA Procurement Regulation. Generally a small business concern is one that is independently owned and operated, is not dominant in its field of operations, and with its affiliates does not employ more than a specified number of persons (usually not more than 500, 750 or 1,000) depending on the type of product called for by the contract. For construction and some service industries, the criterion is a specified annual dollar volume of sales or receipts instead of employment.

APPENDIXES

DISTRIBUTION OF DIRECT NASA PROCUREMENTS

FISCAL YEARS 1959 - 1966

Type	FY 1959*	FY 1960	FY 1961	FY 1962	FY 1963	FY 1964	FY 1965	FY 1966
				Net Value of Awards (Millions)				
<u>Total</u>	<u>\$212.5</u>	<u>\$336.7</u>	<u>\$755.5</u>	<u>\$1,550.6</u>	<u>\$3,230.5</u>	<u>\$4,593.9</u>	<u>\$5,187.4</u>	<u>\$5,031.6</u>
Business Firms	87.8	174.0	423.3	1,030.1	2,261.7	3,521.1	4,141.4	4,087.7
Educational	) 5.8	) 17.0	) 24.5	) 50.2	) 86.9	) 112.9	) 139.5	) 150.0
Nonprofit	)	)	)	)	) 15.3	) 29.1	) 25.3	) 27.7
JPL	22.4	38.3	86.0	148.5	230.2	226.2	247.2	230.3
Government	96.5	107.4	221.7	321.8	628.5	692.6	622.8	512.5
Outside U.S.	(**)	(**)	(**)	(**)	7.9	12.0	11.2	23.4
				Percent of Total				
<u>Total</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>
Business Firms	41	52	56	66	70	77	79	81
Educational	) 3	) 5	) 3	) 3	) 3	) 2	) 3	) 3
Nonprofit	)	)	)	)	(***)	) 1	) 1	) 1
JPL	11	11	12	10	7	5	5	5
Government	45	32	29	21	20	15	12	10
Outside U.S.	(**)	(**)	(**)	(**)	(***)	(***)	(***)	(***)

* Nine months operation.
 ** Included in Government.
 *** Less than 0.5 percent.

Appendix I

DISTRIBUTION OF DIRECT NASA PROCUREMENTS (Cont'd)
FISCAL YEARS 1967 - 1973

Type	FY 1967	FY 1968	FY 1969	FY 1970	FY 1971	FY 1972	FY 1973
				Net Value of Awards (Millions)			
<u>Total</u>	<u>\$4,650.9</u>	<u>\$4,132.7</u>	<u>\$3,652.0</u>	<u>\$3,405.6</u>	<u>\$2,858.2</u>	<u>\$2,737.8</u>	<u>\$2,673.4</u>
Business Firms	3,864.1	3,446.7	3,022.3	2,759.2	2,279.5	2,143.3	2,063.8
Educational	132.9	131.5	131.3	134.3	133.9	118.8	111.7
Nonprofit	39.6	33.6	32.3	33.0	29.3	28.0	26.4
JPL	222.2	207.2	156.3	179.8	173.3	210.8	202.3
Government	366.9	287.0	279.0	265.8	212.5	207.8	235.2
Outside U.S.	25.2	26.7	30.8	33.5	29.7	29.1	34.0
<u>Total</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>
Business Firms	83	83	83	81	80	78	77
Educational	3	3	4	4	5	4	4
Nonprofit	1	1	1	1	1	1	1
JPL	5	5	4	5	6	8	8
Government	8	7	7	8	7	8	9
Outside U.S.	(*)	1	1	1	1	1	1
				Percent of Total			
				<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>

*Less than 0.5 percent.

Appendix I

TOTAL OBLIGATIONS, PROCUREMENT OBLIGATIONS AND DIRECT AND INDIRECT AWARDS TO BUSINESS FIRMS

(Millions of Dollars)

FISCAL YEARS 1959 - 1966

	FY 1959**	FY 1960	FY 1961	FY 1962	FY 1963	FY 1964	FY 1965	FY 1966
Total Obligations	\$275.6	\$493.9	\$923.2	\$1,740.2	\$3,515.5	\$4,917.8	\$5,578.4	\$5,436.4
Procurement Obligations % of Total Obligations	213.0	336.7	755.5	1,550.6	3,230.5	4,593.9	5,187.4	5,031.6
	77	68	82	89	92	93	93	93
Awards to Business Firms	87.8	174.0	423.3	1,030.1	2,261.7	3,521.1	4,141.4	4,087.7
Direct from NASA								
From Others in Behalf of NASA*	104.1	125.4	263.7	380.2	740.5	799.7	748.5	643.3
Total Awards to Business Firms	191.9	299.4	687.0	1,410.3	3,002.2	4,320.8	4,889.9	4,731.0
% of Total Obligations	70	61	74	81	85	88	88	87
% of Procurement Obligations	90	89	91	91	93	94	94	94

* From the Jet Propulsion Laboratory and from other Government agencies.

**Nine months operation.

Appendix II

TOTAL OBLIGATIONS, PROCUREMENT OBLIGATIONS AND DIRECT AND INDIRECT AWARDS TO BUSINESS FIRMS (Cont'd)
(Millions of Dollars)

FISCAL YEARS 1967 - 1973

	FY 1967	FY 1968	FY 1969	FY 1970	FY 1971	FY 1972	FY 1973	
Total Obligations	\$5,092.3	\$4,585.0	\$4,115.6	\$3,949.3	\$3,426.3	\$3,324.1	\$3,269.2	
Procurement Obligations % of Total Obligations	4,650.9 91	4,132.7 90	3,652.0 89	3,405.6 86	2,858.2 83	2,737.8 82	2,673.4 82	
Awards to Business Firms								
Direct From NASA	3,864.1	3,446.7	3,022.3	2,759.2	2,279.5	2,143.3	2,063.8	
From Others in Behalf of NASA*	501.3	407.5	341.8	352.5	277.3	314.8	335.4	
Total Awards to Business Firms	4,365.4	3,854.2	3,364.1	3,111.7	2,556.8	2,458.1	2,399.2	
% of Total Obligations	86	84	82	79	75	74	73	
% of Procurement Obligations	94	93	91	91	89	90	90	

*From the Jet Propulsion Laboratory and from other Government agencies.

Appendix II

COMPETITION IN NASA AWARDS TO BUSINESS FIRMS

FISCAL YEARS 1961 - 1967

Type of Action	FY 1961	FY 1962	FY 1963	FY 1964	FY 1965	FY 1966	FY 1967
<u>Net Value of Awards (Millions)</u>							
<u>Total</u>	\$423.3	\$1,030.1	\$2,261.7	\$3,521.1	\$4,141.4	\$4,087.7	\$3,864.1
<u>Competitive - Total</u>	276.8	565.8	1,302.0	2,119.5	2,630.1	2,692.5	2,698.4
Advertised	38.6	64.1	106.6	134.4	169.2	111.0	81.1
Negotiated	238.2	501.7	1,195.4	1,985.1	2,460.9	2,581.5	2,617.3
<u>New Awards</u>	(*)	167.1	427.1	375.9	334.5	304.2	325.2
Advertised	(*)	41.2	61.9	109.6	61.0	38.2	45.2
Negotiated	(*)	125.9	365.2	266.3	273.5	266.0	280.0
<u>Modifications</u>	(*)	398.7	874.9	1,743.6	2,295.6	2,388.3	2,373.2
Advertised	(*)	22.9	44.7	24.8	108.2	72.8	35.9
Negotiated	(*)	375.8	830.2	1,718.8	2,187.4	2,315.5	2,337.3
<u>Noncompetitive - Total</u>	146.5	464.3	959.7	1,401.6	1,511.3	1,395.2	1,165.7
Follow-on After Competition	(*)	(*)	255.7	494.8	503.6	372.7	346.9
Other Noncompetitive	146.5	464.3	704.0	906.8	1,007.7	1,022.5	818.8
<u>New Awards</u>	(*)	155.5	331.5	309.5	294.7	232.2	369.5
Follow-on After Competition	(*)	(*)	22.2	35.0	68.6	3.2	45.1
Other Noncompetitive	(*)	155.5	309.3	274.5	226.1	229.0	324.4
<u>Modifications</u>	(*)	308.8	628.2	1,092.1	1,216.6	1,163.0	796.2
Follow-on After Competition	(*)	(*)	233.5	459.8	435.0	369.5	301.8
Other Noncompetitive	(*)	308.8	394.7	632.3	781.6	793.5	494.4
<u>Percent of Total</u>							
<u>Total</u>	100	100	100	100	100	100	100
<u>Competitive - Total</u>	65	55	58	60	63	66	70
Advertised	9	6	5	4	4	3	2
Negotiated	56	49	53	56	59	63	68
<u>New Awards</u>	(*)	16	19	11	8	7	8
Advertised	(*)	4	3	3	1	1	1
Negotiated	(*)	12	16	8	7	6	7
<u>Modifications</u>	(*)	39	39	49	55	59	62
Advertised	(*)	2	2	1	3	2	1
Negotiated	(*)	37	37	48	52	57	61
<u>Noncompetitive - Total</u>	35	45	42	40	37	34	30
Follow-on After Competition	(*)	(*)	11	14	12	9	9
Other Noncompetitive	35	45	31	26	25	25	21
<u>New Awards</u>	(*)	15	15	9	7	6	10
Follow-on After Competition	(*)	(*)	1	1	2	(**)	1
Other Noncompetitive	(*)	15	14	8	5	6	9
<u>Modifications</u>	(*)	30	27	31	30	28	20
Follow-on After Competition	(*)	(*)	10	13	10	9	8
Other Noncompetitive	(*)	30	17	18	20	19	12

* Data not compiled.

**Less than 0.5 percent.

Appendix III

COMPETITION IN NASA AWARDS TO BUSINESS FIRMS (Cont'd)

FISCAL YEARS 1968 - 1973

Type of Action	FY 1968	FY 1969	FY 1970	FY 1971	FY 1972	FY 1973
Net Value of Awards (Millions)						
<u>Total</u>	<u>\$3,446.7</u>	<u>\$3,022.3</u>	<u>\$2,759.2</u>	<u>\$2,279.5</u>	<u>\$2,143.3</u>	<u>\$2,063.8</u>
<u>Competitive - Total</u>	<u>2,185.1</u>	<u>1,632.7</u>	<u>1,628.7</u>	<u>1,331.8</u>	<u>1,311.8</u>	<u>1,275.6</u>
Advertised	55.0	36.7	30.4	32.9	36.0	41.6
Negotiated	2,130.1	1,596.0	1,598.3	1,298.9	1,275.8	1,234.0
<u>New Awards</u>	<u>271.9</u>	<u>186.7</u>	<u>277.5</u>	<u>306.6</u>	<u>257.0</u>	<u>308.1</u>
Advertised	27.8	19.8	14.8	14.3	19.8	28.5
Negotiated	244.1	166.9	262.7	292.3	237.2	279.6
<u>Modifications</u>	<u>1,913.2</u>	<u>1,446.0</u>	<u>1,351.2</u>	<u>1,025.2</u>	<u>1,054.8</u>	<u>967.5</u>
Advertised	27.2	16.9	15.6	18.6	16.2	13.1
Negotiated	1,886.0	1,429.1	1,335.6	1,006.6	1,038.6	954.4
<u>Noncompetitive - Total</u>	<u>1,261.6</u>	<u>1,389.6</u>	<u>1,130.5</u>	<u>947.7</u>	<u>831.5</u>	<u>788.2</u>
Follow-on After Competition	458.9	619.7	418.7	177.3	193.8	157.1
Other Noncompetitive	802.7	769.9	711.8	770.4	637.7	631.1
<u>New Awards</u>	<u>211.8</u>	<u>309.8</u>	<u>342.2</u>	<u>256.4</u>	<u>205.5</u>	<u>181.4</u>
Follow-on After Competition	35.2	115.0	30.8	2.9	1.0	0.3
Other Noncompetitive	176.6	194.8	311.4	253.5	204.5	181.1
<u>Modifications</u>	<u>1,049.8</u>	<u>1,079.8</u>	<u>788.3</u>	<u>691.3</u>	<u>626.0</u>	<u>606.8</u>
Follow-on After Competition	423.7	504.7	387.9	174.4	192.8	156.8
Other Noncompetitive	626.1	575.1	400.4	516.9	433.2	450.0
Percent of Total						
<u>Total</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>
<u>Competitive - Total</u>	<u>63</u>	<u>54</u>	<u>59</u>	<u>58</u>	<u>61</u>	<u>62</u>
Advertised	2	1	1	1	2	2
Negotiated	61	53	58	57	59	60
<u>New Awards</u>	<u>8</u>	<u>6</u>	<u>10</u>	<u>13</u>	<u>12</u>	<u>15</u>
Advertised	1	1	(*)	(*)	1	1
Negotiated	7	5	10	13	11	14
<u>Modifications</u>	<u>55</u>	<u>48</u>	<u>49</u>	<u>45</u>	<u>49</u>	<u>47</u>
Advertised	1	(*)	1	1	1	1
Negotiated	54	48	48	44	48	46
<u>Noncompetitive - Total</u>	<u>37</u>	<u>46</u>	<u>41</u>	<u>42</u>	<u>39</u>	<u>38</u>
Follow-on After Competition	13	21	15	8	9	7
Other Noncompetitive	24	25	26	34	30	31
<u>New Awards</u>	<u>6</u>	<u>10</u>	<u>12</u>	<u>11</u>	<u>10</u>	<u>9</u>
Follow-on After Competition	1	4	1	(*)	(*)	(*)
Other Noncompetitive	5	6	11	11	10	9
<u>Modifications</u>	<u>31</u>	<u>36</u>	<u>29</u>	<u>31</u>	<u>29</u>	<u>29</u>
Follow-on After Competition	12	17	14	8	9	7
Other Noncompetitive	19	19	15	23	20	22

*Less than 0.5 percent.

Appendix III

PROCUREMENTS BY CONTRACT PRICING PROVISION

DIRECT AWARDS TO BUSINESS FIRMS*

FISCAL YEARS 1961 - 1967

Pricing Provision	FY 1961	FY 1962	FY 1963	FY 1964	FY 1965	FY 1966	FY 1967
<u>Net Value of Awards (Millions)</u>							
<u>Total</u>	<u>\$362.5</u>	<u>\$308.4</u>	<u>\$2,113.8</u>	<u>\$3,379.6</u>	<u>\$3,993.0</u>	<u>\$3,951.2</u>	<u>\$3,775.4</u>
<u>Incentive</u>	<u>.1</u>	<u>13.1</u>	<u>162.7</u>	<u>269.3</u>	<u>602.2</u>	<u>1,922.5</u>	<u>2,567.6</u>
Fixed Price	.1	3.8	10.2	27.2	100.6	73.6	117.1
Cost Reimbursable	--	9.3	152.5	242.1	501.6	1,848.9	2,450.5
<u>Other Fixed Price</u>	<u>56.3</u>	<u>125.4</u>	<u>251.8</u>	<u>388.4</u>	<u>492.5</u>	<u>407.1</u>	<u>411.3</u>
Firm	55.4	125.0	247.5	387.0	492.0	399.2	409.5
Redeterminable	.9	.4	4.1	1.4	.3	1.3	1.2
Escalation	--	--	.2	--	.2	6.6	.6
<u>Other Cost Reimbursable</u>	<u>300.4</u>	<u>760.2</u>	<u>1,692.5</u>	<u>2,713.6</u>	<u>2,885.5</u>	<u>1,612.1</u>	<u>780.7</u>
Cost-No-Fee	.3	11.1	71.4	46.5	42.9	20.8	5.6
Cost-Plus-Fixed-Fee	299.9	748.6	1,618.0	2,664.9	2,841.3	1,591.0	774.6
Cost Sharing	.2	.5	3.1	2.2	1.3	.3	.5
<u>Labor Hour</u>	<u>--</u>	<u>.2</u>	<u>1.3</u>	<u>1.7</u>	<u>2.0</u>	<u>.1</u>	<u>.7</u>
<u>Time and Materials</u>	<u>5.7</u>	<u>9.5</u>	<u>5.5</u>	<u>6.6</u>	<u>10.8</u>	<u>9.4</u>	<u>15.1</u>
<u>Percent of Total</u>							
<u>Total</u>	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>
<u>Incentive</u>	<u>(**)</u>	<u>1.4</u>	<u>7.7</u>	<u>7.9</u>	<u>15.1</u>	<u>48.7</u>	<u>68.0</u>
Fixed Price	(**)	.4	.5	.8	2.5	1.9	3.1
Cost Reimbursable	--	1.0	7.2	7.1	12.6	46.8	64.9
<u>Other Fixed Price</u>	<u>15.5</u>	<u>13.8</u>	<u>11.9</u>	<u>11.5</u>	<u>12.3</u>	<u>10.3</u>	<u>10.9</u>
Firm	15.3	13.8	11.7	11.5	12.3	10.1	10.9
Redeterminable	.2	(**)	.2	(**)	(**)	(**)	(**)
Escalation	--	--	(**)	--	(**)	.2	(**)
<u>Other Cost Reimbursable</u>	<u>82.9</u>	<u>83.7</u>	<u>80.0</u>	<u>80.3</u>	<u>72.2</u>	<u>40.8</u>	<u>20.7</u>
Cost-No-Fee	.1	1.2	3.4	1.4	1.1	.5	.2
Cost-Plus-Fixed-Fee	82.7	82.4	76.5	78.8	71.1	40.3	20.5
Cost Sharing	.1	.1	.1	.1	(**)	(**)	(**)
<u>Labor Hour</u>	<u>--</u>	<u>(**)</u>	<u>.1</u>	<u>.1</u>	<u>.1</u>	<u>(**)</u>	<u>(**)</u>
<u>Time and Materials</u>	<u>1.6</u>	<u>1.0</u>	<u>.3</u>	<u>.2</u>	<u>.3</u>	<u>.2</u>	<u>.4</u>

* R&D contracts of \$10,000 and over, and all other contracts of \$25,000 and over.

**Less than 0.05 percent.

Appendix IV

PROCUREMENTS BY CONTRACT PRICING PROVISION (Cont'd)

DIRECT AWARDS TO BUSINESS FIRMS*

FISCAL YEARS 1968 - 1973

Pricing Provision	FY 1968	FY 1969	FY 1970	FY 1971	FY 1972	FY 1973
<u>Net Value of Awards (Millions)</u>						
<u>Total</u>	<u>\$3,338.6</u>	<u>\$2,909.2</u>	<u>\$2,666.9</u>	<u>\$2,192.5</u>	<u>\$2,049.8</u>	<u>\$1,981.3</u>
<u>Incentive</u>	<u>1,735.4</u>	<u>1,478.5</u>	<u>1,232.8</u>	<u>949.9</u>	<u>895.4</u>	<u>1,143.0</u>
Fixed Price	71.3	48.7	50.5	53.6	75.3	133.3
Cost Reimbursable	1,664.1	1,429.8	1,182.3	896.3	820.1	1,009.7
<u>Other Fixed Price</u>	<u>310.0</u>	<u>289.1</u>	<u>306.6</u>	<u>327.3</u>	<u>291.5</u>	<u>228.3</u>
Firm	308.8	288.1	304.5	318.1	283.9	226.9
Redeterminable	.9	.7	.6	.1	.1	1.0
Escalation	.3	.3	1.5	9.1	7.5	.4
<u>Other Cost Reimbursable</u>	<u>1,282.2</u>	<u>1,133.3</u>	<u>1,119.2</u>	<u>906.1</u>	<u>854.3</u>	<u>601.4</u>
Cost-No-Fee	15.0	4.9	5.1	3.8	22.3	37.8
Cost-Plus-Fixed-Fee	1,263.2	1,123.9	1,110.8	898.5	830.0	558.3
Cost Sharing	4.0	4.5	3.3	3.8	2.0	5.3
<u>Labor Hour</u>	<u>.9</u>	<u>2.1</u>	<u>2.4</u>	<u>2.8</u>	<u>3.4</u>	<u>2.8</u>
<u>Time and Materials</u>	<u>10.1</u>	<u>6.2</u>	<u>5.9</u>	<u>6.4</u>	<u>5.2</u>	<u>5.8</u>
<u>Percent of Total</u>						
<u>Total</u>	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>	<u>100.0</u>
<u>Incentive</u>	<u>52.0</u>	<u>50.8</u>	<u>46.2</u>	<u>43.3</u>	<u>43.7</u>	<u>57.7</u>
Fixed Price	2.1	1.7	1.9	2.4	3.7	6.7
Cost Reimbursable	49.9	49.1	44.3	40.9	40.0	51.0
<u>Other Fixed Price</u>	<u>9.3</u>	<u>9.9</u>	<u>11.5</u>	<u>14.9</u>	<u>14.1</u>	<u>11.5</u>
Firm	9.3	9.9	11.4	14.5	13.8	11.4
Redeterminable	(**)	(**)	(**)	(**)	(**)	.1
Escalation	(**)	(**)	.1	.4	.3	(**)
<u>Other Cost Reimbursable</u>	<u>38.4</u>	<u>39.0</u>	<u>42.0</u>	<u>41.4</u>	<u>41.7</u>	<u>30.4</u>
Cost-No-Fee	.5	.2	.2	.2	1.1	1.9
Cost-Plus-Fixed-Fee	37.8	38.6	41.7	41.0	40.5	28.2
Cost Sharing	.1	.2	.1	.2	.1	.3
<u>Labor Hour</u>	<u>(**)</u>	<u>.1</u>	<u>.1</u>	<u>.1</u>	<u>.2</u>	<u>.1</u>
<u>Time and Materials</u>	<u>.3</u>	<u>.2</u>	<u>.2</u>	<u>.3</u>	<u>.2</u>	<u>.3</u>

* R&D contracts of \$10,000 and over, and all other contracts of \$25,000 and over.
 **Less than 0.05 percent.

Appendix IV

NEGOTIATED FEES ON NEW COST-PLUS-FIXED-FEE CONTRACTS
AWARDED TO BUSINESS FIRMS*

FISCAL YEARS 1961 - 1967

Percentage Fee	Fiscal Year 1961		Fiscal Year 1962		Fiscal Year 1963		Fiscal Year 1964		Fiscal Year 1965		Fiscal Year 1966		Fiscal Year 1967	
	% of Total	Cumulative Percent	% of Total	Cumulative Percent	% of Total	Cumulative Percent	% of Total	Cumulative Percent	% of Total	Cumulative Percent	% of Total	Cumulative Percent	% of Total	Cumulative Percent
1.00-1.99	--	--	0.2	0.5	0.5	0.1	0.1	--	--	0.3	0.3	0.1	0.1	0.1
2.00-2.99	0.9	0.9	0.4	0.4	0.9	0.3	0.4	0.2	0.2	0.6	0.4	0.1	0.2	0.2
3.00-3.99	1.2	2.1	1.4	1.8	2.1	2.3	2.7	3.1	1.1	0.6	1.0	0.8	1.0	0.8
4.00-4.99	2.5	4.6	2.9	4.7	4.3	3.8	6.5	9.1	2.2	2.2	3.2	3.2	4.2	4.2
5.00-5.99	6.5	11.1	15.1	10.7	15.0	18.0	18.0	14.2	6.8	10.0	7.4	7.4	11.6	11.6
6.00-6.99	32.3	43.4	40.4	55.5	37.9	39.0	40.2	54.4	35.9	45.9	30.8	30.8	42.4	42.4
7.00-7.99	45.3	88.7	34.1	76.9	89.8	34.5	91.5	37.3	91.7	85.7	38.0	38.0	80.4	80.4
8.00-8.99	9.8	98.5	10.0	99.6	99.8	8.2	99.7	8.1	99.8	99.7	19.2	99.6	99.6	99.6
9.00-9.99	0.9	99.4	10.0	100.0	100.0	0.3	100.0	0.1	99.9	100.0	0.3	99.9	99.9	99.9
10.00 & over	0.6	100.0	--	0.1	100.0	--	100.0	0.1	100.0	--	0.3	100.0	100.0	100.0
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Percent of Aggregate Estimated Contract Costs														
1.00-1.99	--	--	0.6	(**)	0.1	(**)	0.1	--	--	0.3	0.3	0.1	0.1	0.1
2.00-2.99	0.4	0.4	0.6	(**)	0.1	0.1	0.1	0.3	0.3	0.3	0.4	0.4	0.1	0.1
3.00-3.99	0.2	0.6	2.1	0.4	0.5	3.4	3.5	0.4	0.7	0.3	0.7	0.4	0.5	0.5
4.00-4.99	1.6	2.2	2.8	1.0	1.5	0.4	3.9	4.1	4.8	2.5	3.2	2.6	3.1	3.1
5.00-5.99	7.3	9.5	26.3	31.8	6.4	55.1	59.0	10.1	10.1	5.9	32.0	7.4	10.5	10.5
6.00-6.99	64.5	74.0	48.0	70.3	76.7	36.0	95.0	32.4	42.5	42.9	92.0	36.1	46.6	46.6
7.00-7.99	17.7	91.7	18.4	98.2	99.7	4.5	99.5	54.9	97.4	37.7	89.7	40.9	87.5	87.5
8.00-8.99	8.0	99.7	1.7	99.9	100.0	0.5	100.0	2.5	99.9	10.2	99.9	12.5	100.0	100.0
9.00-9.99	0.2	99.9	0.1	(**)	(**)	--	--	(**)	99.9	0.1	100.0	(**)	(**)	(**)
10.00 & over	0.1	100.0	--	(**)	(**)	--	--	(**)	100.0	--	100.0	(**)	(**)	(**)
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
No. of Contracts	325		510		814		1,023		917		778		756	
Total Estimated Cost (Millions)	\$127.1		\$222.7		\$2,026.0		\$1,682.1		\$193.4		\$100.2		\$129.0	
Fees (Millions)	\$8.4		\$14.1		\$132.0		\$100.8		\$13.6		\$7.0		\$9.0	
Average Percent Fee	6.65%		6.33%		6.51%		5.99%		7.03%		6.97%		7.01%	

* BEO contracts of \$10,000 and over and all other contracts of \$25,000 and over.

** Less than 0.05 percent.

Appendix V

NEGOTIATED FEES ON NEW COST-PLUS-FIXED-FEE CONTRACTS
AWARDED TO BUSINESS FIRMS* (Cont'd)

FISCAL YEARS 1968 - 1973

Percentage Fee	Fiscal Year 1968		Fiscal Year 1969		Fiscal Year 1970		Fiscal Year 1971		Fiscal Year 1972		Fiscal Year 1973	
	% of Total	Cumulative Percent	% of Total	Cumulative Percent	% of Total	Cumulative Percent	% of Total	Cumulative Percent	% of Total	Cumulative Percent	% of Total	Cumulative Percent
1.00-1.99	0.3	0.3	--	--	0.1	0.1	0.3	0.3	0.3	0.3	0.2	0.2
2.00-2.99	0.2	0.5	0.3	0.3	0.1	0.2	0.1	0.4	0.3	0.6	--	--
3.00-3.99	0.9	1.4	0.5	0.8	0.9	1.1	0.3	0.7	0.5	1.1	0.9	1.1
4.00-4.99	1.2	2.6	1.4	2.2	2.0	3.1	2.8	3.5	2.8	3.9	3.1	4.2
5.00-5.99	7.7	10.3	7.0	9.2	6.4	9.5	7.4	10.9	7.3	11.2	8.8	13.0
6.00-6.99	30.7	41.0	30.5	39.7	30.8	40.3	31.2	42.1	29.3	40.5	34.3	47.3
7.00-7.99	40.3	81.3	41.2	80.9	40.3	80.6	41.2	83.3	43.0	83.5	35.1	82.4
8.00-8.99	18.0	99.3	18.7	99.6	19.0	99.6	16.7	100.0	16.0	99.5	17.6	100.0
9.00-9.99	0.5	99.8	18.7	100.0	0.4	100.0	--	--	0.5	100.0	--	--
10.00 & over	0.2	100.0	--	--	--	--	--	--	--	--	--	--
Total	100.0		100.0		100.0		100.0		100.0		100.0	
Percent of Aggregate Estimated Contract Costs												
1.00-1.99	0.3	0.3	--	--	(**)	(**)	0.3	0.3	0.2	0.2	0.1	0.1
2.00-2.99	0.1	0.4	(**)	(**)	0.5	0.5	0.2	0.5	0.3	0.5	--	--
3.00-3.99	1.5	1.9	0.1	0.1	1.7	2.2	0.4	0.9	0.3	0.8	1.1	1.2
4.00-4.99	0.8	2.7	0.5	0.6	1.1	3.3	1.7	2.6	6.3	7.1	4.6	5.8
5.00-5.99	2.8	5.5	5.4	6.0	4.1	7.4	4.9	7.5	4.3	11.4	10.6	16.4
6.00-6.99	18.9	24.4	23.3	29.3	22.0	29.4	27.0	34.5	28.5	39.9	43.4	59.8
7.00-7.99	28.5	52.9	47.6	76.9	51.4	80.8	59.8	94.3	48.7	88.6	33.0	92.8
8.00-8.99	47.0	99.9	23.0	99.9	18.7	99.5	5.7	100.0	11.3	99.9	7.2	100.0
9.00-9.99	0.1	100.0	0.1	100.0	0.5	100.0	--	--	0.1	100.0	--	--
10.00 & over	(**)		--	--	--	--	--	--	--	--	--	--
Total	100.0		100.0		100.0		100.0		100.0		100.0	
No. of Contracts	646		782		704		705		642		455	
Total Estimated												
Cost (Millions)	\$170.1		\$164.7		\$159.0		\$188.5		\$123.9		\$67.5	
Fees (Millions)	\$12.9		\$12.1		\$11.5		\$13.4		\$8.7		\$4.6	
Average Percent	7.55%		7.32%		7.25%		7.13%		7.04%		6.82%	

* R&D contracts of \$10,000 and over and all other contracts of \$25,000 and over.

** Less than 0.05 percent.

Appendix V

SMALL BUSINESS PARTICIPATION
IN NASA PROCUREMENTS

FISCAL YEARS 1960 - 1966

	FY 1960	FY 1961	FY 1962	FY 1963	FY 1964	FY 1965	FY 1966
			Net Value of Awards (Millions)				
Total Business Firms	<u>*\$174.0</u>	<u>*\$423.3</u>	<u>*\$1,030.1</u>	<u>\$2,261.7</u>	<u>\$3,521.1</u>	<u>\$4,141.4</u>	<u>\$4,087.7</u>
Small Business Total	<u>29.1</u>	<u>63.5</u>	<u>123.6</u>	<u>191.3</u>	<u>240.3</u>	<u>286.3</u>	<u>255.9</u>
Set-Asides	(**)	6.0	14.0	26.0	39.5	67.4	50.6
Other	29.1	57.5	109.6	165.3	200.8	218.9	205.3
Large Business	<u>144.9</u>	<u>359.8</u>	<u>906.5</u>	<u>2,070.4</u>	<u>3,280.8</u>	<u>3,855.1</u>	<u>3,831.8</u>
	Percent of Total						
Total Business Firms	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>
Small Business Total	<u>17</u>	<u>15</u>	<u>12</u>	<u>8</u>	<u>7</u>	<u>7</u>	<u>6</u>
Set-Asides	(**)	1	1	1	1	2	1
Other	17	14	11	7	6	5	5
Large Business	<u>83</u>	<u>85</u>	<u>88</u>	<u>92</u>	<u>93</u>	<u>93</u>	<u>94</u>

* Excludes procurements placed under General Services Administration contracts.

**Data not compiled.

Appendix VI

SMALL BUSINESS PARTICIPATION
IN NASA PROCUREMENTS (Cont'd)

FISCAL YEARS 1967 - 1973

	FY 1967	FY 1968	FY 1969	FY 1970	FY 1971	FY 1972	FY 1973
			Net Value of Awards (Millions)				
<u>Total Business Firms</u>	<u>\$3,864.1</u>	<u>\$3,446.7</u>	<u>\$3,022.3</u>	<u>\$2,759.2</u>	<u>\$2,279.5</u>	<u>\$2,143.3</u>	<u>\$2,063.8</u>
<u>Small Business Total</u>	<u>216.9</u>	<u>189.6</u>	<u>162.8</u>	<u>161.2</u>	<u>178.1</u>	<u>160.9</u>	<u>155.3</u>
Set-Asides	45.7	34.0	31.4	35.7	41.1	45.1	47.3
Other	171.2	155.6	131.4	125.5	137.0	115.8	108.0
<u>Large Business</u>	<u>3,647.2</u>	<u>3,257.1</u>	<u>2,859.5</u>	<u>2,598.0</u>	<u>2,101.4</u>	<u>1,982.4</u>	<u>1,908.5</u>
	Percent of Total						
<u>Total Business Firms</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>	<u>100</u>
<u>Small Business Total</u>	<u>6</u>	<u>6</u>	<u>5</u>	<u>6</u>	<u>8</u>	<u>8</u>	<u>8</u>
Set-Asides	1	1	1	1	2	2	2
Other	5	5	4	5	6	6	6
<u>Large Business</u>	<u>94</u>	<u>94</u>	<u>95</u>	<u>94</u>	<u>92</u>	<u>92</u>	<u>92</u>

Appendix VI

ANALYSIS OF AWARDS TO LARGE AND SMALL BUSINESS FIRMS

FISCAL YEARS 1961 - 1967

Type of Action	Fiscal Year 1961	Fiscal Year 1962	Fiscal Year 1963	Fiscal Year 1964	Fiscal Year 1965	Fiscal Year 1966	Fiscal Year 1967
(Net Value of Awards-Millions of Dollars)							
<u>Awards of \$25,000 and Over</u>	<u>\$348.8</u>	<u>\$896.2</u>	<u>\$2,113.8</u>	<u>\$3,379.6</u>	<u>\$3,993.0</u>	<u>\$3,951.2</u>	<u>\$3,775.4</u>
Small Business Solicited	73.2	188.2	415.8	574.0	758.7	725.8	779.0
Small Business Not Solicited	275.6	708.0	1,698.0	2,805.6	3,234.3	3,225.4	2,996.4
<u>Small Business Solicited</u>	<u>73.2</u>	<u>188.2</u>	<u>415.8</u>	<u>574.0</u>	<u>758.7</u>	<u>725.8</u>	<u>779.0</u>
Small Business Submitted Bids	52.7	114.8	214.0	326.9	412.2	400.4	463.5
Small Business Did Not Bid	20.5	73.4	201.8	247.1	346.5	325.4	315.5
<u>Small Business Submitted Bids</u>	<u>52.7</u>	<u>114.8</u>	<u>214.0</u>	<u>326.9</u>	<u>412.2</u>	<u>400.4</u>	<u>463.5</u>
Small Business Successful	29.2	66.4	112.6	161.2	202.0	176.4	146.2
Small Business Bid Not Low	18.7	40.3	71.1	96.5	131.9	95.7	112.1
Small Business Bid Not Responsive	3.2	8.0	22.5	42.2	57.7	22.5	74.8
Other Reasons Not Successful	1.6	.1	7.8	27.0	20.6	105.8	130.4
<u>Small Business Not Solicited</u>	<u>275.6</u>	<u>708.0</u>	<u>1,698.0</u>	<u>2,805.6</u>	<u>3,234.3</u>	<u>3,225.4</u>	<u>2,996.4</u>
No Known Small Business Source	274.6	693.8	1,691.0	2,678.3	3,104.9	2,986.3	2,726.6
Unsolicited Proposals	1.0	14.2	7.0	15.5	31.4	28.0	36.6
Other Reasons Not Solicited	--	--	--	111.8	98.0	211.1	233.2
<u>Awards Under \$25,000</u>	<u>74.5</u>	<u>133.9</u>	<u>147.9</u>	<u>141.5</u>	<u>148.4</u>	<u>136.5</u>	<u>88.7</u>
Small Business Successful	34.3	57.2	78.7	79.1	84.3	79.5	70.7
Small Business Not Successful	40.2	76.7	69.2	62.4	64.1	57.0	18.0
(Percent)							
<u>Awards of \$25,000 and Over</u>							
Small Business Solicited	21	21	20	17	19	18	21
Small Business Not Solicited	79	79	80	83	81	82	79
<u>Small Business Solicited</u>							
Small Business Submitted Bids	72	61	52	57	54	55	59
Small Business Did Not Bid	28	39	48	43	46	45	41
<u>Small Business Submitted Bids</u>							
Small Business Successful	55	58	52	49	49	44	32
Small Business Bid Not Low	36	35	33	30	32	24	24
Small Business Bid Not Responsive	6	7	11	13	14	6	16
Other Reasons Not Successful	3	(*)	4	8	5	26	28
<u>Small Business Not Solicited</u>							
No Known Small Business Source	100	98	100	95	96	92	91
Unsolicited Proposals	(*)	2	(*)	1	1	1	1
Other Reasons Not Solicited	--	--	--	4	3	7	8
<u>Awards Under \$25,000</u>							
Small Business Successful	46	43	53	56	57	58	80
Small Business Not Successful	54	57	47	44	43	42	20

*Less than 0.5 percent.

Note: R&D awards of \$10,000 and over are included in awards of \$25,000 and over.

Appendix VII

ANALYSIS OF AWARDS TO LARGE AND SMALL BUSINESS FIRMS (Cont'd)

FISCAL YEARS 1968 - 1973

Type of Action	Fiscal Year 1968	Fiscal Year 1969	Fiscal Year 1970	Fiscal Year 1971	Fiscal Year 1972	Fiscal Year 1973
	(Net Value of Awards-Millions of Dollars)					
<u>Awards of \$25,000 and Over</u>	<u>\$3,338.6</u>	<u>\$2,909.2</u>	<u>\$2,666.9</u>	<u>\$2,192.5</u>	<u>\$2,049.8</u>	<u>\$1,981.3</u>
Small Business Solicited	674.6	601.7	615.4	611.3	649.3	651.8
Small Business Not Solicited	2,664.0	2,307.5	2,051.5	1,581.2	1,400.5	1,329.5
<u>Small Business Solicited</u>	<u>674.6</u>	<u>601.7</u>	<u>615.4</u>	<u>611.3</u>	<u>649.3</u>	<u>651.8</u>
Small Business Submitted Bids	404.9	376.7	381.8	324.3	290.3	288.7
Small Business Did Not Bid	269.7	225.0	233.6	287.0	359.0	363.1
<u>Small Business Submitted Bids</u>	<u>404.9</u>	<u>376.7</u>	<u>381.8</u>	<u>324.3</u>	<u>290.3</u>	<u>288.7</u>
Small Business Successful	118.8	103.7	109.9	121.0	111.6	118.6
Small Business Bid Not Low	92.9	77.4	85.4	69.9	83.6	77.4
Small Business Bid Not Responsive	51.6	50.2	38.5	34.2	25.1	19.9
Other Reasons Not Successful	141.6	145.4	148.0	99.2	70.0	72.8
<u>Small Business Not Solicited</u>	<u>2,664.0</u>	<u>2,307.5</u>	<u>2,051.5</u>	<u>1,581.2</u>	<u>1,400.5</u>	<u>1,329.5</u>
No Known Small Business Source	2,356.3	1,988.4	1,519.1	895.6	726.9	795.7
Unsolicited Proposals	76.6	36.8	30.0	27.3	20.8	8.9
Other Reasons Not Solicited	231.1	282.3	502.4	658.3	652.8	524.9
<u>Awards Under \$25,000</u>	<u>108.1</u>	<u>113.1</u>	<u>92.3</u>	<u>87.0</u>	<u>93.5</u>	<u>82.5</u>
Small Business Successful	70.8	59.1	51.3	57.1	49.3	36.7
Small Business Not Successful	37.3	54.0	41.0	29.9	44.2	45.8
	(Percent)					
<u>Awards of \$25,000 and Over</u>						
Small Business Solicited	20	21	23	28	32	33
Small Business Not Solicited	80	79	77	72	68	67
<u>Small Business Solicited</u>						
Small Business Submitted Bids	60	63	62	53	45	44
Small Business Did Not Bid	40	37	38	47	55	56
<u>Small Business Submitted Bids</u>						
Small Business Successful	29	28	29	37	38	41
Small Business Bid Not Low	23	21	22	22	29	27
Small Business Bid Not Responsive	13	13	10	11	9	7
Other Reasons Not Successful	35	38	39	30	24	25
<u>Small Business Not Solicited</u>						
No Known Small Business Source	88	86	74	56	52	60
Unsolicited Proposals	3	2	1	2	1	1
Other Reasons Not Solicited	9	12	25	42	47	39
<u>Awards Under \$25,000</u>						
Small Business Successful	65	52	56	66	53	44
Small Business Not Successful	35	48	44	34	47	56

Note: R&D awards of \$10,000 and over are included in awards of \$25,000 and over.

Appendix VII

SMALL BUSINESS PARTICIPATION

SUBCONTRACT AWARDS AND TOTAL OF PRIME CONTRACT AND SUBCONTRACT AWARDS

FISCAL YEARS 1961 - 1967

	Fiscal Year 1961	Fiscal Year 1962	Fiscal Year 1963	Fiscal Year 1964	Fiscal Year 1965	Fiscal Year 1966	Fiscal Year 1967
Number of Reporting Companies	12	28	33	43	57	71	85
Subcontracted -							
Total - (Millions)	\$28.4	\$244.7	\$279.6	\$1,282.5	\$1,302.0	\$1,232.8	\$902.7
To Small Business	13.3	96.0	232.4	487.1	417.2	456.8	331.2
To Large Business	15.1	148.7	347.2	795.4	884.8	776.0	571.5
Percent Subcontracted to Small Business	47%	39%	40%	38%	32%	37%	37%
Total Prime Contract Awards to Business Firms	\$423.3	\$1,030.1	\$2,261.7	\$3,521.1	\$4,141.4	\$4,087.7	\$3,864.1
Total Awards to Small Business	76.8	219.6	423.7	727.4	703.5	712.7	548.1
Prime Contracts	63.5	123.3	191.3	240.3	286.3	255.9	216.9
Subcontracts	13.3	96.0	232.4	487.1	417.2	456.8	331.2
Total Prime Contract Awards to Business Firms	100	100	100	100	100	100	100
Total Awards to Small Business	18	21	19	21	17	17	14
Prime Contracts	15	12	8	7	7	6	6
Subcontracts	3	9	11	14	10	11	8

Percent of Total

Appendix VIII

SMALL BUSINESS PARTICIPATION
SUBCONTRACT AWARDS AND TOTAL OF PRIME CONTRACT AND SUBCONTRACT AWARDS (Cont'd)

FISCAL YEARS 1968 - 1973

	Fiscal Year 1968	Fiscal Year 1969	Fiscal Year 1970	Fiscal Year 1971	Fiscal Year 1972	Fiscal Year 1973
Number of Reporting Companies	85	86	Subcontract Awards			
Subcontracted -			83	82	84	82
Total - (Millions)	\$815.3	\$618.8	\$405.5	\$472.1	\$486.3	\$376.0
To Small Business	257.9	164.8	109.1	116.1	124.7	98.6
To Large Business	557.4	454.0	296.4	356.0	361.6	277.4
Percent Subcontracted To Small Business	32%	27%	27%	25%	26%	26%
Prime & Subcontract Awards						
Net Value of Awards (Millions)						
Total Prime Contract Awards						
To Business Firms	\$3,446.7	\$3,022.3	\$2,759.2	\$2,279.5	\$2,143.3	\$2,063.8
Total Awards to Small Business						
Prime Contracts	447.5	327.6	270.3	294.2	285.6	253.9
Subcontracts	189.6	162.8	161.2	178.1	160.9	155.3
	257.9	164.8	109.1	116.1	124.7	98.6
Percent of Total						
Total Prime Contract Awards	100	100	100	100	100	100
To Business Firms						
Total Awards to Small Business	13	11	10	13	13	13
Prime Contracts	6	5	6	8	8	8
Subcontracts	7	6	4	5	5	5

Appendix VIII

NEGOTIATION AUTHORITY - ALL DIRECT ACTIONS

FISCAL YEARS 1961 - 1967

Authority 10 U.S.C. 2304(a)	Fiscal Year 1961	Fiscal Year 1962	Fiscal Year 1963	Fiscal Year 1964	Fiscal Year 1965	Fiscal Year 1966	Fiscal Year 1967
Total Negotiated Awards (Thousands)	\$484,316	\$1,141,482	\$2,439,766	\$3,686,173	\$4,305,730	\$4,314,765	\$4,123,984
Percent of Total	100	100	100	100	100	100	100
(11) Research & Development	59	64	72	81	79	79	75
(10) Advertising Impracticable	6	8	9	6	9	9	12
(5) Educational Institutions	20	14	11	7	7	7	7
(17) Otherwise Authorized by Law	1	1	2	3	4	2	2
(3) \$2,500 or Less	6	5	4	2	1	1	1
(1) National Emergency	7	6	1	(*)	(*)	(*)	1
(6) Outside U.S. and Possessions	(*)	(*)	(*)	(*)	(*)	(*)	1
(14) Substantial Initial Investment Required	1	1	(*)	(*)	(*)	(*)	1
(4) Personal or Professional Services	(*)	(*)	(*)	(*)	(*)	(*)	(*)
(2) Public Emergency	(*)	(*)	(*)	(*)	(*)	(*)	(*)
(15) Negotiation After Advertising	--	(*)	--	(*)	(*)	(*)	(*)
(7) Medicines or Medical Supplies	--	--	(*)	(*)	(*)	(*)	(*)
(8) Supplies Purchased for Authorized Resale	--	--	--	(*)	(*)	(*)	(*)
(9) Perishable/Non Perishable	--	--	--	(*)	(*)	(*)	(*)
(13) Subsistence Supplies	--	--	--	(*)	(*)	(*)	(*)
(12) Technical Equipment Requiring Standardization	--	--	--	(*)	(*)	(*)	(*)
(12) Classified Purchases	(*)	--	--	(*)	(*)	(*)	(*)

*Less than 0.5 percent.

Appendix IX

NEGOTIATION AUTHORITY - ALL DIRECT ACTIONS (Cont'd)

FISCAL YEARS 1968 - 1973

Authority 10 U.S.C. 2304(a)	Fiscal Year 1968	Fiscal Year 1969	Fiscal Year 1970	Fiscal Year 1971	Fiscal Year 1972	Fiscal Year 1973
Total Negotiated Awards (Thousands)	\$2,730,242	\$3,273,735	\$3,039,760	\$2,550,219	\$2,438,645	\$2,344,301
Percent of Total	100	100	100	100	100	100
(11) Research & Development	72	68	63	53	50	49
(10) Advertising Impracticable	15	19	22	29	31	32
(5) Educational Institutions	8	7	8	10	11	11
(17) Otherwise Authorized by Law	2	2	3	3	3	3
(3) \$2,500 or Less	1	1	1	2	2	1
(1) National Emergency	1	1	1	2	2	2
(6) Outside U.S. and Possessions	1	1	1	1	1	2
(14) Substantial Initial Investment Required	(*)	(*)	(*)	(*)	(*)	(*)
(4) Personal or Professional Services	(*)	(*)	(*)	(*)	(*)	(*)
(2) Public Exigency	(*)	(*)	(*)	(*)	(*)	(*)
(15) Negotiation After Advertising	(*)	(*)	(*)	(*)	(*)	(*)
(7) Medicines or Medical Supplies	(*)	(*)	(*)	(*)	(*)	(*)
(8) Supplies Purchased for Authorized Resale	(*)	(*)	(*)	(*)	(*)	(*)
(9) Perishable/Non Perishable Subsistence Supplies	(*)	--	--	--	--	(*)
(13) Technical Equipment Requiring Standardization	(*)	(*)	(*)	--	--	(*)
(12) Classified Purchases	(*)	(*)	(*)	(*)	(*)	--

*Less than 0.5 percent.

Appendix IX

PURCHASES AND CONTRACTS PLACED WITH OR THROUGH
OTHER GOVERNMENT AGENCIES
FISCAL YEARS 1961 - 1967
(Thousands of Dollars)

Agency	Fiscal year 1961		Fiscal Year 1962		Fiscal Year 1963		Fiscal Year 1964		Fiscal Year 1965		Fiscal Year 1966		Fiscal Year 1967	
	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total
Total	\$221,655	100	\$321,760	100	\$628,536	100	\$692,596	100	\$622,833	100	\$512,474	100	\$366,918	100
\$25,000 and over	190,754	86	303,560	94	612,160	97	647,672	94	591,160	95	458,678	90	316,521	86
Air Force	141,970	64	166,878	51	224,186	36	233,036	33	268,163	43	276,738	54	159,437	43
Army	23,704	11	104,801	33	348,770	55	319,990	46	197,920	32	85,574	17	61,524	17
Atomic Energy Commission	3,240	2	4,823	2	3,992	1	8,146	1	10,277	2	13,189	2	17,380	5
Commerce Department	2,924	1	2,947	1	2,724	(**)	4,899	1	5,161	1	7,046	1	6,220	2
General Services Administration	343	(**)	1,080	(**)	3,663	1	4,475	1	6,980	1	8,034	2	7,281	2
Interior Department	368	(**)	487	(**)	2,442	(**)	5,612	1	8,076	1	16,006	3	14,267	4
Navy	12,172	6	13,520	4	25,206	4	67,531	10	84,183	13	34,214	7	38,796	10
Miscellaneous	6,033	2	9,024	3	1,177	(**)	3,983	1	10,400	2	17,877	4	11,616	3
Under \$25,000	30,901	14	18,200	6	16,376	3	44,924	6	31,673	5	53,796	10	50,397	14

**Less than 0.5 percent.

Appendix X

PURCHASES AND CONTRACTS PLACED WITH OR THROUGH
OTHER GOVERNMENT AGENCIES (Cont'd)

FISCAL YEARS 1968 - 1973

(Thousands of Dollars)

Agency	Fiscal Year 1968		Fiscal Year 1969		Fiscal Year 1970		Fiscal Year 1971		Fiscal Year 1972		Fiscal Year 1973	
	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total
Total	\$287,009	100	\$279,001	100	\$265,810	100	\$212,527	100	\$207,791	100	\$235,165	100
\$25,000 and over	252,341	88	232,126	83	228,080	86	176,440	83	170,018	82	189,369	81
Air Force	117,281	40	139,563	50	138,292	52	76,651	36	86,397	42	96,092	41
Army	49,884	17	25,741	9	14,474	5	14,296	7	8,616	4	19,851	9
Atomic Energy Commission	20,588	7	13,135	5	10,259	4	13,292	6	12,682	6	7,771	3
Commerce Department	8,314	3	5,342	2	7,066	3	7,756	3	8,158	4	8,643	4
General Services Administration	10,123	4	9,939	4	11,218	4	9,120	4	8,676	4	6,698	3
Interior Department	13,209	5	10,546	4	10,309	4	9,901	5	9,352	5	9,740	4
Navy	27,942	10	20,890	7	23,697	9	29,060	14	23,631	11	26,323	11
Miscellaneous	5,000	2	6,870	2	12,765	5	16,364	8	12,506	6	14,251	6
Under \$25,000	34,668	12	46,875	17	37,730	14	36,087	17	37,773	18	45,796	19

Appendix X

U.S. GEOGRAPHICAL DISTRIBUTION OF NASA PRIME CONTRACT AWARDS FISCAL YEARS 1961 - 1967

(Thousands of Dollars)

State	Fiscal Year 1961		Fiscal Year 1962		Fiscal Year 1963		Fiscal Year 1964		Fiscal Year 1965		Fiscal Year 1966		Fiscal Year 1967	
	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total
Total	\$380,176	100.0	\$939,143	100.0	\$2,181,405	100.0	\$3,490,238	100.0	\$4,103,399	100.0	\$4,127,046	100.0	\$3,943,466	100.0
Ala.	37,130	9.8	81,264	8.7	97,068	4.4	146,400	4.2	236,890	5.8	319,163	7.7	241,233	6.1
Alaska	675	0.2	4,227	0.5	2,057	0.1	846	(*)	1,351	(*)	2,210	0.1	429	(*)
Ariz.	402	0.1	5,583	0.6	6,291	0.3	6,197	0.2	10,836	0.3	10,077	0.2	7,887	0.2
Ark.	25	(*)	37	(*)	322	(*)	336	(*)	464	(*)	233	(*)	193	(*)
Calif.	148,713	39.1	441,179	47.0	1,098,486	50.4	1,663,071	47.6	1,875,663	45.7	1,808,100	43.8	1,562,968	39.1
Colo.	2,567	0.7	3,622	0.4	7,094	0.3	12,238	0.4	10,292	0.3	12,518	0.3	20,272	0.5
Conn.	3,165	0.8	3,796	0.4	9,015	0.4	20,226	0.6	25,156	0.6	28,049	0.7	27,980	0.7
Del.	45	(*)	34	(*)	204	(*)	553	(*)	807	(*)	5,121	0.1	6,597	0.2
D.C.	6,231	1.6	10,975	1.1	27,141	1.2	41,805	1.2	50,799	1.2	21,400	0.5	43,104	1.1
Fla.	5,963	1.3	50,925	5.4	92,393	4.2	141,568	4.1	181,606	4.4	195,840	4.8	289,210	7.3
Ga.	2,921	0.8	3,352	0.4	6,025	0.3	6,416	0.2	7,447	0.2	4,630	0.1	4,709	0.1
Hawaii	160	(*)	--	--	124	(*)	394	(*)	1,237	(*)	3,905	0.1	4,698	0.1
Idaho	--	--	--	--	1,791	0.1	139	(*)	132	(*)	141	(*)	36	(*)
Ill.	3,872	1.0	8,403	0.9	14,837	0.7	15,420	0.4	18,107	0.4	16,032	0.4	11,681	0.3
Ind.	1,055	0.3	1,646	0.2	2,921	0.1	4,167	0.1	6,710	0.2	6,957	0.2	4,578	0.1
Iowa	679	0.2	1,898	0.2	2,548	0.1	1,822	0.1	2,223	0.1	3,584	0.1	3,134	0.1
Kans.	--	--	--	--	898	(*)	503	(*)	1,806	(*)	1,202	(*)	2,951	0.1
Ky.	32	(*)	--	--	82	(*)	398	(*)	967	(*)	659	(*)	685	(*)
La.	79	(*)	18,534	2.0	185,263	8.5	286,257	8.2	355,342	8.7	338,511	8.2	272,335	6.9
Maine	--	--	--	--	192	(*)	197	(*)	172	(*)	169	(*)	2,802	0.1
Md.	12,940	3.4	26,773	2.9	47,185	2.2	69,528	2.0	95,674	2.3	112,412	2.7	121,555	3.1
Mass.	8,008	2.1	19,737	2.1	43,443	2.0	78,557	2.3	62,296	1.5	71,508	1.7	72,787	1.8
Mich.	3,889	1.0	5,644	0.6	9,088	0.4	12,023	0.3	12,421	0.3	16,218	0.4	34,194	0.9
Minn.	1,825	0.5	2,927	0.3	8,583	0.4	23,607	0.7	45,040	1.1	23,703	0.6	21,294	0.5
Miss.	--	--	93	(*)	86	(*)	609	(*)	4,310	0.1	5,025	0.1	3,634	0.1
Mo.	42,428	11.2	70,600	7.5	197,104	9.0	272,022	7.8	171,078	4.2	55,229	1.3	11,554	0.3
Mont.	--	--	--	--	70	--	161	(*)	276	(*)	471	(*)	105	(*)
Nebr.	--	--	--	--	--	--	104	(*)	233	(*)	168	(*)	70	(*)
Nev.	50	(*)	435	(*)	484	(*)	461	(*)	219	(*)	168	(*)	230	(*)
N.H.	29	(*)	320	(*)	585	(*)	1,103	(*)	7,002	0.2	5,960	0.1	7,037	0.2
N.J.	11,893	3.1	26,980	2.9	55,889	2.6	62,918	1.8	113,435	2.8	67,368	1.6	82,723	2.1
N. Mex.	1,302	0.3	1,696	0.2	2,916	0.1	3,432	0.1	7,703	0.2	14,296	0.4	11,552	0.3
N.Y.	43,872	11.5	55,301	5.9	97,471	4.5	231,099	7.2	344,113	8.4	466,665	11.3	555,609	14.1
N.C.	136	(*)	1,695	0.2	1,000	(*)	3,136	0.1	2,023	0.1	2,398	0.1	1,981	0.1
N. Dak.	--	--	--	--	--	--	38	(*)	74	(*)	96	(*)	100	(*)
Ohio	8,136	2.1	11,320	1.2	32,268	1.5	52,193	1.5	53,013	1.3	43,190	1.1	32,473	0.8
Okla.	337	0.1	687	(*)	1,087	0.1	1,877	0.1	6,534	0.2	2,508	0.1	1,195	(*)
Oreg.	200	0.1	33	(*)	575	(*)	868	(*)	549	(*)	993	(*)	860	(*)
Pa.	11,443	3.0	25,291	2.7	30,489	1.4	51,806	1.5	59,513	1.5	61,894	1.5	62,521	1.6
R.I.	83	(*)	243	(*)	356	(*)	641	(*)	1,608	(*)	976	(*)	875	(*)
S.C.	--	--	--	--	76	(*)	204	(*)	345	(*)	262	(*)	214	(*)
S. Dak.	--	--	98	(*)	407	(*)	168	(*)	63	(*)	85	(*)	69	(*)
Tenn.	949	0.2	2,163	0.2	2,301	0.1	2,490	0.1	1,789	(*)	1,892	0.1	1,593	(*)
Tex.	12,180	3.2	32,755	3.5	56,772	2.5	48,735	1.4	149,615	3.6	170,123	4.1	258,128	6.5
Utah	28	(*)	37	(*)	534	(*)	471	(*)	435	(*)	734	(*)	1,759	(*)
Vt.	--	--	112	(*)	128	(*)	96	(*)	434	(*)	290	(*)	357	(*)
Va.	6,830	1.8	13,785	1.5	23,961	1.1	29,469	0.8	42,805	1.0	37,504	0.9	43,754	1.1
Wash.	99	(*)	325	(*)	2,516	0.1	27,354	0.8	54,679	1.3	61,169	1.5	32,224	0.8
W. Va.	--	--	--	--	538	(*)	959	(*)	575	(*)	551	(*)	321	(*)
Wis.	705	0.2	4,618	0.5	12,683	0.6	45,042	1.3	77,279	1.9	126,574	3.1	75,073	1.9
Wyo.	--	--	--	--	38	(*)	114	(*)	263	(*)	115	(*)	143	(*)

* Less than .05 percent.

Note: Includes awards on R&D contracts and awards to educational and nonprofit institutions of \$10,000 and over and on all other contracts of \$25,000 and over; excludes awards placed through other Government agencies, awards outside the U.S., and actions on the JPL contracts.

Appendix XI

U.S. GEOGRAPHICAL DISTRIBUTION OF NASA PRIME CONTRACT AWARDS FISCAL YEARS 1968 - 1973 (Cont'd)

(Thousands of Dollars)

State	Fiscal Year 1968		Fiscal Year 1969		Fiscal Year 1970		Fiscal Year 1971		Fiscal Year 1972		Fiscal Year 1973		Total - FY's 1961 - 1973	
	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total	Amount	% of Total
Total	\$3,498,430	100.0	\$3,065,922	100.0	\$2,830,988	100.0	\$2,351,542	100.0	\$2,194,616	100.0	\$2,115,644	100.0	\$35,222,035	100.0
Ala.	197,651	5.6	139,223	4.5	155,005	5.5	138,195	5.9	113,261	5.2	106,042	5.0	2,008,525	5.7
Alaska	225	(*)	798	(*)	295	(*)	2,135	0.1	1,397	0.1	1,718	0.1	18,363	0.1
Aris.	7,008	0.2	4,523	0.1	6,707	0.2	8,276	0.4	6,240	0.3	6,956	0.3	86,983	0.2
Ark.	116	(*)	195	(*)	64	(*)	59	(*)	90	(*)	87	(*)	2,221	(*)
Calif.	1,317,953	37.7	1,045,855	34.1	874,791	30.9	522,826	22.2	520,455	23.7	696,005	32.9	13,576,065	38.5
Colo.	34,762	1.0	68,660	2.2	119,579	4.2	118,325	5.0	214,165	9.8	194,400	9.2	818,434	2.3
Conn.	21,015	0.6	29,593	1.0	26,213	0.9	26,435	1.1	18,959	0.9	21,711	1.0	261,313	0.7
Del.	8,301	0.2	12,618	0.4	13,399	0.5	6,723	0.3	9,139	0.4	4,300	0.2	67,841	0.2
D.C.	78,869	2.3	36,561	1.2	31,061	1.1	27,471	1.2	21,034	1.0	11,671	0.5	408,098	1.2
Fla.	336,598	9.6	403,632	13.2	295,379	10.4	246,707	10.5	212,741	9.7	215,112	10.2	2,666,774	7.6
Ga.	3,487	0.1	2,060	0.1	3,596	0.1	7,481	0.3	5,263	0.2	5,206	0.2	62,573	0.2
Hawaii	3,024	0.1	3,779	0.1	3,978	0.1	3,006	0.1	2,903	0.1	2,100	0.1	29,308	0.1
Idaho	--	--	--	--	150	(*)	11	(*)	--	--	34	(*)	2,434	(*)
Ill.	9,043	0.3	8,638	0.3	9,877	0.3	9,799	0.4	7,457	0.3	8,357	0.4	141,523	0.4
Ind.	3,649	0.1	3,174	0.1	4,427	0.2	4,960	0.2	4,545	0.2	5,601	0.3	54,390	0.2
Iowa	5,968	0.2	5,105	0.2	4,039	0.1	2,229	0.1	2,031	0.1	4,072	0.2	39,332	0.1
Kans.	820	(*)	928	(*)	1,100	(*)	1,730	0.1	2,105	0.1	1,600	0.1	15,643	(*)
Ky.	942	(*)	387	(*)	325	(*)	313	(*)	350	(*)	167	(*)	5,287	(*)
La.	232,208	6.6	136,611	4.5	109,092	3.9	50,803	2.2	58,590	2.7	49,812	2.4	2,093,437	5.9
Maine	8,535	0.2	8,680	0.3	4,490	0.2	2,485	0.1	--	--	(21)	(*)	27,701	0.1
Mt.	125,172	3.6	134,526	4.4	140,901	5.0	181,072	7.7	173,526	7.9	181,801	8.6	1,423,065	4.0
Mass.	79,309	2.3	74,933	2.4	82,341	2.9	74,587	3.2	62,849	2.9	47,164	2.2	777,339	2.2
Mich.	26,628	0.8	18,983	0.6	27,489	1.0	43,538	1.9	22,800	1.0	10,483	0.5	243,398	0.7
Minn.	23,011	0.7	15,189	0.5	30,641	1.1	7,962	0.3	12,960	0.6	10,578	0.5	227,320	0.6
Miss.	1,667	(*)	2,745	0.1	1,969	0.1	19,008	0.8	14,112	0.6	13,230	0.6	66,488	0.2
Mo.	10,922	0.3	25,576	0.8	103,412	3.7	205,482	8.7	227,031	10.3	111,855	5.3	1,504,293	4.3
Mont.	225	(*)	23	(*)	--	--	(9)	(*)	95	(*)	104	(*)	1,521	(*)
Nebr.	102	(*)	--	--	111	(*)	66	(*)	639	(*)	286	(*)	1,779	(*)
Nev.	257	(*)	214	(*)	863	(*)	328	(*)	242	(*)	578	(*)	4,329	(*)
N.H.	6,501	0.2	3,977	0.1	3,647	0.1	1,495	0.1	990	(*)	979	(*)	39,625	0.1
N.J.	72,777	2.1	67,743	2.2	53,786	1.9	77,735	3.3	58,122	2.7	36,065	1.7	787,434	2.2
N. Mex.	12,476	0.4	11,384	0.4	9,491	0.3	6,656	0.3	4,568	0.2	4,260	0.2	91,732	0.3
N.Y.	443,967	12.7	376,397	12.3	299,878	10.6	135,656	5.8	48,544	2.2	45,193	2.1	3,161,765	9.0
N.C.	1,568	(*)	2,407	0.1	2,359	0.1	2,363	0.1	2,553	0.1	1,637	0.1	25,256	0.1
N. Dak.	13	(*)	4	(*)	--	--	(3)	(*)	8	(*)	--	--	330	(*)
Ohio	27,603	0.8	30,327	1.0	37,950	1.3	37,588	1.6	29,313	1.3	21,278	1.0	416,652	1.2
Ore.	907	(*)	573	(*)	1,126	(*)	1,930	0.1	1,091	0.1	997	(*)	20,849	0.1
Oreg.	536	(*)	524	(*)	579	(*)	597	(*)	866	(*)	1,107	0.1	8,287	(*)
Pa.	55,317	1.6	66,143	2.2	44,069	1.6	87,306	3.7	68,083	3.1	46,926	2.2	670,801	1.9
R.I.	544	(*)	484	(*)	667	(*)	468	(*)	240	(*)	312	(*)	7,497	(*)
S.C.	109	(*)	57	(*)	270	(*)	127	(*)	128	(*)	316	(*)	2,108	(*)
S. Dak.	113	(*)	8	(*)	57	(*)	476	(*)	(8)	(*)	335	(*)	1,871	(*)
Tenn.	964	(*)	1,610	0.1	1,614	0.1	1,844	0.1	1,112	0.1	1,708	0.1	22,029	0.1
Tex.	234,515	6.7	246,299	8.0	266,468	9.4	212,333	9.0	198,095	9.0	180,376	8.5	2,164,394	6.1
Utah	1,879	0.1	2,740	0.1	1,306	(*)	2,146	0.1	1,680	0.1	1,259	0.1	15,008	(*)
Vt.	408	(*)	249	(*)	171	(*)	112	(*)	121	(*)	153	(*)	2,631	(*)
Va.	36,491	1.0	27,920	0.9	30,470	1.1	37,566	1.6	46,788	2.1	44,213	2.1	421,556	1.2
Wash.	16,364	0.5	9,067	0.3	4,301	0.2	11,112	0.5	10,273	0.5	13,322	0.6	242,805	0.7
W. Va.	100	(*)	254	(*)	313	(*)	188	(*)	46	(*)	147	(*)	3,992	(*)
Wis.	47,796	1.4	34,251	1.1	21,054	0.7	21,773	0.9	6,943	0.3	3,854	0.2	477,645	1.4
Wyo.	35	(*)	315	(*)	118	(*)	71	(*)	101	(*)	218	(*)	1,531	(*)

* Less than .05 percent.

Note: Includes awards on R&D contracts and awards to educational and nonprofit institutions of \$10,000 and over and on all other contracts of \$25,000 and over; excludes awards placed through other Government agencies. Awards outside the U.S., and actions on the JPL contracts.

Appendix XI

U.S. GEOGRAPHICAL DISTRIBUTION - PRIME CONTRACT & SUBCONTRACT AWARDS

FISCAL YEARS 1962 - 1973

(Thousands of Dollars)

State	Prime Contract Awards to State		Subcontract Awards			Net Total - Prime Contract & Subcontract Awards	
	Amount	% of Total	Received from Other States	Awarded to Other States	Net Total**	Amount***	% of Total
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)
Total	\$34,841,859	100.0	\$5,087,427	\$5,087,427	\$ --	\$34,841,859	100.0
Alabama	1,971,395	5.7	82,741	159,286	(76,545)	1,894,850	5.4
Alaska	17,688	0.1	1,584	--	1,584	19,272	0.1
Arizona	86,581	0.2	146,645	7,750	138,895	225,476	0.6
Arkansas	2,196	(*)	1,409	11	1,398	3,594	(*)
California	13,427,352	38.5	1,121,213	1,916,967	(795,754)	12,631,598	36.3
Colorado	815,927	2.3	114,360	222,637	(108,277)	707,650	2.0
Connecticut	258,148	0.7	307,300	48,179	259,121	517,269	1.5
Delaware	67,796	0.2	4,089	5,349	(1,260)	66,536	0.2
Dist. Columbia	401,867	1.2	1,344	9,111	(7,767)	394,100	1.1
Florida	2,661,711	7.6	229,590	143,741	86,209	2,747,920	7.9
Georgia	59,652	0.2	4,853	396	4,457	64,109	0.2
Hawaii	29,148	0.1	147	--	147	29,295	0.1
Idaho	2,434	(*)	134	--	194	2,628	(*)
Illinois	137,651	0.4	71,229	1,455	69,774	207,425	0.6
Indiana	53,335	0.2	40,529	9,392	31,137	84,472	0.2
Iowa	38,653	0.1	157,353	72,152	85,201	123,854	0.4
Kansas	15,643	(*)	7,854	377	7,477	23,120	0.1
Kentucky	5,255	(*)	1,396	--	1,396	6,651	(*)
Louisiana	2,093,358	6.0	12,320	201,905	(189,585)	1,903,773	5.5
Maine	27,701	0.1	270	--	270	27,971	0.1
Maryland	1,410,125	4.0	88,105	68,152	19,953	1,430,078	4.1
Massachusetts	769,531	2.2	546,028	91,488	454,540	1,224,071	3.5
Michigan	239,509	0.7	72,686	28,153	44,533	284,042	0.8
Minnesota	225,495	0.6	261,829	8,412	253,417	478,912	1.4
Mississippi	66,488	0.2	48,993	3,502	45,491	111,979	0.3
Missouri	1,461,865	4.2	40,123	449,577	(409,454)	1,052,411	3.0
Montana	1,521	(*)	46	--	46	1,567	(*)
Nebraska	1,779	(*)	5,965	1,259	4,706	6,485	(*)
Nevada	4,479	(*)	2,844	--	2,844	7,323	(*)
New Hampshire	39,596	0.1	4,389	4,145	244	39,840	0.1
New Jersey	775,541	2.2	387,286	116,447	270,839	1,046,380	3.0
New Mexico	90,430	0.3	7,273	918	6,355	96,785	0.3
New York	3,117,893	8.9	341,026	1,031,358	(690,332)	2,427,561	7.0
North Carolina	25,120	0.1	6,846	17	6,829	31,949	0.1
North Dakota	330	(*)	12	--	12	342	(*)
Ohio	408,516	1.2	131,793	17,742	114,051	522,567	1.5
Oklahoma	20,512	0.1	16,999	2,733	14,266	34,778	0.1
Oregon	8,087	(*)	4,865	--	4,865	12,952	(*)
Pennsylvania	659,358	1.9	497,598	99,460	398,138	1,057,496	3.0
Rhode Island	7,414	(*)	7,329	260	7,069	14,483	(*)
South Carolina	2,108	(*)	880	--	880	2,988	(*)
South Dakota	1,871	(*)	233	--	233	2,104	(*)
Tennessee	21,080	0.1 *	9,291	109	9,182	30,262	0.1
Texas	2,152,214	6.2	134,246	107,850	26,396	2,178,610	6.3
Utah	14,980	(*)	10,661	1,608	9,053	24,033	0.1
Vermont	2,631	(*)	20,367	439	19,928	22,559	0.1
Virginia	414,726	1.2	21,502	6,772	14,730	429,456	1.2
Washington	242,706	0.7	84,968	70,280	14,688	257,394	0.7
West Virginia	3,992	(*)	3,803	178	3,625	7,617	(*)
Wisconsin	476,940	1.4	22,625	177,860	(155,235)	321,705	0.9
Wyoming	1,531	(*)	36	--	36	1,567	(*)

Note: Prime contract awards include awards on R&D contracts and awards to educational and nonprofit institutions of \$10,000 and over and on all other contracts of \$25,000 and over; exclude awards placed through other Government agencies, awards outside the U.S., and actions on the JPL contracts. Subcontract awards include those of \$10,000 and over on prime contracts of \$500,000 and over.

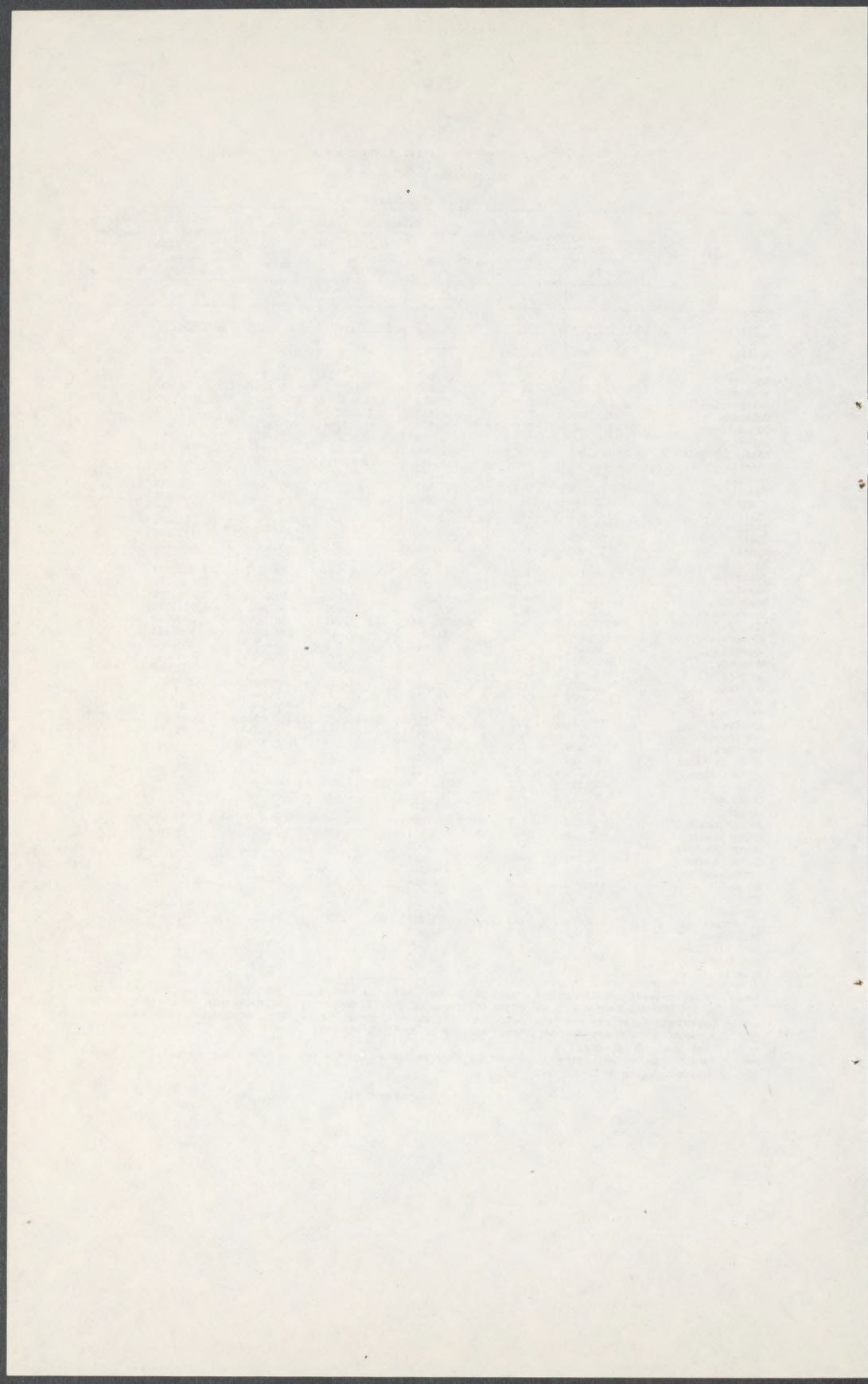
* Less than .05 percent.

** Parentheses indicate that the awards to other states exceed the awards from other states.

*** Column (b) plus or minus column (f).

Appendix XII

GPO 873-084



APPENDIX B

QUESTIONS AND ANSWERS FOR THE RECORD PUBLIC AFFAIRS ACTIVITY

Question 1. We on the Committee know about all the good things coming out of the space program as evidenced here today. How do you plan to get this word to the public during fiscal year 1975?

Answer. For several years, there has been an increasing effort and emphasis in NASA's public affairs program devoted to space benefits. This emphasis includes providing more information and materials dealing with NASA's Technology Utilization and Space Applications programs, as well as benefits from research and development programs. Some examples are:

An increased number of news releases and publications; more films and exhibits, and more time spent in Spacemobile lectures and speeches on the subject of benefits.

The total effort expended on public affairs activity in connection with benefits is very sizable.

For instance, every film feature on the subject goes to more than 700 commercial and educational t.v. stations. Several benefits pamphlets were printed in quantities of 200,000 or more each and distributed to schools and libraries (and NASA centers for answering public mail) throughout the United States. Another new initiative was the renting of space in metropolitan airport terminals for benefits exhibits.

NASA intends to continue all of these activities in FY 1975. In addition, we plan to carry on a much broader program of personal visits and meetings by the Administrator and other top agency officials with leading media executives, correspondents and writers and with opinion leaders throughout the country to provide very positive contact with those who might assist in disseminating information on the content and value of technology transfer and practical benefits from the space program.

Question 2. Is the budget for public affairs activity for fiscal year 1975 the same or lower than previous years?

Answer. The Public Affairs budget for FY 1975 is at the same level as for FY 1974.

TECHNOLOGY UTILIZATION

Question 1. How does your TU Program relate to NSF's Experimental R&D Incentives Program?

Answer: The NASA Technology Utilization Program is charged with transferring the technological results of NASA's aeronautical and space programs to users in industry and the public sector.

The NSF Experimental R&D Incentives Program is an experimental program which attempts to understand and test the process in which R&D is used in industry and applied to public sector needs.

The NSF Experimental R&D Incentives Program areas, where preliminary discussions indicate complementary joint program activity, are the Urban Technology System, the Innovation Centers, and the Federal Laboratory transfer experiment.

In the Urban Technology System program, NASA's Technology Utilization Office is coordinating the possible support of NASA Field Installations as Federal Laboratory support sites.

In addition, discussions have been initiated to use the network of 26 city technology agents to introduce technical innovations emanating from the Technology Utilization Program's applications project activities which appear useful to city governments. Examples are the Firefighters Breathing System, the Improved Road Patch Material, and the Ballistics Identification System.

Initial discussions have taken place with the NSF-sponsored MIT Innovation Center to explore the possibility of utilizing Technology Utilization applications projects as experiments for the Innovation Centers to investigate the clinical experience of entrepreneurship.

Finally, the Technology Utilization Program has been the subject of eight of the ten case studies the NSF Experimental R&D Incentives Program has developed for technology transfer from Federal Laboratories.

Question 2. Have you commissioned any recent studies to measure or describe the benefits and influences of the space program?

Answer: Space Benefit Studies Conducted—1973.

Technology Profiles

(1) Applications of Aerospace Technology in Electric Power Industry.

(2) Applications of Aerospace Technology in the Public Interest: Pollution Measurement.

Case Studies

(3) Rehabilitative Engineering at Rancho Los Amigos Hospital.

(4) Cardiology—A case Study of Technology Transfer.

Space Benefits Report

(5) Benefits from Life Support Systems Technology—an extended series of case studies tracing aerospace technologies developed for life support systems to commercial applications. (To be available by April 15, 1974.)

TRACKING AND DATA RELAY SATELLITE SYSTEM (TDRSS)

Question 1. Would you please give the Committee a brief explanation as to why you have proposed a "lease" approach rather than a "buy" of the system?

Answer. Our analysis clearly indicates that either a leased system approach or a NASA-owned system will be cost effective compared with our conventional network of ground stations, and also each approach will provide significant operational benefits. The lease arrangement we are recommending has the important advantage that expenditures by NASA will be deferred until the TDRSS service begins and the resulting savings are being realized. We feel that this permits the most efficient utilization of our resources, particularly during the period FY 1976-78 when shuttle development funding requirements will be at their peak. We believe that the lease arrangement is the best way to get the needed benefits of a TDRS system, permitting us to maintain a balanced program without unnecessarily increasing the NASA budget in the year immediately ahead.

Although TDRSS is now a new concept in our tracking and data acquisition support of NASA missions, it will be a long-continuing one. We feel, therefore, that it is desirable to bring industry into this picture at this time, and initiate this capability under the lease arrangement with industry. If we start it as a NASA effort, it will have the effect of locking NASA into the operation for a long term.

Further, the lease arrangement we are proposing is consistent with the long standing policy and practice of the Government in relying upon industry to provide communication services. The maturing of the communication satellite industry, which is now beginning to move into the domestic communications area and particularly into areas of special services such as the MARISAT system for communications services for the Navy and the maritime community, makes it possible to consider government leasing of TDRSS services from the private sector rather than developing and operating the system inhouse. We feel that the technology is ready and that industry is in a position to establish the system and to provide the required service.

Question 2. Is it not true that the lease arrangement will cost more than if it were bought by NASA?

Answer. Our analysis indicates that the lease arrangement may be more costly than a NASA-owned system by as much as ten to twenty percent in terms of discounted dollars (present value of future dollar). It should be noted that a NASA-owned system would require peak funding in the near term, that is FY 1976-78, whereas a leased arrangement would not require funding until the service actually begins, in FY 1979, and continuing through the 1980's; hence "discounted value" presents the proper basis of cost comparison for the two approaches.

It is possible, however, that lower cost might be achieved in a leased system if the contractor can provide TDRSS service through a shared system which is also providing other communication services to other users. If such an arrangement turns out to be feasible, and we will of course explore this possibility in our competitive procurement, then leased services could be lower cost than the NASA-owned system.

Question 3. Does your decision result from the OMB budget ceiling set for NASA for the next few years?

Answer. OMB has not set a budget ceiling for NASA for the next few years; however, NASA recognizes that there will continue to be severe fiscal constraints on the total NASA budget. The lease arrangement permits us to defer the TDRSS expenditures until the years when the resulting savings are being realized and to move ahead in acquiring the TDRSS capability without overlaying on the NASA budget the near term funding that would be required to procure a NASA-owned TDRSS system.

NASA EQUAL EMPLOYMENT OPPORTUNITIES AND AFFIRMATIVE PROGRAMS

Question 1. What is the total aggregate undergraduate annual graduation of all types of scientists and engineers from minority groups in the United States? What fraction of this total is employed annually by NASA? How does this compare to other parts of the Federal Government?

Answer 1. In November 1973, NASA Headquarters conducted a survey of HEW (Office of Education), National Science Foundation, the Department of Labor and some Professional Societies in an effort to determine the annual baccalaureate graduates in the areas of education related to the major occupational categories within the NASA workforce.

Integral to this survey was an effort to determine the numbers of minorities in each of these educational categories. While we were unable to accumulate data which could be categorized as "hard data", we were able to develop data which certainly would indicate the trends in these areas. The data below was the result of this survey and reflects graduations through the academic year ending June 30, 1972.

BACCALAUREATE GRADUATES JUNE 30, 1972 (SCIENTISTS AND ENGINEERS)

	Total	Minorities
Engineers.....	45,580	579
Mathematicians.....	25,370	(1)
Physical scientists.....	21,160	119
Total.....	92,110	

¹ Data not available.

Our response to the latter portions of this question is limited by both the availability of data on the total number of minority scientific and engineering graduates and the scientific and engineering graduate hiring pattern data for the other parts of the Federal Government. In addition to these factors our internal hiring pattern has been affected by our continuing reduction in manpower, re-employment rights of RIF'ed employees and the general scarcity of candidates as reflected by the figures above. However, we have recently received data from the U.S. Civil Service Commission which should provide a common basis for comparison relative to the percentage of minorities scientists and engineers in the respective workforces.

During January of this year, the U.S. Civil Service Commission in conjunction with NASA provided statistical data as of 6/30/73 which indicated the percentage of minorities in the various occupational categories within the Federal Government. About 5.1% of the Federal employees in scientific and engineering occupational categories are minorities compared to 3.5% employment ratio for minorities in scientific and engineering positions in NASA.

Question 2. What is the total aggregate annual graduation of women scientists and engineers in all categories in the United States? What portion of this group does NASA employ? How does this compare to other parts of the Federal Government?

Answer 2. In November 1973, NASA Headquarters conducted a survey of HEW (Office of Education), National Science Foundation, the Department of Labor and some Professional Societies in an effort to determine the annual baccalaureate graduates in the areas of education related to the major occupational categories within the NASA workforce.

Integral to this survey was an effort to determine the numbers of women in each of these educational categories. While we were unable to accumulate data which could be categorized as "hard data," we were able to develop data which certainly would indicate the trends in these areas. The data below was the result of this survey and reflects data based on graduations through the academic year ending June 30, 1972.

BACCALAUREATE GRADUATES JUNE 30, 1972 (SCIENTISTS AND ENGINEERS)

	Total	Women
Engineers.....	45,580	519
Mathematicians.....	25,370	9,494
Physical scientists.....	21,160	2,440
Total.....	92,110	12,453

Our response to the latter portions of this question is limited by the women scientific and engineering graduate hiring pattern data for the other parts of the Federal Government. In addition to these factors our internal hiring pattern has been affected by our continuing reduction in manpower, re-employment rights of RIF'ed employees and the general scarcity of candidates as reflected by the figures above. However, we have recently received data from the U.S. Civil Service Commission which should provide a common basis for comparison relative to the percentage of women scientists and engineers in the respective work forces.

During January of this year, the U.S. Civil Service Commission in conjunction with NASA provided statistical data as of 6/30/73 which indicated the percentage of women in the various occupational categories within the Federal Government. About 2.6% of the Federal employees in scientific and engineering occupational categories are women compared to a 2.2% employment ratio of women in scientific and engineering positions in NASA.

Answer to question 3: For NASA Centers:

Specific numerical goals for hiring and placement of minorities were developed for the first time this year, thus there is not yet enough experience to evaluate progress by each installation. The goals developed cover CY 1974. To date we are on target in meeting the Agency's commitments.

We have recently developed a uniform report format to facilitate monitoring the progress of the Centers in achieving the EEO commitments. This format will be used for the first time in the quarterly reports for the first quarter of CY 1974.

As far as contractors are concerned: It is government policy to interpret numerical goals in terms of hiring opportunities and workers available in the job market. A contractor's performance is judged in terms of his "good faith" effort to meet his goals commitment. The judgment is not simply a statistical comparison. Our judgments result from the in-depth reviews conducted of our contractors annually.

Attached is a listing of the performance of contractors (by NASA Installation) in achieving the goals stated in their Affirmative Action Plans. The compilation uses data on female and minority employment as of December 31, 1973, and compares that with goals stated in AAP's to be achieved during 1973.

The largest contractor work forces are at the following centers:

Center	Contractors	Employees
Kennedy Space Center.....	30	10,025
Marshall Space Flight Center.....	63	9,765
Johnson Space Center.....	53	8,937

We find that those contractors which have a large component of technical and scientific employees experience the greatest difficulty in meeting their goals. Over the last few years, several of these larger contractors have not made the progress we would have liked. In many instances this has been due to reduction in the work force due to phase down and change of programs as the Manned Space Flight Program achieved its objectives.

Nevertheless, NASA contractors as a whole have shown progress in that overall minority and female employment has progressed in spite of the decrease of some 6,000 jobs in NASA programs. Exhibits I and II summarizes the combined performance of contractors for which NASA has compliance responsibility.

Answer to Question 4. NASA requires Affirmative Action Programs for prime contractors and subcontractors down to the level of \$50,000 and 50 employees.

EXHIBIT I

NUMBER OF CONTRACTORS MEETING OR EXCEEDING AAP GOALS FOR MINORITIES AND WOMEN BY NASA INSTALLATION

Center	Total contractors	Number meeting goals for minority	Number meeting goals for women
ARC.....	16	13	12
FRC.....	5	4	4
GSFC.....	31	21	23
JSC.....	44	21	32
KSC.....	25	12	16
LARC.....	17	9	6
LERC.....	5	3	1
MSFC.....	40	20	32
NAPO.....	41	30	31
WS.....	17	13	12
MAF.....	9	8	7
MTF.....	7	2	5
Total.....	257	¹ 156	² 181

¹ 60.4 percent.² 70.4 percent.

EXHIBIT II

SUMMARY OF CONTRACTOR WORK FORCE DATA

Total employment:	
Dec. 31, 1971.....	51,275
June 30, 1973.....	41,531
Dec. 31, 1973.....	45,219

EMPLOYMENT OF MINORITIES (IN PERCENT)

	Dec. 31, 1971	June 30, 1973	Dec. 31, 1973
Officials and managers.....	3.4	4.8	5.4
Professionals.....	5.9	7.8	8.1
Technicians.....	10.2	13.6	15.5
Sales workers.....	3.8	6.7	9.0
Office and clerical.....	15.6	19.4	20.9
Skilled crafts.....	8.8	9.6	10.6
Operatives (semiskilled).....	21.4	27.6	28.9
Laborers (unskilled).....	47.5	51.7	62.2
Service workers.....	47.4	46.4	44.0
Total.....	11.8	14.4	15.0

EMPLOYMENT OF WOMEN (IN PERCENT)

	Dec. 31, 1971	June 30, 1973	Dec. 31, 1973
Officials and managers.....	2.1	2.8	3.9
Professionals.....	5.5	7.6	8.4
Technicians.....	8.5	10.6	11.6
Sales workers.....	17.0	13.3	21.0
Office and clerical.....	68.7	70.7	72.3
Skilled crafts.....	3.1	2.7	3.5
Operatives (semiskilled).....	15.2	22.8	29.8
Laborers (unskilled).....	16.0	10.5	13.0
Service workers.....	11.8	14.7	18.0
Total.....	15.7	17.5	19.0

Note: Percentages shown are of the total work force in that job category.

Question 5. Does NASA sponsor and undertake special programs for minority training at the technician and professional levels?

Answer. NASA has developed a number of cooperative education programs over the years which we are now adapting to meet our needs for proper representation of minorities and females throughout our workforce. Additionally, we have developed Upward Mobility programs to assist minority and females presently employed by the Agency.

Our Cooperative (Co-op) Education Program, the largest co-op program in government, is being used to increase the number of minority and women candidates for professional positions in the workforce. (Participation by minorities

and women has increased 100% since FY 72). We also have developed vocational co-op programs to bring an increased number of minorities and women into the skilled craft areas of our workforce. Both programs are directed towards educational/work experience for individuals outside our present permanent workforce.

The Upward Mobility Program was designed to provide present NASA employees with opportunities to grow, enhance their qualifications, effectively utilize their capabilities and compete for new positions with higher promotion potential. To this end, nation-wide CSC-approved training agreements have been developed and career counseling is being provided.

The principal elements of the NASA Upward Mobility Program are outlined below:

CEP I: is a training program designed to permit employees to improve themselves by taking courses after work at NASA's expense.

CEP II: is a goal-oriented program. To be eligible an employee must be in a non-professional position and have 12 semester credit hours behind him or her, have a designated goal and a program outlined to reach that goal. Participants are allowed to be away from work with pay for a maximum of 8 hours per week to attend college.

GO: enables any non-professional employee from GS-2 through GS-9 to enter a non-professional career sequence, which may or may not be allied to the present one, and be trained for a target position with a higher promotion potential.

STEP: enables *non-professional employees*, GS-5 through GS-10, to enter *professional ranks* with planned training from a year to 18 months, depending on the entry level of the participant, and promises eligibility for promotion to the next grade level upon successful completion of the training.

CROSSOVER: enables professional employees, GS-5 through GS-15, to be selected competitively and trained for new professional career fields unrelated to their past occupations.

Question 6: To what extent does NASA contracting provide opportunity to minority business groups? What is the dollar value of the contracts in force and the number of people employed?

Answer: NASA has established a Minority Business Enterprise Program in conformance with Executive Order 11625 to ensure that minority firms are given an equitable opportunity to participate in NASA procurements. NASA's Minority Business Enterprise Program for FY-74, attached as enclosure 1, translates into an active program for seeking out and assisting minority firms in doing business with NASA, and its major prime contractors and subcontractors. Significant elements of this program include the following:

A NASA Section 8(a) minority contracting goal of \$11 million has been established for FY-74. This represents a 29 percent increase over the \$8.5 million awarded by NASA in FY-73. NASA also placed \$2.2 million in direct awards in FY-73; on-site support services contractors awarded an additional \$3.2 million to minority firms.

The extent of a prospective contractor's small business and minority business subcontracting plans has been established as a factor for consideration in NASA's source evaluation and selection process.

Minority business enterprise subcontracting has been established as a contractual requirement as set forth in NASA Procurement Regulation 1.332 (enclosure 2). Additionally, major NASA contractors are being contractually required to develop minority business subcontracting plans.

All major NASA prime and subcontractors are required to submit a quarterly minority business subcontracting report to NASA Headquarters. During the first half FY-74, NASA contractors reported \$2.9 million in subcontract awards to minority firms.

NASA actively participates in all Interagency committees established to foster and coordinate the government's business efforts. The NASA Deputy Administrator is the NASA member of the Interagency Council for Minority Business Enterprise. At the field level, NASA Centers participate in the activities of the Minority Business Opportunity Committees (MBOC) to provide regional program coordination. A Small Business-Minority Business Specialist, assigned to each Center is the NASA member of the local MBOC.

During FY-73 participation by minority firms in NASA's Section 8(a) procurement program and direct competitive procurement resulted in \$10,621,934 of awards and employed approximately 655 people. In the first half of FY-74, NASA awarded a total of \$3,789,881 in Section 8(a) and direct competitive procurements to minority firms employing approximately 365 people.

STATEMENT OF NASA MINORITY BUSINESS ENTERPRISE PLANS FOR
FISCAL YEAR 1974

During fiscal year 1974, NASA, working from an established base, will continue to place appropriate emphasis on implementation of the Minority Business Enterprise Program (MBE). It is NASA's intent to effect a well-balanced minority business procurement program in consonance with its established mission, and in support of its research and development work and operational requirements.

The essential elements of the FY-74 plan include:

Continued emphasis on the Section 8(a) program as set forth in NASA Procurement Regulation 1.705-5, as this presents the most feasible means for ensuring procurement awards to minority firms. During FY-73 approximately 42% of NASA's Section 8(a) procurement dollars were made in the areas of research and development, technical services, and computer related services. Efforts to seek out and work with good technically oriented minority firms for Section 8(a) and competitive procurements will be stressed. Additional emphasis is also being placed on construction contracting opportunities.

Increased attention is being given to the minority business subcontracting program as set forth in NASA Procurement Regulation 1.332. Minority subcontracting requirements are included in most NASA contracts valued in excess of \$500,000. Participating prime contractors are now to report quarterly all awards to minority firms on NASA Form 524. The NASA contract for the Space Shuttle is receiving special attention in this regard. Arrangements have also been made with the Department of Defense to ensure that NASA prime contractors are included in DOD's regular subcontracting surveillance reviews as set forth in NASA Procurement Regulation 1.707.

NASA Installations will continue their efforts to seek out and determine the capabilities of minority firms, and to assist them in the awareness of and participation in procurement opportunities. This effort is now called for in NASA Procurement Regulation 1.332.

NASA intends to participate in all activities sponsored by the Interagency Task Force on Procurement for Minority Businessmen including minority business conferences and seminars.

NASA Installations will foster, and participate in, as appropriate, minority business enterprise activities at the local level. This includes active participation and cooperation with the Minority Business Opportunity Committees of the Federal Executive Boards and their local business development affiliates.

In summary, NASA intends to pursue a well-balanced and aggressive minority business program during FY-74. We will continue to seek innovative and effective ways for assisting minority firms, and for ensuring their maximum participation in NASA's procurement opportunities.

NASA pledges its full support and cooperation toward achievement of the basic objectives of the Minority Business Enterprise Program.

NASA PROCUREMENT REGULATIONS

1.332 Minority Business Enterprises.

1.332-1 *General.*

(a) In connection with Executive Order 11625, October 13, 1971, (36 F.R. 199, October 14, 1971), it has been determined that the national interest requires increased involvement of minority business enterprises in Federal procurement programs. In support of this policy, continuing efforts will be made (i) to facilitate the placement of minority individuals and minority-owned firms on source lists to assure that they are appropriately solicited, (ii) to counsel such individuals and firms with respect to procurement policies and procedures and NASA business opportunities so as to enhance their potential participation, and (iii) to inform such individuals and firms concerning subcontracting opportunities, including identification of major NASA programs and current or prospective prime contractors that might offer opportunity for participation. Unless otherwise assigned by the Head of the Installation, the small business/labor surplus area specialist at each installation is assigned primary responsibility for this effort.

(b) The implementation of this policy involves other types of assistance such as contracting with the Small Business Administration under Section 8(a) of the Small Business Act (see 1.705-5). Additionally, to further the opportunities of minority business enterprises to participate in the performance of Government contracts, maximum practicable opportunity should be provided for these firms to participate as subcontractors and suppliers to prime contractors and subcontractors under Government contracts.

(c) Accordingly, effort should be put forth to provide to minority business enterprises counseling services with respect to procurement policy and procedures and information covering NASA business opportunities, and to have the names of such firms included on source lists at the various procurement offices. Also, the Minority Business Subcontracting Program (1.332-2) shall be effectively implemented.

(d) *Definition.* A minority business enterprise is defined in paragraph (b) of the clause in 1.322-3(a).

1.332-2 *Minority Business Enterprises Subcontracting Program.* The Government's minority business enterprises subcontracting program requires Government contractors to assume affirmative obligations with respect to subcontracting with minority business enterprises. These obligations are in addition to those required under the small business subcontracting program (1.707) and under the labor surplus area subcontracting program (1.805). In contracts which range from \$5,000 to \$500,000, the contractor undertakes the accomplishment of a maximum amount of subcontracting with minority business enterprises, consistent with efficient performance of the contract. This is set forth in the clause 1.332-3(a). For contracts which may exceed \$500,000 the clause set forth in 1.332-3(b) requires that the contractor undertake a number of specific responsibilities designed to assure that minority business enterprises are given all possible consideration in the placement of subcontracts and to impose similar responsibilities on major subcontractors.

1.332-3 *Required Clauses.*

(a) The following clause shall be included in all contracts in amounts which may exceed \$5,000 except contracts which, including all subcontracts thereunder, are to be performed entirely outside the United States, its possessions, Puerto Rico, and the Trust Territory of the Pacific Islands.

UTILIZATION OF MINORITY BUSINESS ENTERPRISES (DECEMBER 1971)

(a) It is the policy of the Government that Minority Business Enterprises shall have the maximum practicable opportunity to participate in the performance of Government contracts.

(b) The Contractor agrees to use his best efforts to carry out this policy in the award of his subcontracts to the fullest extent consistent with the efficient performance of this contract. As used in this contract, the term "minority business enterprise" means a business, at least 50 percent of which is owned by minority group members or, in case of publicly owned businesses, at least 51 percent of the stock of which is owned by minority group members. For the purposes of this definition, minority group members are Negroes, Puerto Ricans, Spanish-speaking American persons, American-Orientals, American-Indians, American Eskimos, and American Aleuts. Contractors may rely on written representations by subcontractors regarding their status as minority business enterprises in lieu of an independent investigation.

(b) The following clause shall be included in all contracts (except maintenance, repair and construction contracts) which may exceed \$500,000, which require the clause in (a) above and which, in the opinion of the contracting officer, offer substantial subcontracting possibilities. Furthermore, prime contractors who are to be awarded contracts which may not exceed \$500,000 but which, in the opinion of the contracting officer, offer substantial subcontracting possibilities, shall be urged to accept the clause.

MINORITY BUSINESS ENTERPRISES SUBCONTRACTING PROGRAM (DECEMBER 1971)

(a) The Contractor agrees to establish and conduct a program which will enable minority business enterprises (as defined in the clause, entitled, "Utilization of Minority Business Enterprises") to be considered fairly as subcontractors and suppliers under this contract. In this connection, the Contractor shall:

(1) Designate a liaison officer who will administer the Contractor's "Minority Business Enterprises Program."

(2) Provide adequate and timely consideration of the potentialities of known minority business enterprises in all "make-or-buy" decisions.

(3) Assure that known minority business enterprises will have an equitable opportunity to compete for subcontracts, particularly by arranging solicitations, time for the preparation of bids, quantities, specifications, and delivery schedules so as to facilitate the participation of minority business enterprises.

(4) Maintain records showing (i) procedures which have been adopted to comply with the policies set forth in this clause, including the establishment of a source list of minority business enterprises, (ii) awards to minority business enterprises on the source list, and (iii) specific efforts to identify and award contracts to minority business enterprises.

(5) Include the "Utilization of Minority Business Enterprises" clause in subcontracts which offer substantial minority business enterprise subcontracting opportunities.

(6) Cooperate with the Contracting Officer in any studies and surveys of the Contractor's minority business enterprises procedures and practices that the Contracting Officer may from time to time conduct.

(7) Submit periodic reports of subcontracting to known minority business enterprises with respect to the records referred to in subparagraph (4) above, in such form and manner and at such time (not more often than quarterly) as the Contracting Officer may prescribe.

(b) The Contractor further agrees to insert, in any subcontract hereunder which may exceed \$500,000 provisions which shall conform substantially to the language of this clause, including this paragraph (b), and to notify the Contracting Officer of the names of such subcontractors.

1.705-5 *Contracting with the Small Business Administration.*

(a) *Authority.* When the Small Business Administration (SBA) certified to the NASA contracting officer, in accordance with Section 8(a) of the Small Business Act (15 USC 637(a)) that the SBA is competent to perform a specific contract, the contracting officer is authorized, in his discretion, to award the contract to the SBA.

(b) *Policy.* It is the policy of NASA to enter into contracts with the SBA to foster or assist in the establishment or the growth of small business concerns as designated by the SBA so that these concerns may become self-sustaining, competitive entities within a reasonable period of time. The SBA is empowered to arrange for the performance of such contracts by negotiating or otherwise letting contracts to small business concerns or others.

(c) *Procedures.*

(1) *Supplies, Services and Research and Development.*

(A) In contracts for supplies, services and research and development, it is the stated policy of the SBA to contract with only those small firms which have submitted a written business plan specifically outlining a reasonable approach to the attainment of the policy objectives of (b). This business plan, if approved by the SBA, will be the basis for NASA's consideration of participation in a Section 8(a) program for the firm. In the execution of this policy, the SBA will furnish to the Director of Procurement, NASA Headquarters or to the Procurement Officer of a particular NASA installation, when the requested procurement is of a local nature, its request for a commitment to support the approved plan. SBA requests addressed to NASA Headquarters will be coordinated with appropriate installations.

(B) The SBA request for a commitment to support the approved plan will show at least the following information:

(i) the background and ownership of the firm;

(ii) how and when the firm is expected to become a self-sustaining, competitive entity;

(iii) the extent to which procurement assistance is needed and an identification of the requirements sought from NASA (the identification of the supplies or services which the SBA may require in connection with a small firm's business plan will be developed by the SBA representatives. This may be accomplished through liaison with appropriate procurement offices either before or after the SBA's approval of a small firm's business plan as the SBA may elect. Small business specialists and minority business specialists at NASA installations shall cooperate and assist the SBA representatives in developing identifying information for the requirements being sought from the procurement office. To the extent possible, identifying information furnished by the SBA will be definitive and include purchase descriptions and Federal stock numbers. The small business specialist or the minority business specialist shall, when practicable and feasible, arrange for such additional assistance as may be required from procurement, technical and supply management officials in order that the development of the identifying information may be meaningful. Current and future requirements of a small firm's business plan, if identified in meaningful terms will enable NASA to relate the items to present and future procurement requirements); and

(iv) if the firm is currently in existence, the present production capacity and related facilities and how any additional facilities needed will be provided.

(C) In addition to considering specific requests for commitments to support the business plans submitted by the SBA in (A) above, the NASA small business specialist or other responsible individuals shall review and evaluate, on a continuing basis, all procurement requirements to determine their suitability for

referral to the SBA for 8(a) consideration. Upon completion of such evaluation, a recommendation concerning award to the SBA will be made to the contracting officer. In the event the contracting officer disagrees with the recommendation, the procedure set forth in 1.706-3(f) shall apply. In these evaluations consideration shall be given to:

- (i) availability of qualified prospective 8(a) contractors;
- (ii) estimated total quantities of the identified items planned for procurement in the current fiscal year and, to the extent known, future fiscal years;
- (iii) required monthly rates of production and delivery schedules;
- (iv) items of similar complexity and nature if there are no known requirements of the specifically identified items;
- (v) problems encountered in prior production of the items either by the proposed contractor or other contractors;
- (vi) impact if slippage in delivery occurs;
- (vii) impact if items were procured historically by small business or labor surplus area set-aside; and
- (viii) any other information concerning the items or the proposed contractor which is pertinent to the evaluation of the requested commitments.

(D) After the SBA requested commitments have been evaluated or a specific procurement has been designated as suitable for 8(a) contracting, the cognizant contracting officer shall notify the SBA and the Director of Procurement, NASA Headquarters (Attention: Small Business Advisor). The notification will include the extent to which a Section 8(a) contract may be placed with the SBA and the time frame within which the prime and subcontract actions must be completed in order to satisfy NASA's requirements. This notification represents a firm commitment by NASA to negotiate with the SBA, provided that there is no material change in requirements, availability of funds, or other pertinent factors. In the notification to the SBA, the installation should also establish a time limit (generally not less than 30 working days after receipt of notification) within which the SBA must establish contact with the installation and initiate negotiations of the Section 8(a) contract. If negotiations with the installation procurement office have not been initiated by the SBA within the time indicated, the procurement office will notify the Director of Procurement, NASA Headquarters (Attention: Small Business Advisor) of the intent to proceed with the procurement without further regard to the Section 8(a) procedures, unless additional time is requested by the SBA and such additional time can be granted considering the urgency of the requirement.

(E) It will be the responsibility of the SBA to provide written certification as to its competency to perform the contract, to the NASA contracting officer.

(F) A pre-award survey of the SBA's contractor, as required by 1.905-4, will not generally be requested by the NASA contracting officer. The SBA or the NASA contracting officer may request a cognizant contract administration office to assist in a review of a specific element pertaining to the SBA contractor's responsibility.

(G) When required by 3.807-3, the SBA shall secure from the prospective subcontractor cost or pricing data together with any necessary supporting certificate.

(H) When satisfactory terms and conditions, including price, have been negotiated with the SBA's contractor, the NASA procurement office shall proceed with the award of a contract to the SBA.

(I) For follow-on year procurements in support of the SBA requested commitment, the SBA will initiate individual requests to NASA for each ensuing proposed Section 8(a) contract. This process will permit NASA, prior to actual negotiations of follow-on Section 8(a) awards, to verify the availability of requirements, funding and other pertinent factors. It will be the responsibility of the SBA to provide certification to the cognizant NASA contracting officer, for each individual Section 8(a) contract.

(J) To assist the SBA, NASA procurement offices shall prepare two contract sets as follows:

(i) Prepare Standard Form 26 for use by the SBA with the SBA's contractor. The standard Form 26 shall show "15 USC 637 (a)" in Block 13 and contain all of the information required with the exception of the following, which will be inserted by the SBA:

(i) Prepare Standard Form 26 for use by the SBA with the SBA's contractor. The Standard Form 26 shall show "15 USC 637 (a)" in Block 13 and contain all of the information required with the exception of the following, which will be inserted by the SBA:

- (a) Block 1, the SBA contract number;

- (b) Block 2, the effective date;
- (c) Block 24, the signature of the SBA's contractor;
- (d) Block 25, the SBA contractor's date;
- (e) Block 27, the signature of the SBA's contracting officer;
- (f) Block 28, the name of the SBA's contracting officer; and
- (g) Block 29, the date signed.

The contract shall incorporate the general provisions of Standard Form 32, including NASA Form 250, and other appropriate provisions as required, recognizing that this contract will be executed between the SBA and the SBA's contractor. The contract shall also include a clause as follows:

For the purpose of this contract, the reference to "his duly authorized representative" in the "Disputes" clause of this contract shall be deemed to refer to the NASA Board of Contract Appeals.

The contract set prepared as shown herein will be provided to the SBA at the time of distribution of the contract set prepared in accordance with (ii) below.

(ii) Prepare a Standard Form 26 for execution with the SBA without incorporating any general provisions of Standard Form 32. The general provisions are not applicable to the SBA. "10 USC 2304(a)(17)" shall be cited as the authority for negotiation of this contract. This contract shall include a statement as follows:

It is agreed that the provisions of the "Termination for Convenience," "Changes," "Disputes," and "Default" clauses which are included in the contract between the SBA and its Contractor shall be invoked in appropriate cases when requested by the NASA Contracting Officer. If the SBA does not agree with the NASA Contracting Officer's request, the case shall be referred to the Director of Procurement, NASA Headquarters, for decision.

(K) Unless otherwise agreed upon, the contract between the SBA and NASA shall provide that performance of contract administration functions, including payment, under the contract between the SBA and the SBA's contractor shall be the responsibility of the cognizant NASA procurement office subject to the authority to redelegate performance of such services to other Government agencies as provided for in Part 51.

(L) The execution and distribution of procurement documents by the cognizant NASA procurement office shall be in accordance with Part 50. The procurement office shall accomplish internal NASA distribution of both the prime contract and the subcontract, and provide the SBA with a duplicate original copy of the executed prime contract and such additional authenticated conformed or reproduced copies as requested by the SBA. The SBA shall provide the NASA procurement office with two duplicate original copies of the executed subcontract and such additional authenticated, conformed or reproduced copies as requested by the procurement office for internal NASA distribution.

For purposes of fund obligation and payment the NASA contracting officer shall ensure that the NASA paying office identified in the contract is provided a signed copy of each contract. In addition a conformed copy of each contract is to be provided the Procurement Office (DK-2), NASA Headquarters.

(2) Construction.

(A) In contracts for construction, it is the stated policy of the SBA to contract with only those small firms which have been approved by the SBA as supporting the policy objectives of 1.705-5(b). In the execution of this policy, the SBA will furnish to the Director of Procurement, NASA Headquarters, or to the Procurement Officer of a particular NASA installation when the requested procurement is of a local nature, its request for a commitment(s) showing at least the following information:

(i) the identification of the SBA's contractor(s) and the capabilities and qualifications of the contractor(s) to accomplish various categories of maintenance, repair, alteration and construction work in such specific work project categories as mechanical, electrical, heat and air conditioning, demolition, building, painting, paving, earth work, water front work or general construction work;

(ii) the total extent to which procurement assistance is needed and an individual identification of the estimated dollar value in each category in which the SBA's contractor(s) have capabilities; for example, electrical up to \$100,000, mechanical up to \$100,000;

(iii) any other information concerning the capabilities of the proposed contractor(s) which would be pertinent to the evaluation of the requested commitments.

(B) The Procurement Office, NASA Headquarters (Attention: Small Business Advisor) will coordinate the evaluation of the SBA's request for a commitment(s) it receives with installation procurement offices, to determine whether or to what extent NASA has proposed work projects for which funding is available, in those categories for which the SBA has indicated its contractors have capabilities to perform. In addition, the NASA Small Business Specialist, or other responsible individual, shall review on a continuing basis, all construction procurement requirements to evaluate their suitability for referral to the SBA for 8(a) consideration. Upon completion of such evaluation, recommendation concerning award to the SBA will be made to the contracting officer. In the event the contracting officer disagrees with the recommendation, the procedure set forth in 1.706-3(f) shall apply. In these evaluations consideration shall be given to:

- (i) the extent to which work project(s) of the type requested by the SBA are planned for procurement in the current fiscal year and, to the extent known, future fiscal years;
- (ii) required performance schedule(s);
- (iii) work project(s) of similar complexity and nature if there are no known work project(s) of the specific type requested;
- (iv) problems encountered in prior work project(s) of the type requested;
- (v) impact if slippage occurs in the performance schedule;
- (vi) impact if the work project(s) was procured historically by small business set-aside; and
- (vii) any other information concerning the work project(s) or the contractor which is pertinent to the evaluation of the requested commitment(s).

(C) After the SBA requested commitments have been evaluated or a specific NASA construction requirement has been designated as suitable for 8(a) contracting, the cognizant contracting officer shall notify the SBA and the Director of Procurement, (NASA Headquarters (Code DK-2)). The notification shall contain information with regard to the work project(s) as follows:

- (i) a summary of the scope of the proposed work;
- (ii) detailed Government cost estimates;
- (iii) plans and specifications;
- (iv) required performance schedules; and
- (v) any other pertinent and reasonably available data.

This notification represents a firm commitment by NASA to negotiate with the SBA, provided there is no material change in requirements, availability of funds, or other pertinent factors. In the notification to the SBA the installation should also establish a time limit (generally not less than 30 working days after receipt of notification) within which the SBA must establish contact with the installation and initiate negotiations of the Section 8(a) contract. If negotiations with the installation procurement office have not been initiated by the SBA within the time indicated, the procurement office will notify the Procurement Office, NASA Headquarters (Attention: Small Business Advisor) of the intent to proceed with the procurement without further regard to the Section 8(a) procedures, unless additional time is requested by the SBA and such additional time can be granted considering the urgency of the work project.

(D) Provisions of the Miller Act with respect to performance and payment bonds do not apply to the prime contract between NASA and the SBA, but do apply to the contract between the SBA and its contractor.

(E) When required by 3.807-3, the SBA shall secure from the prospective subcontractor cost or pricing data together with any necessary supporting certificate.

(F) It will be the responsibility of the SBA to provide written certification, as to its competency to perform the contract, to the contracting officer.

(G) When satisfactory terms and conditions, including, price, have been negotiated with the SBA's contractor, the NASA procurement office shall proceed with the award of a contract to the SBA.

(H) To assist the SBA, NASA procurement offices shall prepare two contract sets as follows:

- (i) prepare appropriate contractual documents for use by the SBA with the SBA's contractor. These documents shall be completed, except for signatures and award information (see 1.705-5(c)(1)(J)(i)), based on information requested or furnished by the SBA. This contract shall incorporate the mandatory general provisions and standard forms as required and also shall include a statement as follows:

For the purpose of this contract, the reference to "his duly authorized representative" in the "Disputes" clause shall be deemed to refer to the NASA Board of Contract Appeals.

(ii) prepare Standard Form 19 or Standard Form 23 or other appropriate forms for execution with the SBA without incorporating any general provisions. The general provisions are not applicable to the SBA. "10 USC 2304 (a)(17)" shall be cited the authority for negotiations of this contract. This contract shall include a statement as follows:

It is agreed that the provisions of the "Termination for Convenience," "Changes," "Differing Site Conditions," "Default-Damages for Delay-Time Extensions," "Suspension of Work," "Disputes," and "Payments to Contractor" clauses which are included in the contract between the SBA and its Contractor shall be invoked in appropriate cases when requested by the NASA Contracting Officer. If the SBA does not agree with the NASA Contracting Officer's request, the case shall be referred to the Director of Procurement, NASA Headquarters, for decision.

(I) Contract administration functions under the contract shall be in accordance with Part 51.

(J) The execution and distribution of procurement documents shall be in accordance with Part 50 and as set forth in 1.705-5(c)(1)(L) herein.

Question 7. Total professional employment in NASA has been declining for the past several years. Has the absolute number of minority professionals and women employed by NASA increased or decreased in that time?

Answer. Over the past several years, NASA employment has decreased approximately 30 percent from a peak in excess of 34 thousand in 1967. The rate of decrease has been sharpest during the past four fiscal years. A comparison of the statistics for minorities and women professionals as of June 30, 1970 versus comparable numbers for December 31, 1973 are as follows:

PERMANENT EMPLOYEE STRENGTH—PROFESSIONAL (MINORITY AND WOMEN)

	June 30, 1970	Dec. 31, 1973	Net change
Minority professionals.....	601	549	-52
Women professionals.....	998	842	-156

However, it is important to note that during the same period of time as covered by the statistics above, NASA had an overall absolute decrease of total professional employees of 2261.

Question 8. Have the minority and women professionals employed in NASA increased as a percentage of total employment in the last several years?

Answer. During the same period covered by the statistics in question 7 the percentage of total employment for minorities and women professionals are as follows.

PERCENTAGE OF PERMANENT EMPLOYEE STRENGTH—PROFESSIONAL (MINORITY AND WOMEN)

[In percent]

	June 30, 1970	Dec. 31, 1973	Change
Minority professionals.....	3.4	3.5	+ .1
Women professionals.....	5.6	5.4	-.2

However, it is important to note that during the same period of time as covered by the statistics above, NASA had an overall decrease of total professional employees of 12.7%.

Question 9. Is there a conscious effort within NASA to employ women professionals who are trained in fields closely allied to the direct scientific and engineering technical disciplines? What is the number and percentage of total employment of such skilled women with NASA?

Answer. NASA management has recognized clearly the issue of the small percentage of women in professional positions. We have established a goal of 80 female placements in professional positions during calendar year 1974. To insure achievement of this goal NASA has implemented an Agency-wide recruitment effort for minorities and women professionals and also is implementing an Upward Mobility program to assist installation managers in providing current non-professional employees with high potential with opportunities to move into professional positions. As we indicated in response to question 5 these efforts are being supplemented by increased effort to recruit women into our Co-op program which is predominately populated by scientific and engineering candidates.

As of December 31, 1973 NASA employed 285 female scientists and engineers (S&E's) which represents 2.4% of the total (11,882) S&E's in NASA. The data for similar S&E's positions government-wide occupied by women as of June 30, 1973 was 2.6%.

SATELLITE SOLAR POWER STATION

Question 1. To what extent, in the judgement of NASA, is there hope that some significant portion of our long-term National energy problems may be alleviated by using power from space generated in a Satellite Solar Power Station?

Answer. The creation of large amounts of power from solar energy in stations in orbit about the earth is one of the more intriguing possible futuristic alternatives to fossil fuels. There are many aspects of such a concept that warrant study and experimentation to further define the economic viability which will, to a large extent, determine the likelihood that satellite solar power stations and terrestrial power relay stations can alleviate our long-term energy requirements. Even if the concept never appears to be competitive relative to our power systems, the research and development will bear fruit in much broader areas of interest to the nation both in space and in terrestrial applications.

Question 2. Are you considering the Satellite Solar Power Station as a possible mechanism for exploiting various NASA developed technologies (for example, solar cells, microwave power transmission, assembly of structures in space, etc.)? If so, how are you planning to schedule and implement this work?

Answer. The future possibilities of satellite solar power stations or of satellite power relay stations have obviously influenced our choice of projects being carried out under authorization for energy related work in the 1974 NASA Authorization (Section 1(a)(7) of P.L. 93-74). These projects include the following:

Space-based solar power conversion and power relay systems study.

Earth-based solar-thermal power conversion and delivery systems studies.

Microwave energy transmission and reception.

These and other energy-related NASA projects undertaken to support our general needs in space and aeronautics are summarized in our report "Energy-Related Research and Development" to the Committee on Aeronautical and Space Sciences, United States Senate (see particularly Section 5.0).

On the other hand, NASA is not, at this time, considering a satellite solar power station as a planned program. A decision to establish such a program requires much more study and experimentation than we have been authorized to pursue to date. In addition, it requires much greater insight into the comparative economics of this and other future power systems than is presently available. An example of one of the many technical and economic uncertainties is the fact that it presently requires more energy to produce a solar cell than can be obtained from that cell over its expected lifetime. This unfavorable situation can only be reversed by further research and development. Also, it is not yet determined that solar cells will ultimately be the most efficient means for the conversion of solar energy to electricity.

Question 3. In the NASA program plans, are you considering potential space shuttle missions to support development of a Satellite Solar Power Station?

Answer. The establishment and support of a satellite solar power station is not now included in NASA's Space Shuttle mission model. It will be sometime before the economic feasibility of such power stations has been demonstrated to the point where such planning would be warranted.

Question 4. What are NASA's plans to develop further the technologies which must be applied, in order to utilize solar power generated by a Satellite Solar Power Station?

Answer. Within the limited authorization authority presently available to NASA, we will continue to study and to perform research and development in areas applicable to satellite solar power stations as well as to other possible uses of the space environment. Until it becomes clear through these and future studies that satellite solar power stations are potentially competitive with other sources of energy, we do not intend to specifically address the utilization of such solar power, i.e., the detailed characteristics of a reception, distribution, power peaking and marketing system on earth.

Question 5. Are you aware of the international interest in the Satellite Solar Power Station technology, particularly in Europe and Japan? If so, will you outline any NASA plans for joint international development efforts?

Answer. There are no immediate plans for international involvement in the major technological development programs required for the satellite solar power station. Once some of the more difficult technical questions have been further explored and the economic competitiveness has been determined, the implementation of an operational system is certainly a program which would lend itself to international cooperation in view of the great general interest of many countries in future energy alternatives.

Question 6.—Will you describe the time scale which NASA has set up for orderly development of the Satellite Solar Power Station energy option, so that it may be exercised, if necessary?

Answer. NASA does not feel that the establishment of a specific program for the development of satellite solar power stations is warranted by our present understanding of the technical and economic feasibility required to justify such a program. We do feel, however, that it is important to extend studies and experimentations related to this concept to the point where its credibility as a future energy option is proved or disapproved. Given the present uncertainties of other futuristic energy systems, it would seem only prudent to do so.

A technology demonstration payload related to specific aspects of the satellite solar power station concept probably should be considered for an early mission of the space shuttle. If the early 1980's saw the establishment of satellite solar power stations as a credible energy option, then a full demonstration could be considered for the latter part of that decade. By this time, our understanding of other options also should be much greater and our decisions could be based on much more certain data than is presently available.

Question 7. To what extent can the Satellite Solar Power Station energy option be considered, in view of the President's stated goal of achieving National energy self-sufficiency?

Answer. The President's goal of National self-sufficiency can be broken down into three phases: first, the immediate need to relieve the present problem of supply and dependency on uncertain foreign sources of petroleum; second, the need for alternatives to petroleum that are presently technically and economically viable and that can maintain adequate self-sufficiency into the 21st century; and, third, the future need for inexhaustible or renewable sources of energy to replace fossil fuels and establish long-term self-sufficiency to the extent required for national security. It is in the third of these three phases that the satellite solar power stations should be considered as an option along with fusion and the broad use of geothermal and ocean thermal sources.

Question 8. Do you see a linear increase in cost with an increase in electrical power output? Or does the project become more economical per Kw as it is made larger?

Answer. There are many trade-offs which must be analyzed in great detail prior to determining an optimum system size for satellite solar power stations. At this point, only very general statements can be made; however, it is expected that above some base cost for research, development, design, test, and deployment, the cost will increase linearly as the power output is increased. Just how long this linear cost/power output relationship continues until other major step increases occur requires further study. Some maximum system size is suspected beyond which it would be more economical to deploy a separate system.

Question 9. Along the same line, would it be best to gear up for production of units of selected output (5 Mw, 100 Mw, etc.) or build each satellite to the particular needs of the situation?

Answer. Once the concept of satellite solar power stations is seen to be a credible energy option, it seems likely that economics would dictate a single optimum size. It appears, however, to be much too soon to speculate any further than this.

Question 10. In the case of remote communities that individually do not use a great deal of power, but collectively could use 50-1000 Mw have you explored what type ground reception and transmission facilities would be needed to serve all the communities from one satellite.

Answer. As indicated in our answer to question 4, NASA has conducted no studies that deal with the earth-based utilization of satellite solar power. We consider such studies to be premature until the concept is more clearly defined technically and economically.

FACILITIES PLANNING AND DESIGN

Question 1. During the period FY 1970 through FY 1974, there has been a total of \$33.6 million authorized for Facility Planning and Design.

a. How much of this authorization has been funded?

Answer. The total \$33.6 million has been funded.

Question b. Of the amount funded, how much has been obligated?

Answer. As of January 31, 1974 some \$18.0 million of the \$33.6 million has been obligated.

Question c. When will the balance be obligated?

Answer. Current projections indicate that obligations will total about \$27 million by June 30, 1974, and that the remaining amount will all be essentially obligated by the end of calendar year 1974.

Question 2. Not all construction projects upon which Facility Planning and Design funds have been expended for preliminary and advance design survive the budget review process. Roughly, what percent of the annual appropriations for these purposes are lost because of project cancellations or other denials?

Answer. It is estimated that on the average an amount equivalent to less than $\frac{1}{2}$ of 1% of our total Facility Planning and Design resources may be expended on facility projects which, for various reasons, are not ultimately executed.

Question 3. Of the \$900,000 being requested for Master Planning and Facility Studies:

a. How much is intended for master plan updates?

Answer. A total of \$250,000 has been included for Master Plan up-dating and improvements.

Question b. How much is intended for as-built drawings?

Answer. At the moment no specific amount has been identified nor included in the estimate for this purpose. It is intended that any priority requirements of this nature which may develop and cannot otherwise be provided for will be accommodated through adjustments to the detailed program on which these estimates were based.

Question c. For value engineering and analysis?

Answer. A total of \$120,000 has been included for Value Engineering and analysis.

Question. d. For Building Research and Advisory Board support? What is this board and what is its purposes?

Answer. A total of \$50,000 has been included for Building Research Advisory Board support. The Building Research Advisory Board, a unit of the NAS-NAE National Research Council, undertakes activities serving research in building science and technology, and provides for appropriate dissemination of information resulting from those activities. In its work for and with private organizations and units of government, the Board provides advice on research or technical problems, monitors research studies undertaken by others, organizes conferences and symposia, acts to stimulate research and correlate information, and, in general, explores subjects in the housing, building, and related community and environmental design and development field where objective treatment is needed. Voluntary association of research-interested individuals and organizations is provided by the Board through its Building Research Institute; the Federal Construction Council provides continuing cooperation among construction agencies of the Federal Government in advancing the science and technology of Federal Government building and construction; and the Building Industry Manufacturers Research Council, having as its central purpose the consideration of the needs and opportunities of the manufacturing segment of the building industry, provides counsel to the Board on specific matters of mutual concern.

The 36 members of the Board, together with a number of individuals from Federal agencies who serve in a liaison capacity, are recognized authorities in building-interested segments of industry, government, and academic and research institutions, appointed on a rotating and overlapping basis by the Chairman of the NRC Division of Engineering with approval of the President of the National

Academy of Sciences. Each Board member serves as an individual, never as a representative of any other organization or interest group. The Board, acting as a body, establishes special and standing advisory or study committees, panels, task groups, and similar working bodies as needed to carry out its various undertakings.

NASA has contributed to the support of this activity for several years now in the same manner that many other government agencies do. We participate in these mutually advantageous activities and receive reports and other support therefrom.

Question 4. How much of the Preliminary Engineering Report activities are conducted in-house? Are funds for in-house work included in the \$450,000 request?

Answer. It is estimated that on an average about 30-35% of our PER effort is accomplished by in-house capabilities. Funds are not included in this \$450,000 request for this type of in-house work.

Question 5. Last year, \$800,000 was authorized for preliminary engineering reports for other than shuttle requirements. What is your revised estimate for these purposes in FY 1974? How much will be carried over into FY 1975?

Answer. It is presently estimated that this \$800,000 will still be needed for Preliminary Engineering Reports for other than shuttle requirements for projects proposed for the FY 1976 Program. Some adjustment to the estimate may result when our review of FY 1976 "candidate" facility projects is complete. This review is now in progress. It is expected that all Preliminary Engineering work for the FY 1976 Program will be under contract by June 30, 1974, and that only a small amount, if any, will be carried over into FY 1975.

Question 6. Is the request for \$2,550,000 for final design for FY 1976 projects based upon the 6% limitation for A&E work?

Answer. No, it is not based on the 6% limitation for A&E work. While this limitation is recognized in the estimating process, we generally budget at a level below that. Our average cost of final design for the five years FY 1971 through FY 1975 is about at the 5.5% level, with the FY 1975 portion being at a 5.6% average level.

Question 7. It is noted that for FY 1975 \$4.4 million is being requested for Shuttle Facilities Planning and Design. How much has been authorized, appropriated, funded and obligated to date for these purposes?

Answer. Through fiscal year 1974 some \$12.7 million has been specifically authorized and appropriated for Shuttle Facilities Planning and Design. Of this total \$3.8 million was in FY 1973 and \$8.9 million in FY 1974. In addition to this \$12.7 million specifically authorized and appropriated, NASA has allocated an additional \$5.2 million of FY 1972 and prior years' resources to bring the total presently allocated to Shuttle Facilities Planning and Design to \$17.9 million. As of March 31, 1974, our obligation plan reflects approximately \$11.0 million to be obligated against this total. In this regard, it is recognized that shuttle facility final designs for FY 1975 are just moving into the contract phase to be followed closely by the PER cycle for FY 1976 "candidate" projects. We estimate that by October-November 1974, the residual amounts needed for these purposes will be under contract.

Question 8. For Shuttle facilities in the \$4.4 million request, how much is intended for:

a. Studies and engineering reports?

Answer. The total is \$150,000.

Question b. Preliminary Engineering Reports?

Answer. The total is \$550,000.

Question c. Final Design?

Answer. The total is \$3,700,000.

Question 9. The FY 1975 request for FP&D includes \$2.6 million in the category of "other requirements for Large Aeronautical Facilities Planning and Design." The request is broken down as follows: High Reynolds Number Transonic Wind Tunnel, Langley—\$800,000; Additional Combustion Air, Propulsion Systems Laboratory, Lewis—\$850,000; and Modification of the 40x80-foot Subsonic Wind Tunnel, Ames—\$950,000.

a. Are these projects all part of the jointly sponsored National Aeronautical Facility Program?

Answer. No. Only the High Reynolds Number Transonic Research Tunnel project and the Modification of the 40x80-foot Subsonic Wind Tunnel project are part of the NASA/DOD jointly sponsored National Aeronautical Facilities Program.

Question b. It appears that all requirements involve future major projects? What criteria is used to determine whether a project qualifies for the National Aeronautical Facility Program?

Answer. The Aeronautics and Astronautics Coordination Board initially established the following criteria to qualify a project for the National Aeronautical Facilities Program:

1. The project would be too large or expensive to be handled by one agency through normal channels.

2. The project would provide a unique capability.

The initial objective of this effort was to identify major National Aeronautical Facilities required to carry out development of future civil and military aeronautical vehicles.

The above criteria were subsequently found to be too restrictive and the following additional criteria for other facilities were added:

1. Workload for the project and its utilization are sufficient to require similar capabilities at different locations.

2. Sufficient distinction to justify similar types of facilities at different locations, such as one installation with unique research capabilities and another with unique development capabilities.

In all of the above cases, applicable facility requirements are considered and formal coordinated positions are taken on each.

Question c. How much FP&D money has been authorized, appropriated, funded and obligated to date for the NASA projects included in the National Aeronautical Facility Program?

Answer. A funding summary of the NASA projects included in the National Aeronautical Facilities Program (NAFP) is shown below:

	Amount and fiscal year authorized	Amount appropriated	Amount funded	Amount obligated, Jan. 31, 1974
High Reynolds number transonic research tunnel.....	\$400,000 (fiscal year 1974)	\$400,000	\$400,000	\$60,000
Modification of the 40 by 80 ft subsonic wind tunnel.....	750,000 (fiscal year 1973)	750,000	1 860,000	50,000

¹ An additional \$110,000 of facility planning and design funds which were previously made available have been redirected to this project.

It is estimated that all funds will be obligated by the end of 1974.

Question d. When will the construction projects for Lewis and Ames be programmed?

Answer. The proposed Additional Combustion Air facility project, which would further enhance the capabilities of the LeRC Propulsion Systems Laboratory, and the Modification of the 40x80-foot Subsonic Wind Tunnel at Ames Research Center will be considered as "candidate" projects for inclusion in some near-term CofF request. The specific year in which each or a portion of each might be so included cannot now be identified; however, this is being reviewed in terms of relative priority in relation to other pending program requirements. Our goal in proceeding now with this portion of final design for these facilities is to reduce risks and develop procurement and fabrication lead-time and overall optimum schedules and develop improved cost data. This effort is in keeping with our objective to produce the best possible plans and specifications for facilities in a timely manner. It is noted that in all cases our FY 1975 final design requests for these large facilities may not complete these final design efforts but will at least achieve the goals listed above. Additional resources will probably be required in each case to compile final documentation and place plans and specifications in condition for project procurement. However, it is prudent that these scheduled final design efforts proceed at an early date so that the objectives indicated may be secured.

Question 10. How is the Facility Planning and Design program managed?

Answer. The Facility Planning and Design program is managed centrally by the Office of Facilities. That office provides the consolidated estimates of requirements and releases resources directly to field Centers or others involved in the execution of these design and planning activities.

Question a. To what extent do the various program directorates become involved?

Answer. FP&D requirements and requests for releases of resources have, in the past, been submitted to the Office of Facilities via the appropriate program and institutional offices, and releases of resources have been coordinated with those offices. Those offices have a primary role in the establishment of requirements and relative priorities.

Question b. To what extent to Center directors become involved?

Answer. Field Centers normally indicate special large FP&D requirements as a part of their annual submittals of CofF requirements. These are processed through the appropriate program/institutional offices and reviewed by the Office of Facilities as a basis for action. Requests for the releases of FP&D resources generally follow the same pattern. Of course, additional large FP&D requirements may be initiated in the program and institutional offices. The Office of Facilities works closely with the field Centers in evaluating requirements, requests for resources, as well as in connection with all matters relating to planning and design schedules and costs.

Question c. Will the recently announced reorganization of NASA cause a revision in the present management structure for FP&D?

Answer. We see no significant impact on the overall management of FP&D resources. As now envisioned, the Office of Facilities will work on requirements and priorities for technical/programmatic facilities with the program offices, and on requirements and priorities related to other facilities with newly-created office of Associate Administrator for Center Operations.

FISCAL YEAR 1975—NASA RESEARCH AND PROGRAM MANAGEMENT HEADQUARTERS NASA

Question 1. Considerable differences are reflected in the budget data for the FY 1973 budget operating plan as presented last year and the actual costs for that year as shown in the FY 1975 data. Please explain the following differences:

(In thousands of dollars)

Category	Fiscal year 1973 budget plan	Fiscal year 1973 actual	Difference
Personnel.....	\$41,332	\$42,299	+\$967
Travel.....	2,667	2,291	-376
Facilities services.....	289	470	+181
Technical services.....	9,574	9,951	+377
Administrative support.....	6,202	6,556	+354
Total.....	60,064	61,567	+1,503

Answer. Personnel increase of \$967,000 is due to the pay raise in January 1973. Travel difference of -\$376,000 was the result of actual requirements being less than anticipated when the budget was prepared.

Facilities Services increased \$181,000 due to an increase in requirements for Government buildings alterations. An appreciable portion was associated with release of 42,000 square feet in the Reporters Building. Also, the Office of Applications was established during this time.

Technical Services increased \$377,000 in connection with the operation of the NASA Scientific and Technical Information Facility.

Administrative Support increase of \$354,000 was primarily attributable to the updating of avionics and communications equipment on NASA Administrative Aircraft, partially offset by economies and savings in other administrative support areas.

Question 2. Also there are some differences in the amounts authorized for FY 1974 and those now shown as the FY 1974 Budget Operating Plan. Please explain the following differences:

(In thousands of dollars)

Category	Fiscal year 1974 authorized	Fiscal year 1974 budget plan	Difference
Personnel.....	\$41,587	\$44,880	+\$3,293
Travel.....	2,600	2,565	-35
Facilities services.....	273	327	+54
Technical services.....	10,029	9,988	-41
Administrative support.....	5,798	5,788	-10
Total.....	60,287	63,548	+3,261

Answer: The \$3,261,000 increase is attributable to the January and October, 1973 pay raises. Adjustments in other areas resulted in an anticipated net decrease of \$32,000.

Question 3. It is not quite clear why the Headquarters shows a reduction in R&PM costs for FY 1975 while all field centers show significant increases. Both the Headquarters and the field were equally affected by the October 1, 1973 pay increase; all were affected by agency-wide increases in materials, equipment and other inflationary items common in all parts of the country. Please comment.

Answer: The question refers to a reduction in R&PM costs for FY 1975; however, the R&PM Budget shows a net increase in the amount of \$3,785,000. There was a decrease in personnel related costs of \$966,000, primarily the result

of the full year effect of abolished positions in 1974 in both personnel compensation and benefits, and a decrease in the cost of the NASA-wide Workmen's Compensation, offset by the full year's cost of revised salary rates implemented by Executive Order, effective October 1973.

Question 4. It has never been clearly defined as to the distribution of Headquarters costs to the various program offices. Direct personnel are easily defined, travel can be allocated reasonably well in advance, etc. Actually, how is the Headquarters budget compiled? Are they direct costs compiled from program directorate inputs and what is the formula for proration of indirect costs?

Answer. Indirect costs are not prorated back to program offices. Indirect costs are budgeted and controlled by the Director, Headquarters Administration. Included in indirect costs are some agency-wide indirect costs such as postage, Workmen's Compensation, and Fellowship Training. Direct costs take into consideration program directorate inputs.

Question 5. How much is included in the FY 1975 Headquarters R&PM estimate for Public Affairs activities? Are any R&D funds managed by the Headquarters earmarked for Public Affairs activities? If so, how much?

Answer. Headquarters R&PM estimate for Public Affairs activities is \$4,051,000, including \$1,951,000 for salaries. There are no R&D funds managed by the Headquarters earmarked for Public Affairs activities.

Question 6. Overtime estimates for FY 1975 amount to \$224,000, the same as for FY 1974. What is the Headquarters policy with regard to the payment of overtime? Are all grades (including excepted positions) entitled to overtime compensation, or is there a formula of compensatory adjustment in existence?

Answer. The overtime policy is based on 5 U.S.C. 5541 et. seq. and Part 550, CSC Regulations (5 CFR Part 550). The policy provides for management approval, and review as well as fiscal control of overtime to insure overtime is not generally paid to employees; (a) unless working in excess of a 40 hour regularly scheduled workweek; (b) are grade GS-10 or below; (c) if paid overtime during three consecutive pay periods totaling 30 hours or more; (d) if receiving a stipulated percentage of annual pay for a position which involves substantial hours of irregular unscheduled overtime. Exceptions require review and approval by Officials-in-Charge of the Administrator's Program, and Staff offices as well as review on a continuing basis of individual exceptions by the Director of Headquarters Administration. Compensatory time-off is controlled in the same manner as paid overtime and authorized in lieu thereof.

Question 7. Workman's compensation apparently is carried in the Headquarters account for the entire agency. How much has this amounted to over the past five years?

Answer. During the past five years workmen's compensation has been paid as follows:

Fiscal Year:

1974	\$1,266,000
1973	939,000
1972	742,000
1971	711,000
1970	499,000

Question 8. Supporting personnel costs will increase in FY 1975 apparently due to increases in reassignments of field center personnel from field centers to the Headquarters for purposes of career development. How many personnel have been involved in this program for fiscal years 1972, 1973, 1974, and how many are projected for FY 1975?

Answer. Personnel have been involved in this program as follows:

Projected for fiscal year 1975	47
Projected for fiscal year 1974	42
Fiscal year 1973	30
Fiscal year 1972	15

Question 9. The \$50,000 increase in travel for FY 1975 is mainly attributable to accelerated joint meetings with the U.S.S.R. associated with the Apollo-Soyuz mission. Is this strictly for travel by U.S. personnel, or does the United States pay travel and per diem costs of U.S.S.R. participants in the program? If so, is the arrangement reciprocal? Are any R&D funds used to defray these costs?

Answer. The U.S.S.R. pays the cost of travel by Soviet personnel to meeting sites in the United States. Under an informal understanding between NASA and the Soviet Academy of Sciences, we pay a per diem allowance and provide local ground transportation for Soviet personnel attending project meetings in the

U.S. The Soviet Academy does the same for NASA personnel attending project meetings in the U.S.S.R. The following breakdown by fiscal year states NASA per diem costs charged against the Headquarters budget under these arrangements.

Fiscal year:	
1973	\$27, 000
1974	55, 530
1975	96, 600

We have an identical arrangement in connection with the NASA/Soviet Academy of Sciences Agreement on Space Science and Applications.

Question 10. It is noted that P.L. 92-313 requires that agencies occupying GSA space may now pay for the space and/or services (about \$3.9 million) rendered. Are these funds directly reimbursed to GSA or to the U.S. Treasury?

Answer. They are directly reimbursed to GSA.

Question 11. Specifically, what is the Headquarters Occupational Medicine and Environmental Health Unit in the Headquarters for which funds are being requested? Are similar costs incurred at the field center level?

Answer. NASA Headquarters has a requirement for operation of a NASA Headquarters Health Clinic and Stress Laboratory. The requirement entails the conduct of a comprehensive program of preventive and occupational medicine on an eight-hours per day, five-days per week basis.

The operation of the Health Clinic and the Stress Laboratory is so closely related that the two functions are combined under the principal responsibility of the Health Clinic Director. Patients with cardiovascular abnormalities, obesity, muscular and skeletal problems, hypertension, alcoholism, etc., are referred to the Stress Laboratory for rehabilitation and treatment to seek not only improvement of their conditions but to keep them on the job and, in cooperation with personal physicians, decrease time-consuming visits to their offices. Similar costs are incurred at field centers.

Question 12. With regard to Automatic Data Processing, if NASA already owns an IBM 360/50 computer, why does the agency have to lease another one? How many shifts does the owned computer operate?

Answer. One computer (the IBM 360/50 owned by NASA) is located at and supports the operations of the Scientific and Technical Information Facility at College Park, Maryland (See answer to question 13). The second computer is located at and supports the NASA Headquarters ADP requirements i.e. Management systems (financial and administrative). The requirements for ADP support at Headquarters exceed the time available; i.e. could not carry the load of the Scientific and Technical Information requirements. This computer is currently operated with three shifts, seven days a week. The Headquarters computer is operating also with three shifts, seven days a week.

Question 13. Specifically, what is the NASA Scientific and Technical Information Facility? Where is it located? Is this part of the Public Affairs Office? Why is there an increase of \$610,000 for FY 1975 (from \$2.6 million to \$3.6 million)?

Answer. The NASA Scientific and Technical Information Facility is a Government-furnished, contractor-operated facility and is located at the Litton Industries Building, 5007-09 Calvert Road, College Park, Maryland. The Facility is under the technical direction of the Director, Scientific and Technical Information Office, responsible for (in part) implementing the multifaceted NASA-wide scientific and technical information program; directing the planning, execution and review of programs for the acquisition, processing, publication, announcement, and dissemination of scientific and technical information. The Public Affairs Office is not involved with the functions of the Facility. The increase of \$610,000 in FY 1975 is the result of actions to realign the obligation with the year in which the services were performed for the operation of the scientific and technical information facility and additional requirements for the publications, documentation, printing and dissemination of scientific and technical information.

GENERAL PROVISIONS—H.R. 12689

1. *Elimination of Cost Ceilings for Compensation and Benefits:*

(For the past several years, annual NASA Authorization Acts have included language under Section (c) (Research and Program Management) which limits the amount to be authorized for personnel and related costs, and Section 4(b) which sets forth related similar language pertaining to the transfer of funds into the Research and Program Management account. This language has been added to the bill by the Senate annually, and the House has agreed to the Senate amendment each year.)

a. The NASA letter transmitting the draft of the FY 1975 Authorization Bill states that the previously imposed "limitation is considered unnecessary for the fiscal year beginning July 1, 1974."

Question (1) What is the basis of the NASA statement?

Answer: a. (1) Expenditure of funds by NASA for personnel and related costs are controlled, as a practical matter, by employment and outlay ceilings established by the Office of Management and Budget. In addition to these limitations, the General Provisions of the NASA fiscal year 1972 Appropriation Act excluded the authority to transfer funds to the R&PM account, previously made available to NASA in prior years; and the FY 1973 and 1974 Appropriation Acts did not provide transfer authority between any NASA appropriations, thereby eliminating the possibility of increasing the R&PM appropriation, other than by supplemental appropriation acts passed by the Congress.

Question (2) Have these limitations included over the past several years imposed any undue hardship or unsurmountable restraints on the nation's space program?

Answer: a. (2) These limitations have not imposed any undue hardship or unsurmountable restraints on the nation's space program.

2. *Elimination of Provision Concerning Grants to Nonprofit Institutions Barring Armed Forces Recruiting Personnel from Campuses:*

(This provision, originally introduced by Senator Curtis in the FY 1969 Act, requires the Secretary of Defense to report semi-annually to the Administrator, NASA, those institutions barring military recruiters from college campuses, and prohibits federal grants from being made to those institutions barring military recruiters. The amendment was introduced during the Vietnam war, and during the period of campus disorders.)

Question 2a. To what extent has this provision been enforced?

Answer. Only one university with whom NASA does business has ever been listed as barring military recruiters from its campus. NASA was advised by the Department of Defense on July 20, 1970, that Johns Hopkins University was barring recruiting personnel of the Armed Forces from their premises or property at that time. On October 28, 1970, the Department of Defense notified NASA that Johns Hopkins had changed their policy and were allowing recruiters on campus. During the period from July 20, to October 28, 1970, no grant or contract awards were made to Johns Hopkins.

Question 2b. Are there presently any educational institutions barring Armed Forces Recruiting personnel from their campuses?

Answer. As of March 1, 1974, the following universities are listed by the Department of Defense as barring recruiters from the premises or property:

Adelphi University—Garden City, New York.

Bluffton College—Bluffton, Ohio.

Boston State College—Boston, Massachusetts.

Brooklyn College, CUNY—Brooklyn, New York.

Elizabethtown College—Elizabethtown, Pennsylvania.

New College—Sarasota, Florida.

Wilmington College—Wilmington, Ohio.

NASA has no active grants or contracts with any of the universities listed.

3. *Increase in Authorized Upward Variance from 5% to 10% in Construction Projects to Meet Unusual Cost Variations:*

(The Congress, in its wisdom, in the FY 1960 Authorization Act (PL 86-45) included a provision which permitted Administrator, NASA, at his discretion to vary upward by 5 per centum, amounts authorized for individual construction items to meet unusual cost variations, however, with the stipulation that the cost of *all* work authorized for construction not be exceeded. This provision has been in effect for *fifteen* consecutive years. NASA now proposes to increase this upward variation to 10 per centum.)

Question 3a. Each construction project estimate submitted to the Congress includes a factor for contingencies and one for annual pricing escalation. On the average, what are these percentages at present?

b. To what extent have these percentages varied over the past five years?

c. The 5 percent upward variance has been included in authorization acts over the past fifteen years. Why now does this suddenly have to be doubled?

d. If the ten percent upward variance is passed into law, will this reduce the amounts included in future individual project estimates for contingencies and escalation?

Answer: 3a. Construction of Facilities projects included in our budget estimates include average factors as follows:

(1) Construction contingencies, non-shuttle projects—10%.

(2) Construction contingencies, shuttle projects—15%.

(3) Anticipated construction cost growth—8% per year compounded annually to the scheduled mid-point of construction.

Answer 3b. There have been extremely few variations over the past five years in the normal construction contingency factors—i.e., 10% or 15%. This factor is intended to provide for “unknowns” arising during construction on the job site, or minor requirements revisions made necessary during the life of the project.

With regard to the inclusion of a factor for anticipated growth in construction costs in the FY 1970-71 time-frame, we did generally use about 6% compounded annually. More recently, we have used an estimated factor of 7-10%, but have accepted figures outside this bracket when justified for a specific location. For the FY 1975 estimates, the 8% average mentioned above applies. It is our objective to adjust this factor upward or downward to the extent that a national or local area trend can be established and reasonably supported. It is our intent that this factor recognize any highly probable, persistent, and appreciable change in the general level or average cost of our construction. It will not, of course, cover the full extent of possible “peaks” in such upward trend, for which we would first look to the Section 2 variance for relief.

Answer 3c. The 5% variance included in authorization acts since FY 1960 is provided to meet “unusual cost variations” and includes the proviso that the total work authorized will not be exceeded.

Recent experience indicates unusual cost variations being generated by the energy situation and associated materials availability and delivery problems which heavily impact construction. These situations are of such a nature that their cost or schedule impacts cannot be reasonably evaluated in advance, either by location or extent.

The cost estimating limitation of this recognized situation could have been minimized by increasing contingency or cost growth factors on an “across-the-board” basis. However, the fuels and materials problems cited are, in themselves, of varying nature and intensity and such a broad application of increasing these factors would, based on experience to date, have been an overreaction and have diluted the integrity of the basic engineering estimates and these factors. It is, therefore, considered more prudent, in recognition of the real situation as it exists, to extend the scope of the Section 2 variance for application on a case-by-case basis to meet these very unusual and widely variable “peak” needs.

Answer 3d. The relationship between an increase in the Section 2 variance from 5% to 10% and the amounts included in future estimates for construction contingencies and escalation is not a direct one as explained above. If the revision to the 10% variance is enacted, then it is intended to continue the present policy with regard to construction contingencies by holding to the average of 10-15% and making exceptions outside that bracket only in the most obviously justified cases. It is likewise intended to continue the present policy of including a factor for anticipated growth in construction costs which such a factor being on the lower and more conservative side of estimates for this purpose. This factor may increase or decrease depending on the broad, general situation. This would leave the Section 2 variance of 10% to cope with the unusual or peak situations, especially recognizing the unforeseeability and unpredictability of the fuels and ma-

terials availability situation and the resultant "unusual cost variations" which may be encountered. Everything reasonable is done to implement CoF projects within the approved amounts and the use of Section 2 flexibility is and will continue to be reserved for the clearly "unusual cost variations" for which it is intended.

4. Amendment to the 1958 Basic Space Act Increasing the Amounts that May Be Paid to Experts or Consultants:

(The basic space act of 1958 contains a provision (section 203 (b) (9) which permits NASA to hire experts or consultants at a rate not to exceed \$100.00 per diem. At that time other Federal agencies were governed by the generally applicable statute, the act of August 2, 1946 (then Title 5 U.S.C.—55a) which was based upon the General Service Schedule at a much lesser rate. Over the past 15 years, the General Schedule rates have been increased several times, and NASA now finds itself in a non-competitive and unequal position with other agencies regarding the hiring of experts and consultants. According to the NASA proposal, other agencies are authorized pursuant to Section 5332 of Title 5, U.S.C. to pay experts and consultants at a rate not in excess of the maximum daily rate paid to a GS-18, which now amounts to \$138.46 per diem as opposed to the NASA limit of \$100.00. NASA proposes an amendment to the basic Act which would permit them to hire on a comparable basis.)

Question a. Has the existing limitation prescribed in the Basic Act actually imposed a barrier to NASA in the hiring of experts and consultants?

Answer. When NASA was first established in 1958, section 203(b) (9) was included in NASA's organic act in the present form to permit NASA to pay up to \$100.00 per diem for the services of experts or consultants. At that time, the generally applicable statute, the Act of August 2, 1946 (5 U.S.C. 55a), provided for a significantly lesser rate. In the 15 years since 1958, the General Schedule rates have been increased several times and NASA, rather than being in a favorable position to hire experts or consultants pursuant to section 203(b) (9), as was intended, now finds that several other agencies are authorized to pay their experts or consultants at a rate almost 40% higher than NASA. Two of these agencies are the Department of Defense and the Atomic Energy Commission. It is felt that the present situation has placed NASA in an unequal position in securing the services of consultants and experts of the calibre that it needs.

Question b. If the provision in the Basic Act were deleted in its entirety rather than amended as proposed, would not NASA's need to served by other existing statutes?

Answer. If the provision in the Basic Act were deleted in its entirety, NASA's need for expert or consultant services would not be served by other existing statutes. To the best of our knowledge there is no statute, other than the Space Act provision, which authorizes NASA to meet such needs. The authority currently available to NASA under section 203(b) (9) of the Space Act (42 U.S.C. 2473(b) (9)) is to obtain services as authorized by what is now 5 U.S.C. 3109, at rates not to exceed \$100 per diem for individuals. Subsection (b) of 5 U.S.C. 3109 conditions the acquisition of expert or consultant services upon authorization "by an appropriation or other statute." It is the Space Act provision here under discussion which NASA has relied upon to secure expert or consultant services in accordance with 5 U.S.C. 3109.

Question c. To the best of your knowledge, are other cognizant agencies exercising the authority to pay experts and consultants at the maximum rate paid to a GS-18?

Answer. Yes. For example, it is our understanding that the Department of Transportation and the Environmental Protection Agency, among others, have authority to pay all experts or consultants at rates not to exceed the maximum for a GS-18, and that this authority is being exercised.

Question d. The NASA proposal would permit the agency to pay *all* experts or consultants the increased rate. Agencies such as the Department of Defense, Atomic Energy Commission, and the National Science Foundation are currently authorized to pay at the GS-18 rate "experts and consultants employed in professional engineering positions primarily concerned with research and development and professional positions in the physical and natural sciences and medicine." Why is it necessary for NASA to have more liberal application?

Answer. Approximately 90.7 percent of all NASA compensated expert and consultant positions can be categorized as "professional engineering positions primarily concerned with research and development and professional positions in the physical and natural sciences and medicine." The remaining 9.3 percent of the positions consist of civil engineers and professional administrators. The need for these particular experts and consultants make it necessary for NASA to have a more liberal application.

Question d. How many consultants does NASA presently have on its rolls?

Answer. As of 12/31/73 NASA had 351 experts and consultants on its rolls, 221 who receive compensation and 130 serving without compensation.

Question f. How many of the consultants and experts were used in FY 1973 and FY 1974?

Answer. The number of experts and consultants employed is:

	Fiscal year 1973	Fiscal year 1974 (through December 31, 1973)
Total.....	244	204
Compensated.....	106	107
Uncompensated.....	138	97

Question g. How many mandays of consultant effort were used in FY 1973 and FY 1974?

Answer. The total number of mandays used is:

	Fiscal year 1973	Fiscal year 1974 (through December 31, 1973)
Total.....	2,446	1,207
Compensated.....	1,855	813
Uncompensated.....	591	394

Question h. How much was disbursed for consultants during FY 1973 and thus far in FY 1974? What is the average per diem payment? What is the basis for determining the amount to be paid for services?

Answer. Total salary payments:

Fiscal year:	
1973.....	\$161,000
1974.....	71,000

(Through December 31, 1974.)

Average payment per day: \$86.75

Payment rationale is:

(A) We pay only experts who perform operating functions and work on projects and studies of limited duration. We do not pay consultants who only provide advice and counsel. Both experts and consultants are reimbursed for travel and subsistence expenses.

(B) We pay what an individual normally earns but not more than \$100 per day.

(C) In the event that the expert is a re-employed annuitant, he gets the difference between his annuity for a day and the normal compensation.

SUPPORT SERVICE CONTRACTING, NASA

(Following the questions and answers on this subject there is included for the record: 1. Staff brief on support service contracting; 2. Partial Summary judgment and order, U.S. District Court for the District of Columbia, *AFGE v. NASA and NCTSI* (Judge Waddy); 3. Memorandum opinion, U.S. District Court for the District of Columbia, *AFGE v. NASA and NCTSI* (Judge Waddy); and NASA report, support service contracts, Fiscal Year 1973.)

Question 1. Under the Partial Summary Judgment, Order and Memorandum Opinion rendered by the Court, the Civil Service Commission was to have reviewed the matter of "employer-employee" relationships between NASA and support service contract personnel and reported its findings to the Court within 60 days from the date of filing.

a. Has the Civil Service Commission submitted its report as instructed?

Answer. No—Civil Service Commission is scheduled to report to the Court its findings by May 30.

Question b. Was NASA consulted during the Civil Service Commission's deliberations?

Answer. By letter of February 22, 1974:

(1) NASA was requested to submit to the Commission copies of all the contracts involved in the case.

(2) All parties to the suit were invited to submit to the Commission a statement setting forth all the information, references to the record and other matters which the Commission should consider.

(3) Each party was invited to submit comments on the submissions made by the other parties.

NASA has made submission pursuant to (1) and (2) above and is preparing a submission pursuant to (3). In addition, NASA has been cooperating with the CSC review in order to expedite the study.

Question c. What is the present status of this matter?

Answer. A CSC review team is presently at MSFC interviewing and taking sworn statements from Marshall and contractor personnel. This on-site review will be completed by March 29, 1974.

Question 2. If the District Court's November 30, 1973, opinion were to be upheld, what would the impact be on NASA activities both economically and operationally?

Answer. If the opinion of the District Court were to be upheld, it would have severe consequences on operations at NASA and the Government generally. Under the opinion, the Courts and the Commission will be thrust into a position of deciding issues not proper for judicial determination.

The head of each Agency is charged with responsibility by law to structure his Agency, and to enter into such contractual arrangements as in the Agency's judgment most effectively carry out its functions. In this connection, the CSC Chairman Hampton wrote NASA in August 1970, "that we (the CSC) no longer discuss proscribed supervision (of contractor employees) as being 'illegal,' because that shorthand expression has been widely misunderstood, and we urge that you avoid the use of that term also." NASA and the CSC recognize that the Commission's role in respect of such matters is only advisory.

There is presently an intra-Executive Department procedure for correcting any undesirable features found to inhere in on-site "support-service" contractual arrangements. The proper resolution between CSC and NASA of such an intra-Executive Department policy matter entails "nice issues of judgment and choice" requiring "the exercise of informed discretion." In the event the heads of the two agencies cannot agree, the resolution of intra-Executive Department differences will be the Presidential level. Accordingly, it seems quite clear that the ultimate judgment reached in respect of such matters is wholly committed to intra-Executive Department discretion, without judicial intrusion into such matters at all.

The operational result of the Court's having taken jurisdiction over this matter will be to hamper agencies in restructuring and realigning their resources as changes in program requirements dictate. Regarding the economic impact, it is impossible at this time to make a projection.

Question 3. Do you agree with the Court's findings that NASA is required to appoint all officers and employees in excess of 425 scientists, engineers and administrative personnel in accordance with civil service laws and that NASA is prohibited from entering into contracts for these purposes? If not, what is the basis for the NASA policy in this regard?

Answer. The Court's reliance on Section 203(b)(2) of the Act is misplaced. That Section simply addresses the Civil Service status and compensation NASA is to pay such employees as NASA determines, in the exercise of its judgment, it requires to accomplish its assigned space mission. Its provisions simply authorize NASA "in the performance of its functions * * * to appoint and fix the compensation of such officers and employees as (NASA) may (find to) be necessary to carry out such functions." Thus, it is only after NASA has exercised its discretionary authority to appoint such agency officers and employees as it determines its needs to carry out its functions, that the succeeding portion of Section 203(b)(2) becomes operative. Only then does Section 203(b)(2) make it mandatory that such employees "shall be appointed in accordance with the Civil Service laws," and their compensation fixed in accordance with the Classification Act provisions (subject to the limited exception therein set forth.)

NASA agrees that under Section 203(b)(2) of the Space Act all employees and officers of the Agency must be appointed in accordance with the Civil Service laws with the exception of the 425 excepted positions. However, the contractual authority conferred on NASA by Section 203(b)(5) of the Act is, on its face, broad in scope. The legislative history provides strong confirmation that the Congress intended just such a broad meaning for that statutory provision. Prior to enactment of the Space Act, the Congress was expressly informed that NASA would expand its functions "largely by means of contract work rather than through research conducted by the Agency itself. After enactment of the Act in 1958, NASA applied its Section 203(b)(5) authority to enter into on-site "support-service" contractual arrangements. In doing so consistently ever since then, NASA has been guided by the established Executive policy directive placing the Government's primary reliance on the private enterprise system to meet its needs for products and services, subject to the overriding "national interest" requirement that NASA was directed to mobilize all the national resources, public and private, successfully to achieve its assigned space mission as soon as practicable.

The subsequent legislative enactments, and the exchanges passing between NASA and the Congress, demonstrate the Congress' continued approval of NASA construction of its Section 203(b)(5) contractual authority.

Accordingly, Section 203(b)(5) of the Space Act constitutes clear statutory authority for NASA to contract for support. NASA is not contracting for employees but rather for the performance of specific work requiring the management and expertise of an independent contractor.

Question 4. The total number of support service contract personnel on board at end FY 1973 was 24,802 (actually expressed in man years of effort). The total cost of these activities for FY 1973 was \$441.6 million (both R&D and R&PM funded) or almost 13% of the total space budget for that year. What is your estimate for FY 1974 and FY 1975 in terms of man years and dollar costs?

Answer:

	1974		1975	
	Man-years	Amount	Man-years	Amount
RD.....	18, 126	\$356, 759	15, 839	\$352, 533
RPM.....	5, 387	75, 410	5, 144	75, 142
Total.....	23, 513	432, 169	21, 983	427, 675

Question 5. Is NASA being forced into securing support service contracts because of imposed ceilings on civil service personnel strengths.

Answer. No—It has always been NASA's policy to make full use of existing resources in the industrial, commercial and educational sectors in carrying out NASA's assigned mission.

Question 6. Is each decision to enter into a support service contract based upon an analysis as to whether it is more economical to perform a given service by contract or by employing civil service personnel? What are the procedures for making these determinations?

Answer. NASA is always striving to perform its mission in the most economical and effective manner. Decisions to contract are made on many bases, including cost. Where cost is determined to be the prime factor, detailed studies are made in accordance with the NASA implementation of OMB Circular A76. It should be understood however that specialized skills, fluctuating workload and historical experience are also major factors on which the decision to contract is based.

COMMITTEE ON SCIENCE AND ASTRONAUTICS, STAFF BRIEF, SUPPORT SERVICE CONTRACTING—NASA

JANUARY 8, 1974.

References:

- a. Staff Report, subject above, for the Subcommittee on NASA Oversight dated April 18, 1968.
- b. Hearings before the Subcommittee on NASA Oversight, subject above, on July 11, 1968.
- c. Partial Summary Judgment and Order, and Memorandum Opinion, Judge Joseph Waddy, United States District Court for the District of Columbia, filed November 30, 1973.

GENERAL

Support Service Contracting by NASA has been, and continues to be, a controversial issue. This matter has been under continuing surveillance by the Committee since the early years of the space program. The balance between in-house and service support contractual forces, and the relative costs thereof, have been the subjects of special inquiry in conjunction with visits to field centers and annual authorization reviews.

The American Federation of Government Employees (AFGE) continues to strongly oppose the use of contract employees to perform services, particularly in view of the extensive reductions-in-force (RIF) in the NASA civil service work force during recent years.

Referenced staff report and subsequent hearings were conducted as an aftermath of the June 1967 GAO report which concluded that \$5.3 million could have been saved annually, if certain services at Goddard and Marshall were provided by civil service employees rather than procured under contract. These findings were followed by an opinion rendered by the General Counsel of the Civil Service Commission (Pallerzi) in October 1967 which held that the contracts investigated by the GAO and all like them were proscribed by Federal personnel laws. This opinion in effect challenged the legality of NASA's implementation of existing Executive Branch policies concerning the use of private enterprise to meet the needs for services. The Judge Waddy Summary Judgment, Order and Memorandum Opinion filed on November 30, 1973 (reference C, copy attached) appears to uphold the Pallerzi opinion rendered in October 1967.

BACKGROUND

The Marshall Space Flight Center (MSFC) may, by circumstance, be the focal point for a legal test of support service contracting versus civil service employment. A chronology follows:

On December 6, 1967, 764 civil servants at MSFC received RIF notices informing them that they would either be reduced in grade or separated from government service effective January 13, 1968.

On December 27, 1967, six of the affected employees filed suit moving for a preliminary injunction against the RIF.

On January 11, 1968, Judge Holtsoff, U.S. District Court for the District of Columbia, granted a preliminary injunction halting the RIF. (The purpose of the injunction was to provide time for resolution of differences between the Civil Service Commission and NASA.)

On February 26, 1968, the Civil Service Commission and NASA filed with the court an agreement which provided that all but 166 of the 764 notices were to be cancelled.

On March 12, 1968, the preliminary injunction was dissolved.

On April 24, 1968, the defendant's (NASA) motion to dismiss the case was granted on the basis that the plaintiffs had not exhausted administrative remedies available to them.

The plaintiffs appealed, and the Court of Appeals in an opinion rendered April 21, 1970 found that the appellants did in fact have standing and granted "leave to file a supplemental plea alleging exhaustion of administrative remedies," and directing the District Court to solve all aspects of the case on the merits.

On September 9, 1971, the plaintiffs filed a motion for summary judgment.

On November 29, 1971, the defendant (NASA) filed a cross motion for summary judgment.

On December 3, 1971, the Intervenor-Defendant, in this case the National Council of Technical Service Industries (NCTSI), filed a motion to dismiss the complaint.

SUMMARY JUDGMENT, ORDER AND OPINION

On November 30, 1973, Judge Joseph Waddy, United States District Court for the District of Columbia filed a partial summary judgment and order in the case of AFGE vs NASA and NCTSI (Civil Action No. 3261-67) (enclosure 1 attached) which:

a. Cited Title 42 USC under which NASA is required to appoint all of its officers and employees in excess of 425 scientists, engineers and administrative personnel in accordance with civil service laws; and is prohibited from entering into and enforcing contracts with the Intervenor (NCTSI) or others.

b. Declared all such contracts in existence on December 6, 1967 and at present null and void.

c. Denied the Intervenor's (NCTSI) motion to dismiss the complaint.

d. Denied the Defendant's (NASA) cross motion for summary judgment.

e. Referred this matter to the Civil Service Commission with directions to apply the "Pallerzi Standards" and determine whether the relationship of "employer-employee" existed on December 6, 1967, and exists at present between NASA and support service contract personnel, and to report its findings to the Court within 60 days from date of filing.

f. Held in abeyance plaintiff's appeal for injunction relief, reinstatement, back pay, and employment benefits.

NASA in coordination with the Civil Service Commission and the U.S. Attorney General filed a motion for clarification in view of certain amendments made to the "Pallerzi Standards" subsequent to the October 1967 opinion. This motion was granted by the Court on December 21, 1973. The Civil Service Commission working in coordination with NASA and the Attorney General has 60 days from that date and is now proceeding to review the NASA service support contract relationships in accordance with the court order.

FACTORS FOR CONSIDERATION

As of end FY 1973, NASA had under contract 24,802 support service contract personnel as opposed to an end fiscal year strength of 26,850 civil service employees.

The total dollar value of support service contracts in effect during FY 1973 was approximately \$441.6 million (enclosure 2 attached). This represents over 12.9 percent of the total budget for that year.

If the Partial Summary Judgment Order and Opinion rendered by the court were to be upheld, the carefully conceived balance between civil service and support service contractor employees within NASA would be upset with probable significant economic and operational impact on the NASA program.

It is interesting to note that Judge Waddy's order, judgment and opinion basically upholds the "Pallerzi Standards". These standards are based upon the opinion rendered by the Civil Service Commission in October 1967. At that time, Mr. Leo M. Pallerzi was General Counsel for the Commission. Pallerzi is now General Counsel for the American Federation of Government Employees (AFGE).

RECOMMENDATIONS

In view of the court order requiring an analysis and report on NASA support service contract procedures within sixty days, it appears that further formal Committee action on this matter should await the release of the Civil Service Commission report to Judge Waddy, expected on or about February 21, 1974.

In the interim, it is recommended that this matter be the subject of:

a. Continuing staff surveillance,

b. A special item of inquiry during the FY 1975 NASA Authorization Hearings,

c. Further consideration as a full Committee oversight hearing item prior to the end of the fiscal year.

United States District Court for the District of Columbia

[Filed, Nov. 30, 1973, James I. Davey, Clerk]

Civil Action No. 3261-67

LODGE 1858, AMERICAN FEDERATION OF GOVERNMENT EMPLOYEES, ET AL.,
PLAINTIFFS

v.

ADMINISTRATOR, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION, ET AL.,
DEFENDANTS

and

NATIONAL COUNCIL OF TECHNICAL SERVICE INDUSTRIES, INTERVENOR-DEFENDANT

PARTIAL SUMMARY JUDGMENT AND ORDER

Upon consideration of the Motion of plaintiffs for summary judgment, the motion of the intervenor to dismiss the complaint, the cross-motion of defendants for summary judgment, the memoranda, points and authorities, and exhibits on file in the case, and the entire record herein, and the Court having filed a Memorandum Opinion herein, and having determined that the material facts stated by plaintiff as set forth in said Memorandum Opinion are without substantial controversy and that plaintiff is entitled to a partial summary judgment, it is by the Court this 30th day of November, 1973,

Ordered and adjudged:

1. This Court has jurisdiction of the parties and of the subject matter.
2. That under the provisions of Title 42 United States Code, Section 2473(b)(2) National Aeronautics and Space Administration and the Administrator thereof are required to appoint all of its officers and employees in excess of 425 of the scientific, engineering and administrative personnel in accordance with the Civil Service laws and prohibits the said Administrator from entering into and enforcing contracts with the Intervenor National Council of Technical Service Industries or others that make contractor non-civil service employees employees of National Aeronautics and Space Administration; and that all such contracts in existence on December 6, 1967, and at present, were and are null and void.
3. Intervenor's motion to dismiss the complaint is hereby denied.
4. The defendants' cross-motion for summary judgment is hereby denied.
5. This matter is hereby referred to the United States Civil Service Commission with directions to apply the "Pallerzi Standards" and determine whether the relationship of "employer-employee" existed on December 6, 1967, and exists at the present time between National Aeronautics and Space Administration and the contractor non-civil service employees involved in this case, and report its findings to this Court within 60 days from the date hereof.
6. Plaintiffs' prayers for injunctive relief, reinstatement, back pay and employment benefits are held in abeyance pending further proceedings herein.

JOSEPH WADDY,
Judge.

United States District Court for the District of Columbia

[Filed, Nov. 30, 1973, James F. Davey, Clerk]

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NATIONAL COUNCIL OF TECHNICAL SERVICE INDUSTRIES, INTERVENOR-
DEFENDANT

MEMORANDUM OPINION

This action is before the Court on plaintiffs' Motion for Summary Judgment, intervenor's Motion to Dismiss the Complaint and defendants' Cross Motion for Summary Judgment.

Plaintiffs are six former civil service employees of the National Aeronautics and Space Administration who were located at the Marshall Space Flight Center (Marshall), in Huntsville, Alabama and Lodge 1858 of the American Federation of Government Employees, the union which serves as the sole bargaining agent for all civil servants at Marshall. Defendants are the Administrator of NASA and the members of the Civil Service Commission (CSC). Intervenor is the National Council of Technical Service Industries (NCTSI), a non-profit corporation comprised of companies which contract with various Federal agencies, including NASA, to supply support services.

The plaintiffs allege in their complaint that NASA has entered unlawfully into contracts with private firms to procure manpower to perform tasks which the agency is required by statute to have performed by civil servants. The plaintiffs also claim that, as a result of NASA budget cuts, the individual plaintiffs and about 760 civil servants at Marshall were, on December 6, 1967, notified that they would be subjected to reduction in force (RIF) actions, either terminating their employment or reducing their grade levels, while private contractor employees, performing the same tasks as plaintiffs, were not to be affected by the RIF actions. These employment practices by NASA are alleged to violate:

1. the provision of the NASA enabling act which limits NASA to 425 non-civil service personnel, 42 U.S.C. 2473(b)(2) (1964);
2. the several civil service laws and the regulations promulgated pursuant thereto, 5. U.S.C. 2101, et seq. and 5 C.F.R. 1.1 et seq.;
3. The Union's collective bargaining agreement with NASA.

In their amended complaint filed on October 7, 1970 the plaintiffs seek declaratory judgment, injunctive relief, reinstatement and an award of back pay and employment benefits.

Prior Proceedings in the Case

On December 6, 1967, as a result of NASA budget cuts, the individual plaintiffs and about 760 other civil servants received RIF notices informing them that they would either be reduced in grade or separated from government service effective January 13, 1968.

On December 27, 1967 the plaintiffs filed this suit and moved for a preliminary injunction against the RIF.

On January 11, 1968 the late Judge Alexander Holtzoff of this Court granted the requested preliminary injunction halting the RIF which was to become effective on January 13, 1968 noting in his Findings of Fact:

"... NASA and the Civil Service Commission are in the process of harmonizing NASA's operational needs and service contract policies of the Marshall Space Flight Center, with the legal requirements and Commission policies under the civil service laws. And NASA is itself in the process of evaluating the NASA operations at that Center, to insure that, in accord with established NASA personnel policy, no civil service employee is separated or reduced in grade or pay in the reduction-in-force actions while non-Government (contractor) personnel performing the same function continue to work on site at the Center under service contracts currently in effect with private contractors."

Judge Holtzoff made it clear that the only purpose of granting the injunction was to preserve the status quo pending resolution of the differences between the Civil Service Commission and NASA as to the legality of the R.I.F. (See page 3 of Judge Holtzoff's April 24, 1968 opinion dismissing the case).

On February 26, 1968 the Civil Service Commission and NASA filed an agreement which provided that all but 166 of the 764 RIF notices were to be canceled. On March 12, 1968 the preliminary injunction was dissolved and on April 24, 1968 the defendant's motion to dismiss the case was granted on the basis that the individual plaintiffs still affected had not exhausted their administrative remedies. Plaintiffs appealed.

On appeal appellees argued that the dismissal was proper not only for non-exhaustion of administrative remedies but also because appellants lacked standing to challenge NASA's support service contracting policies. This issue had been raised by NCTSI in its Answer to the Complaint. The Court of Appeals in their April 21, 1970 opinion¹ found that appellants did have standing. The Court never reached the exhaustion issue because one week before argument of the case before the Court of Appeals the Civil Service Commission's Board of Appeals and Review rendered its final decision stating:

"[a] decision to carry out some of its functions by using other than Federal civilian employees is a matter solely within the administrative discretion of the agency and the propriety of such a decision is not subject to review or modification by the Civil Service Commission in the adjudication of the reduction-in-force appeal of any federal civilian employee affected thereby."

In view of this development the Court of Appeals granted appellants "leave to file a supplemental pleading alleging exhaustion of administrative remedies . . ." and directing the District Court to "proceed to solve all aspects of this case on the merits."²

Plaintiffs filed a supplemental and amended complaint on October 7, 1970 alleging that administrative remedies had been exhausted as to all plaintiffs.

Plaintiffs' motion for summary judgment presently before the Court was filed on September 9, 1971. Defendants' cross motion for summary judgment was filed November 29, 1971 and Intervenor's motion to dismiss the complaint was filed December 3, 1971.

Statement of Material Facts

The plaintiffs in accordance with rule 1-9(g) of the Rules of the United States District Court for the District of Columbia have filed a statement of material facts as to which they contend there is no genuine issue.

Plaintiffs contend that after Judge Holtzoff dissolved the preliminary injunction and NASA proceeded with that portion of the RIF not subject to the NASA—Civil Service Commission agreement, 161 employees in the class represented by plaintiff either lost their jobs or suffered reductions in grade while NASA continued to employ over 5,000 non-civil service contractor employees supplied by 9 private companies to perform regular NASA work functions. Specifically, Everett A. Brouillette, one of the named plaintiffs, after 21 years of civil service was reduced in grade, and suffered a salary cut from \$12,000 per year to \$8,000 per year and had his former job functions assigned to contractor employees of Hayes International Corp., who formerly had worked side-by-side with Mr. Brouillette at the Manufacturing Engineering Laboratory. Four of the other five named plaintiffs were removed from their positions totally while contractor employees continued to perform work substantially similar to that formerly done by these civil servants. The remaining named plaintiff retained his employment at the same level pursuant to the NASA—Civil Service Commission agreement.

¹ *Lodge 1858 American Federation of Government Employees v. Paine*, 436 F. 2d 882 (D.C. Cir.).

² *Lodge 1858 American Federation of Government Employees v. Paine*, *supra* note 1, at page 898.

At the time this suit was filed in 1967, NASA had 12 support service contracts with private companies through which 8,218 contractor employees were utilized in NASA operations at a cost to NASA of approximately 70 million dollars per year. The contract employees filled positions that ranged from janitors, guards, refuse collectors, drivers and clerical employees to technicians, engineers, doctors and scientific personnel.

The contracts were negotiated in terms of the number of "man-years" to be supplied by a firm. Often the firm awarded the contract would then subcontract for either all or a portion of the man-years to be supplied. The contracts were for a one-year term with the total duration of the contract not to exceed five years. The contracts in effect when this suit was filed were originally entered into in 1965 and they continued in effect until 1969 when they expired by their own terms. NASA then extended them until 1971 and also announced it was going to negotiate nine new contracts.

The contract employees in major part worked at the Marshall Space Flight Center in government buildings, in the same work areas as civil servants, using government equipment. The contractor employees in Management Services, Technical Services and in the laboratories received their assignments from the civil service directors of the office or lab or from one of his civil service assistants in the following manner: The civil service director would prepare written work assignments which would be given to the contractor's designated representative in the lab or office who would pass the assignment on to the contractor personnel; and when the assignment was completed it then had to be accepted and approved by the originating civil service director.

The work performed by the contractor employees could have been performed by civil service employees who were available through the Civil Service system. In some instances work satisfactorily performed by civil service employees was reassigned to contractor employees solely because of NASA's management philosophy favoring support service contracts. Mr. Dieter Grau, Director of the Quality and Reliability Assurance Laboratory and Mr. Helmut Hoelzer, Director of the Computation Laboratory, both testified in their depositions that they had specifically requested that certain functions in their laboratories be performed by civil service employees and the NASA management had denied their requests and directed them to utilize contractor employees.

Mr. John Wills, Director of Personnel for the U.S. Department of Commerce at the request of the Civil Service Commission, conducted a study of NASA's personnel practices in January of 1968. His report (dated January 15, 1968) concluded that at the Marshall Space Flight Center there were two separate personnel systems, the Civil Service system run by the Director of Personnel and the contractor employee system run by the Purchasing Office. There was little coordination between the offices and when new work requirements developed the strong tendency was to contract for the employees with little consideration given to the relative merits of each system in supplying the needed employees. NASA considered the support service contracts preferable largely because they were thought to afford more flexibility when the work force had to be increased or decreased rapidly. Mr. Wills found that similar flexibility could be achieved through the Civil Service System by using appointments classified as: (1) Temporary, (2) unless-actually-employed or (3) experts and consultants.

On June 9, 1967 the Comptroller General of the United States reported to Congress that he had conducted a cost review of three support service contracts at Marshall and six contracts at Goddard Space Flight Center and it was concluded that if civil service employees were used instead of contractor employees for these functions, NASA would realize an estimated annual savings of 5.3 million dollars.

In October of 1967, the General Counsel to the Civil Service Commission rendered a written opinion (the Pellerzi opinion) which examined two representative support service contracts at Goddard Space Flight Center and concluded that they created an employer-employee relationship between the private employees and NASA which violated the Civil Service laws.

In response to the above opinion NASA promised to rectify all violations. However, they still employ thousands of contractor employees and renew support service contracts while civil service employees are being subjected to RIF's. In an effort to eliminate the appearance of improper service contract operations at Marshall NASA took the following actions.

1. Caused partitions to be constructed to physically segregate contractor employees;
2. Moved some contractor employees away from the Marshall Center even though they continued to perform the same work under civil service supervisors;

3. Issued the following direction to its management personnel:

"Each of us should devote more time to defining the roles of Civil Service and Support Contractor people with the organizations. As a minimum, the support contractors may be moved to an out-of-house operation. Our direction to the contractors must become more formal and the Civil Service personnel must work more independently from the support contractors. . . . Mr. Cook and legal people surveyed the physical location relationship of support contractors and civil service people within the Laboratory. Generally it was good, but there are still some Technical Directives (TD's) and questioned use of the statement ' . . . for further information contact . . .'. This statement should be left off future TD's."

On February 8, 1968 Chairman Macy of the Civil Service Commission in a "Memorandum for the Record" stated, *inter alia*, that when the then existing contracts expired in the next few months, "a joint NASA-CSC review will be conducted to determine whether the support functions to be performed should be continued under contract or transferred to Civil Service staffing. The review will be made on site to permit not only a study of the contract provisions but an inspection of the actual performance of the work." General Counsel Mondello of the Civil Service Commission testified in his deposition that he could not recall any such review having been made after Chairman Macy's memorandum.

NASA continued to renew its support service contracts and made nine new contracts effective in mid-1971. The contracts can be terminated on any anniversary date without cost to the government.

Defendants' Opposition

In the defendants' opposition to the plaintiffs' motion for summary judgment they incorporate their statement of material facts and their memorandum of points and authorities in support of their cross-motion for summary judgment and in addition state:

"Furthermore, in order to avoid any possibility the Court may assume that Government defendants do not controvert the 'Plaintiffs' Statement [of Facts] Pursuant to Local Rule 9(h)' ³ which plaintiffs filed herein on September 8, 1971 in support of their 'Plaintiffs' Motion for Summary Judgment', Government defendants add the following Statement for purposes of Local Rule 9(h):

"1. Government defendants genuinely dispute that there is in existence today at NASA's George C. Marshall Space Flight Center any close direct supervision by NASA employees of any private contractor employees engaged in on-site 'support service' contract work, or any other undesirable feature, warranting intra-Executive Department corrective action.

"2. Government defendants also genuinely dispute plaintiffs' assertion that NASA and the CSC did not jointly review the support-service' contractual arrangements in force at Marshall. And in no event are these material facts for judicial trial."

The Court has concluded that the material facts stated by plaintiffs exist without substantial controversy and that the exceptions of the defendants, noted above, are not genuine issues of material facts that preclude the granting of a partial summary judgment on the pending cross-motions for summary judgment.

The Critical Issue Involved

The initial issue facing the Court for resolution is whether the support service contracts in effect at the Marshall Space Flight Center violate the personnel procurement restrictions of the NASA enabling act as delineated in 22 U.S.C. 2473(b)(2) or whether they fall within the scope of the broad contracting authority granted to NASA by 42 U.S.C. 2473(b)(5).

Reconciliation of 42 U.S.C. 2473(b)(2) And 42 U.S.C. 2473(b)(5)

42 U.S.C. 2473(b)(2) provides:

"(b) In the performance of its functions the Administration [NASA] is authorized—

"(2) to appoint and fix the compensation of such officers and employees as may be necessary to carry out such functions. *Such officers and employees shall be appointed in accordance with the civil service laws and their compensation fixed in accordance with the Classification Act of 1949, except that (A) to the extent the Adminis-*

³ Under the revised U.S. District Court Rules adopted on August 1, 1973, Rule 1-9(g) has been substituted for Rule 9(h).

tration deems such action necessary to the discharge of his responsibilities, he may appoint not more than four hundred and twenty-five of the scientific, engineering and administrative personnel of the Administration without regard to such laws, and may fix the compensation of such personnel not in excess of the highest rate of grade 18 of the General Schedule of the Classification Act of 1949, as amended, and (B) to the extent the Administrator deems such action necessary to recruit specially qualified scientific and engineering talent, may establish the entrance grade for scientific and engineering personnel without previous service in the Federal Government at a level up two grades higher than the grade provided for such personnel under the General Schedule established by the Classification Act of 1949, and fix their compensation accordingly;" (*Italic supplied*).

42 U.S.C. 2473(b) (5) provides:

"(b) In the performance of its functions the Administration is authorized—

"(5) without regard to section 529 of Title 31, to enter into and perform such contracts, leases, cooperative agreements, or other transactions as may be necessary in the conduct of its work and on such terms as it may deem appropriate, with any agency or instrumentality of the United States, or with any State, Territory, or possession, or with any political subdivision thereof, or with any person, firm, association, corporation, or educational institution. To the maximum extent practicable and consistent with the accomplishment of the purpose of this chapter, such contracts, leases, agreements, and other transactions shall be allocated by the Administrator in a manner which will enable small-business concerns to participate equitably and proportionately in the conduct of the work of the Administration;"

The plaintiffs contend that the meaning of Section 2473 of (b)(2) is plain on its face and NASA must utilize civil servants to perform all its functions with the exception of 425 scientific, engineering and administrative employees.

The defendants maintain that the proper reading of Section 2473(b)(2) is that NASA is given authority to decide how many, if any, civil servants it will need to carry out its functions and it is only after this decision is made that the succeeding part of Section 2473(b)(2) becomes operative to make it mandatory that such employees "be appointed in accordance with the civil service laws" and their compensation fixed in accordance with the Classification Act provisions. Under this rather strained construction NASA's administrator could decide that no civil servants are necessary for NASA to fulfill its mission and then contract out for all its employees and pay them without regard to the federal salary schedule, thus avoiding the stricture of Section 2473(b)(2) altogether. The Court has concluded that the defendants' construction is inconsistent with the plain language of Section 2473(b)(2) and with the Congressional intent evidenced in the legislative history of the NASA enabling act.

In House Report No. 1770, May 24, 1958 (1958 U.S. Code Cong. and Admin. News, pg. 1360, et seq.) which accompanied the bill, H.R. 12575, which eventually was enacted into law, the committee stated at page 3168:

"Changes have also been made in certain administrative provisions. Some of these provisions deserve brief discussion.

"(1) Much thought has been given to the compensation of agency officers and employees. The previous bill authorized the agency to fix rates of pay which were 'reasonably comparable with prevailing rates paid by non-Federal employers for similar work.' This provision would have exempted the agency completely from the Classification Act of 1949. No limit was set either to the rates of pay or to the number of recipients. *While recognizing that the agency would need authority to pay higher compensation than the Classification Act allows, in order to recruit and hold qualified scientists and engineers, your committee concluded that unlimited authority was unnecessary and would lead to harmful consequences.* With unlimited authority to fix rates of pay, the new agency would make raids on the scientific and engineering personnel of other agencies engaged in programs of equally high priority. In turn, it could still be outbid by private companies holding cost-plus contracts with the Federal Government. This competition with other agencies and with private contractors might cause a pay spiral that would greatly increase the cost of all programs requiring scientific and engineering services, and, in addition to widespread harmful effects, would defeat the purpose of the pay provision. *Certain other consequences of unlimited authority to fix rates of pay, such as the distortion of the civil service retirement system would also be undesirable.*" (*Italic supplied*).

The committee also stated at page 3163 that:

"As the committee entered upon final drafting of H.R. 12575, it sat in executive session with representatives of the NACA, the Bureau of the Budget, the Comptroller General, and other agencies to insure that the committee would have the

full benefit of any final suggestion from these agencies. *It would not be correct to state that everything the administration desires has been included. For example, the committee does not recommend the exemption of all space agency employees from the civil-service classification rules and salary scales, however meritorious in principle, because it believes that such a recommendation would exceed the practical limits of its responsibilities.* The recommendation of the committee represent its best judgment of what will accomplish the objectives of both the administration and the Congress with the least distraction by side issues which might impede passage of the bill at the earliest opportunity." (Italic supplied).

Although it seems clear that the defendants' interpretation of the language of Section 2473(b)(2) is incorrect, the Court still must reconcile that Section with the provisions of Section 2473(b)(5).

House Report 1770, *supra*, specifically states at page 3178 the intention of Congress to give NASA broad contractual authority:

"Paragraph (5) gives the Administrator broad authority to enter into and perform contracts on such terms and for such periods as he deems appropriate with any public or private agency, firm, educational institution, or other person"

The government contends that support service contracts were intended to be within the ambit of this broad contractual power. They support this contention by drawing the Court's attention to the fact that each annual NASA Authorization Act since 1966 has provided:

"When so specified in an Appropriation Act for the National Aeronautics and Space Administration, (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 service 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."

Even though Sec. 2473(b)(5) confers upon the Administrator of NASA the right to contract, even "broadly", it does not include the right to contract illegally, i.e., in contravention of the express provisions of Sec. 2473(b)(2). Nothing in the language or the legislative history of the NASA enabling act persuades the Court to conclude that Congress intended the provisions of Sec. 2473(b)(5) to be the vehicle for nullifying the requirement of Sec. 2473(b)(2) that "officers and employees of NASA shall" be appointed and paid in accordance with the civil service laws.

Defendants argue that Congress' passage of appropriation acts allowing for such contracting out of the work demonstrates a Congressional intent to authorize the practice. This Court disagrees. In *Committee for Nuclear Responsibility, Inc. v. Seaborg*, 463 F.2d 783 (C.C.A., D.C. 1971), the Atomic Energy Commission argued that in spite of the provisions of the National Environmental Policy Act, 42 U.S.C. Sec. 4332, et seq. the Commission had the right to conduct tests without detailed compliance with NEPA because Congress had passed authorization and appropriation bills for said tests. In rejecting that argument the Court of Appeals stated, at page 785:

"Congress must be free to provide authorizations and appropriations for projects proposed by the Executive even though claims of illegality . . . are pending in the courts. There is, of course, nothing inconsistent with adoption of appropriations and authorizations measures on the pro tanto assumption of validity, while leaving any claim of invalidity to be determined by the courts."

Furthermore, the fact that Congress has recognized in an Appropriation Act that "support services contracts" are being or may be entered into is inapposite to the precise issue here. The Court is not deciding, nor do the plaintiffs contend, that all contracts lumped generally under the appellation of "support service contracts" are illegal. The Court must simply decide whether or not the contracts *in question here*, no matter what they are called, make non-civil servants NASA employees in contravention of the clear direction of Sec. 2473(b)(2) that NASA employees shall be appointed and paid according to the civil service laws.

Employer—Employee Relationship

The undisputed facts in this case establish peradventure that in December, 1963, plaintiffs, civil servants, employed at NASA were the subject of a reduction-in-force while contract, non-civil servants, were not the subject of such reduction but continued to perform work at NASA similar to that performed by plaintiffs and on the same job sites. If these contract, non-civil servants were NASA employees then it is clear that plaintiffs were removed and/or reduced in grade

and pay in violation of their retention preference rights, particularly the applicable provisions of Title 5 United States Code Section 3501, et seq. and 5 Code of Federal Regulations, 351 et seq. entitled "reductions in force".

In 1967 General Counsel Pellerzi of the Civil Service Commission undertook an in depth study ⁴ (Defendants' exhibit 8b to their cross-motion for summary judgment) of two representative NASA support service contracts at the Goddard Space Center. The General Counsel's opinion states at page 4:

"The Commission's authority and responsibility to interpret and administer the personnel laws to effectuate their purposes has long been recognized by the attorney General, by the Congress, and the courts. See H.R. Rep. No. 188, 89th Cong., 1st. Sess. (1965), and authorities cited therein; see also *Born v. Allen*, 291 F. 2d 345 (D.C. Cir. 1966); *Adelstein, et al. v. Macy, et al.* 265 F. Supp. 171 (E.D.N.Y. 1967).

... it has been the Civil Service Commission's experience that the procurement and use of personnel by unauthorized contracting practices has an adverse impact upon the civil service system and tends to frustrate the purposes and national policies expressed by the personnel laws."

With this statement of authority and purpose, the General Counsel proceeded to examine the work relationship established by the support service contracts between contractor-employees and NASA against the criteria of what constitutes a civil service employee under the provisions of 5 U.S.C. 2105(a). This section states:

"(a) For the purpose of this title, 'employee', except as otherwise provided by this section or when specifically modified, means an officer and an individual who is—

(1) appointed in the civil service by one of the following acting in an official capacity—

- (A) the President;
- (B) a Member or Members of Congress, or the Congress;
- (C) a member of a uniformed service;
- (D) an individual who is an employee under this section;
- (E) the head of a Government controlled corporation; or
- (F) the adjutants general designated by the Secretary concerned under section 709(c) of title 32, United States Code;

(2) engaged in the performance of a Federal function under authority of law or an Executive act; and

(3) subject to the supervision of an individual named by paragraph (1) of this subsection while engaged in the performance of the duties of his position."

The opinion concludes after a lengthy, detailed discussion of the particular provisions of the contracts, the actual performance of contracts at Goddard and the legal standards to be applied that the contracts did establish an employer-employee relationship contrary to the civil service laws and that:

"In the absence of clear legislation expressly authorizing the procurement of personnel to perform the regular functions of agencies without regard to the personnel laws, we must insist on scrupulous adherence to those laws and the policies they embody. Accordingly, contracts which, when realistically viewed, contain all the following elements, each to any substantial degree, either in the terms of the contract, or in its performance, constitute the procurement of personal services proscribed by the personnel laws.

Performance on-site

Principal tools and equipment furnished by the Government

Services are applied directly to integral effort of agencies or an organizational subpart in furtherance of assigned function or mission

Comparable services, meeting comparable needs, are performed in the same or similar agencies using civil service personnel

The need for the type of service provided can reasonably be expected to last beyond one year

The inherent nature of the service, or the manner in which it is provided, reasonably requires directly or indirectly, Government direction or supervision of contractor employees in order:

To adequately protect the Government's interest or

To retain control of the function involved, or

To retain full personal responsibility for the function supported in a duly authorized Federal officer or employee.

⁴ Hereinafter "Pellerzi opinion".

"Applying these standards,⁵ the contracts under review and all like them are proscribed unless an agency possesses a specific exception from the personnel laws to procure personal services by contract."

The Court is of the opinion that the standards set forth in the Pellerzi opinion should be applied in deciding whether or not an employer-employee relationship has been established between NASA and the private contractor employees by the terms and performance of each of the support service contracts at issue here.

The Supreme Court in the case of *Red Lion Broadcasting Co. v. FCC*, 395 U.S. 367 (1969) stated at page 381:

"Subsequent legislation declaring the intent of an earlier statute is entitled to great weight in statutory construction. And here this principle is given special force by the equally venerable principle that the construction of a statute by those charged with its execution should be followed unless there are compelling indications that it is wrong . . ." [Emphasis supplied.]

In *National Automatic Laundry and Cleaning Council v. Shultz*, 443 F. 2d 689, 1971 Judge Leventhal of the D.C. Circuit stated at page 696:

"They [the courts] are to accord 'great deference to the interpretation given the statute by the officers or agency charged with its administration'." [citing *Udall v. Tallman*, 380 U.S. 1 (1965).]

The authorities for this proposition are myriad and the defendants in opposing the application of the Pellerzi standards to the subject contracts present no convincing argument that the interpretation of the statute contained in the opinion is not sound.

Based upon all of the foregoing this Court has concluded that a partial summary judgment should be granted to the plaintiffs declaring that 42 U.S.C. Section 2473(b)(2) requires NASA to appoint all of its officers and employees in excess of 425 of the scientific, engineering and administrative personnel in accordance with the Civil Service laws and prohibits the Administrator of NASA from entering into contracts and enforcing contracts with Intervenor or others that make non-civil service employees NASA employees as defined in the Pellerzi opinion, and that all such contracts in existence on December 6, 1967, and at present, were and are null and void.

This case will be referred to the Civil Service Commission with directions to apply the "Pellerzi Standards" and determine whether the relationship of employer-employee exists between NASA and the contract non-civil service employees involved in this case, and report its findings to this Court within 60 days from the date hereof.

Defendants' cross-motion for summary judgment and Intervenor's motion to dismiss will each be denied. Plaintiffs' prayers for injunctive relief, reinstatement, back pay, and employment benefits will be held in abeyance pending further proceedings subsequent to receipt of the report of the Civil Service Commission.

Date: November 30, 1973

JOSEPH WADDY,
Judge.

⁵ Hereinafter "Pellerzi standards"

National Aeronautics and Space Administration

SUPPORT SERVICES CONTRACTS

FISCAL YEAR 1973

NASA HEADQUARTERS WASHINGTON, D. C. 20546

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INTRODUCTION

This report presents data on NASA's contracts for support services to be provided during Fiscal Year 1973. Definitions and coverage of the data are as follows:

1. Definitionsa. Support Services Contracts

- (1) They call for furnishing of services as opposed to contracts where the primary requirement is for delivery of an end product per a set of specifications, a drawing, a catalog description, etc.
- (2) They are of a continuing nature (day to day or week to week) as opposed to services on an "on call" or "as needed" basis.
- (3) They involve on-site support by contractor personnel whether it be on or near the installation itself or on or near a remote component of the installation.
- (4) They are contracted for on a level of effort basis (usually man-years).

Of course, there are cases where a contract does not meet all of the above and is still reportable as a support services contract. For example:

- (1) A contract for janitorial services may be priced on a fixed rate square foot basis; but if it is a "continuing" effort, it is obviously a support service.
- (2) Support services contracts may involve work being performed at the contractor's facility. One example would be a contract which calls for the performance of services or tasks (e.g., computer services) on a level of effort basis rather than for deliverable end items such as fabricated assemblies, machined parts, repaired equipment or laundered linen.
- (3) Guard services may be contracted for on a fixed price basis. However, since the effort involved consists almost entirely of labor (man-years of effort) and must be performed on-site, the contract should be reported as a support services contract.

- b. Many Year Equivalent - The sum of the number of hours of straight time and the hours of overtime divided by 2,000.
- c. On-site Effort - Work performed within the confines of a NASA installation, or near to the installation but only because facilities are not available within the installation.
- d. Type of Service - Categorization of the support services by type of service is based on the services listed in the contract document. However, in many instances the contract document does not list each service provided to NASA. In such instances, the categorization is extended beyond the line items of the contract. Where this was necessary, the categorization is based on the services rendered to NASA rather than the incidental services the contractor performs for himself.

2. Coverage

- a. The data contained in the report cover those contracts for which the costs of the support services will amount, on the basis of best estimates, to \$100,000 or more during Fiscal Year 1973.
- b. For contracts that are scheduled for completion in Fiscal Year 1973 or where the current option expires in Fiscal Year 1973, and it is expected that the services will continue to be obtained by contract, the data on many years of effort and costs include best estimates for the full Fiscal Year 1973.
- c. Data on many year equivalents include prime contractor and subcontractor personnel (except employees of subcontractors providing only materials and supplies).
- d. Section II of the report provides selected data on individual contracts. For contracts that are scheduled for completion in Fiscal Year 1973 or where the current option expires in 1973, the data show the names of the follow-on contractors and/or contract numbers, if known at the time the data were compiled.

NASA SUPPORT SERVICES CONTRACTS - FISCAL YEAR 1973

SUMMARY

For Fiscal Year 1973, NASA estimates that there will be in effect 172 support services contracts of \$100,000 or more. The manyyears of contractor effort required for the services are projected to total 24.8 thousand. Costs on the contracts are estimated at \$441.6 million.

As indicated in the following table, Kennedy Space Center, Goddard Space Flight Center, Johnson Space Center and Marshall Space Flight Center project the greatest use of contractor personnel by a wide margin. These four installations will account for 87.5% of the total.

<u>Installation</u>		<u>Contractor Manyears - FY 1973 (Estimated)</u>	
	<u>Number</u>	<u>% of Total</u>	
<u>Total</u>	<u>24802</u>	<u>100.0</u>	
Kennedy	6462	26.1	
Goddard	6152	24.8	
Johnson	5605	22.6	
Marshall	3480	14.0	
Langley	1126	4.5	
Ames	607	2.4	
Headquarters	471	1.9	
Lewis	394	1.6	
Wallops	337	1.4	
Flight	167	0.7	

The next table indicates that Engineering Services and Facilities Services will account for most of the manyears of effort performed under the contracts. Together, these two types are projected to represent 59.7% of the total.

<u>Contractor Manyears - FY 1973 (Estimated)</u>		
<u>Type of Service</u>	<u>Number</u>	<u>% of Total</u>
<u>Total</u>	<u>24802</u>	<u>100.0</u>
Engineering Services	9732	39.3
Facilities Services	5061	20.4
Data Processing	4589	18.5
Administrative Support	2859	11.5
Technical Services	2541	10.3

The manyears of effort categorized by type of skill are shown below. "Technicians" and "Scientists & Engineers" personnel will account for 62.6% of the total.

<u>Contractor Manyears - FY 1973 (Estimated)</u>		
<u>Type of Skill</u>	<u>Number</u>	<u>% of Total</u>
<u>Total</u>	<u>24802</u>	<u>100.0</u>
Technicians	9441	38.0
Scientists & Engineers	6098	24.6
Blue Collar	5402	21.8
Clerical	2246	9.1
Administrative	1613	6.5

Of the 24,802 manyears of contractor effort, 16,836 or 76 percent will be performed on-site, i.e., on NASA installations; 5,944 or 24 percent will be performed off-site.

It is estimated that 83% of the costs of the contracts will be funded from the Research and Development appropriation and 17% from the Research and Program Management appropriation.

NASA SUPPORT SERVICES CONTRACTS
NUMBER OF CONTRACTS, MANPOWER AND COSTS - BY INSTALLATION
FISCAL YEAR 1973

<u>Installation</u>	<u>No. of Contracts</u>	<u>Manyear Equivalents</u>	<u>Costs (Thousands)</u>			<u>Total</u>
			<u>R&M Appropriation</u>	<u>R&D Appropriation</u>	<u>Total</u>	
<u>Total</u>	<u>172*</u>	<u>24002</u>	<u>\$ 73073</u>	<u>\$ 368559</u>	<u>\$ 441632</u>	
Ames	23	607	1323	9932	11305	
Flight	8	167	905	2151	3056	
Goddard	42	6152	4596	106186	110782	
Headquarters	9	471	6607	2380	8987	
Johnson	20	5605	12689	98524	111413	
Kennedy	14	6462	27249	87675	114924	
Langley	20	1126	3653	12865	16518	
Lewis	8	394	2871	1537	4408	
Marshall	15	3480	11712	44247	55959	
Wallops	13	337	1268	3012	4280	

* Excludes duplications resulting from awards of follow-on contracts during the year.

NASA SUPPORT SERVICES CONTRACTS
MANPOWER AND COSTS BY TYPE OF SERVICE AND MANPOWER BY TYPE OF SKILL
FISCAL YEAR 1973

Service or Skill	Manyear Equivalents	Costs (Thousands)		
		R&PM Appropriation	R&D Appropriation	Total
<u>Total</u>	<u>24802</u>	<u>\$ 73073</u>	<u>\$ 368559</u>	<u>\$ 441632</u>
Data Processing	4589	11373	77244	88617
Facilities Services	5061	34943	33705	68648
Technical Services	2541	10379	29349	39728
Administrative Support	2859	15756	34440	50196
Engineering Services	9752	622	193821	194443

BY TYPE OF SKILL

<u>Total</u>	<u>24802</u>
Scientists & Engineers	6098
Administrative	1613
Technicians	9441
Clerical	2246
Blue Collar	5402

NASA SUPPORT SERVICES CONTRACTS
MANPOWER BY INSTALLATION AND BY TYPE OF SKILL
FISCAL YEAR 1973
(MANYEAR EQUIVALENTS)

<u>Installation</u>	<u>Total</u>	<u>Scientists & Engineers</u>	<u>Administrative (Professional)</u>	<u>Technicians</u>	<u>Clerical</u>	<u>Blue Collar</u>
<u>Total</u>	<u>24802</u>	<u>6098</u>	<u>1613</u>	<u>9441</u>	<u>2248</u>	<u>5402</u>
Ames	607	124	12	368	5	96
Flight	167	10	5	51	21	50
Goddard	6152	1264	226	3577	450	635
Headquarters	471	38	219	104	89	21
Johnson	5606	2243	410	1547	578	828
Kennedy	6462	930	444	2163	688	2237
Langley	1126	276	35	296	49	470
Lewis	394	14	4	119	9	248
Marshall	3460	1137	257	1052	353	681
Wallops	337	62	1	164	6	104

NASA SUPPORT SERVICES CONTRACTS
MANPOWER BY INSTALLATION AND BY TYPE OF SERVICE
FISCAL YEAR 1973
(MANYEAR EQUIVALENTS)

Installation	Total	Data Processing	Facilities Services	Technical Services	Administrative Support	Engineering Services
<u>Total</u>	<u>24802</u>	<u>4589</u>	<u>5061</u>	<u>2541</u>	<u>2859</u>	<u>9732</u>
Ames	607	273	79	48	32	175
Flight	167	11	75	7	42	32
Goddard	6152	1745	633	347	664	2763
Headquarters	471	144	23	233	28	43
Johnson	5605	1195	732	610	509	2540
Kennedy	6462	321	1946	988	922	2285
Langley	1126	235	366	59	151	315
Lewis	394	5	254	--	47	88
Marshall	3480	625	838	234	442	1341
Wallops	337	35	95	15	22	170

NASA SUPPORT SERVICES CONTRACTS
 COSTS (TOTAL - R&PM & R&D APPROPRIATIONS) BY INSTALLATION AND BY TYPE OF SERVICE
 FISCAL YEAR 1973
 (THOUSANDS OF DOLLARS)

Installation	Total	Data Processing	Facilities Services	Technical Services	Administrative Support	Engineering Services
<u>Total</u>	<u>\$441632</u>	<u>\$88617</u>	<u>\$58648</u>	<u>\$39728</u>	<u>\$50196</u>	<u>\$194443</u>
Ames	11305	5273	756	982	415	3877
Flight	3056	239	721	50	931	1115
Goddard	110782	32720	9738	5567	16917	45040
Headquarters	8987	2153	131	3391	1159	2153
Johnson	111413	29985	12296	10360	7552	51220
Kennedy	111424	4915	27146	15104	13614	54145
Langley	16518	3325	3839	1389	2206	5759
Lewis	4408	255	2292	--	487	1374
Marshall	55959	9329	10653	2695	6759	26523
Wallops	4280	423	1074	190	156	2437

NASA SUPPORT SERVICES CONTRACTS
COSTS BY APPROPRIATION (R&M & R&D) BY INSTALLATION AND BY TYPE OF SERVICE
FISCAL YEAR 1973
(THOUSANDS OF DOLLARS)

Installation	Total	Data Processing	Facilities Services	Technical Services	Administrative Support	Engineering Services
R&M APPROPRIATION						
Total	\$73073	\$11373	\$34943	\$10379	\$15756	\$622
Ames	1323	190	805	113	415	--
Flight	905	--	422	50	373	--
Goddard	4596	732	1841	305	1718	--
Headquarters	6607	2072	131	3245	1159	--
Johnson	12869	1100	6679	2019	2616	--
Kennedy	27249	2459	16595	3356	4839	475
Langley	3653	360	1807	159	1282	45
Lewis	2671	--	2292	--	487	92
Marshall	11712	4387	3482	1132	2711	--
Wallops	1268	73	1029	--	156	10
R&D APPROPRIATION						
Total	\$366559	\$77244	\$33705	\$29349	\$34440	\$19321
Ames	9922	5083	153	869	--	3877
Flight	2151	239	239	--	958	1115
Goddard	106186	31988	7297	5262	15199	45640
Headquarters	2310	81	--	146	--	2153
Johnson	96324	28085	5617	8341	4936	50745
Kennedy	67675	2456	10551	11748	6775	54145
Langley	12865	2965	2032	1230	924	5714
Lewis	1537	255	--	--	--	1262
Marshall	44247	4942	7171	1563	4048	26523
Wallops	3012	350	45	190	--	2421

NSA SUPPORT SERVICES CONTRACTS
DATA PROCESSING SERVICES AND FACILITIES SERVICES - MANPOWER BY INSTALLATION AND BY TYPE OF EFFORT
FISCAL YEAR 1973
(MANYEAR EQUIVALENTS)

Installation	Data Processing			Facilities Services				Instrument Repair		
	Total	Systems Design & Programming	Processing & Maintenance & Repair	Total	Buildings & Ground Maint. & Alteration	Security	Janitorial		Cleaning (Incl. Chem.) & Refuse	Fire Protection
<u>Total</u>	<u>4569</u>	<u>2259</u>	<u>2330</u>	<u>5061</u>	<u>2528</u>	<u>766</u>	<u>1061</u>	<u>195</u>	<u>278</u>	<u>233</u>
Aces	273	128	145	79	--	28	51	--	--	--
Flight	11	5	6	75	33	19	13	--	--	10
Godard	1745	839	906	633	394	76	133	4	17	9
Headquarters	144	74	74	23	--	8	15	--	--	--
Joneson	1195	880	315	752	423	69	166	--	72	22
Kennedy	321	136	185	1946	1083	335	177	160	120	91
Langley	235	134	101	366	158	38	110	--	--	60
Levis	5	--	5	254	34	86	109	9	12	4
Marshall	625	32	593	838	405	84	265	22	42	20
Wallops	35	35	--	95	18	23	22	--	15	17

NASA SUPPORT SERVICES CONTRACTS
TECHNICAL SERVICES - MANPOWER BY INSTALLATION AND BY TYPE OF EFFORT
FISCAL YEAR 1973
(MANYEAR EQUIVALENTS)

Installation	Total	Documentation	Design & Drafting	Exhibit & Educational	Graphics	Library	Microfilming	Photographic	Reliability & Quality	Technical Writing	Technology Utilization
Total	2541	579	230	109	132	91	39	256	409	163	533
Ares	46	--	12	8	--	12	--	--	16	--	--
Flight	7	--	6	--	--	--	--	--	1	--	--
Goddard	347	43	65	23	--	1	7	14	61	30	100
Headquarters	233	106	--	44	3	36	21	2	8	8	6
Johnson	610	76	2	31	47	23	11	164	153	103	--
Kennedy	988	233	62	--	--	11	--	59	159	12	425
Langley	59	9	36	--	2	3	--	--	9	--	--
Lewis	--	--	--	--	--	--	--	--	--	--	--
Marshall	234	110	20	6	80	2	--	2	2	10	2
Wallops	15	--	--	--	--	--	--	15	--	--	--

NASA SUPPORT SERVICES CONTRACTS
ADMINISTRATIVE SUPPORT - MANPOWER BY INSTALLATION AND BY TYPE OF EFFORT
FISCAL YEAR 1973
(MANYEAR EQUIVALENTS)

Installation	Total	Aircraft Maintenance	Communications	Logistics & Supply	Mail & Messenger	Medical	Moving & Hauling	Reproduction & Printing	Shipping & Receiving	TV Systems	Transportation Services	Motor Pool
<u>Total</u>	<u>2859</u>	<u>273</u>	<u>482</u>	<u>1271</u>	<u>108</u>	<u>161</u>	<u>127</u>	<u>85</u>	<u>73</u>	<u>36</u>	<u>95</u>	<u>125</u>
Ames	32	--	--	16	--	4	--	--	--	--	12	--
Flight	42	5	3	26	2	--	--	--	2	--	4	--
Goldard	664	12	84	365	9	13	54	57	26	--	5	19
Headquarters	28	--	1	15	3	8	--	1	--	--	--	--
Johnson	509	219	1	146	1	53	32	1	19	36	--	1
Kennedy	922	--	286	511	50	70	--	2	14	--	1	2
Langley	151	11	7	23	36	--	41	8	14	--	12	--
Lewis	47	--	6	1	2	2	--	16	--	--	32	--
Marshall	442	26	94	138	2	31	--	--	--	--	29	106
Wallops	22	--	--	10	--	--	--	--	12	--	--	--

NASA SUPPORT SERVICES CONTRACTS
ENGINEERING SERVICES - MANPOWER BY INSTALLATION AND BY TYPE OF EFFORT
FISCAL YEAR 1973
(MANYEAR EQUIVALENTS)

<u>Installation</u>	<u>Total</u>	<u>Basic/Applied Research</u>	<u>Design/Development/ Sustaining Engineering</u>	<u>Integration Engineering</u>	<u>Test Support</u>	<u>Operations Support</u>
<u>Total</u>	<u>9752</u>	<u>60</u>	<u>1321</u>	<u>237</u>	<u>1750</u>	<u>5364</u>
Ares	175	--	--	--	82	93
Flight	32	--	--	--	10	22
Goddard	2763	2	160	55	144	2382
Headquarters	43	13	22	--	--	8
Johnson	2540	7	655	94	569	1215
Kennedy	2285	--	315	71	840	1059
Langley	315	--	58	8	76	135
Lewis	88	--	46	--	--	42
Marshall	1341	--	31	--	10	1300
Wallops	170	--	14	9	19	128

NASA SUPPORT SERVICES CONTRACTS
MANPOWER BY INSTALLATION - ON-SITE AND OFF-SITE
FISCAL YEAR 1973
(MANYEAR EQUIVALENTS)

<u>Installation</u>	<u>Total</u>	<u>On-Site</u>	<u>Off-Site</u>
<u>Total</u>	<u>24802</u>	<u>18858</u>	<u>5944</u>
Ames	607	599	8
Flight	167	165	2
Goddard	6152	2852	3300
Headquarters	471	332	139
Johnson	5606	4740	866
Kennedy	6462	6462	--
Langley	1126	653	473
Levis	394	348	46
Marshall	3480	2370	1110
Wallops	337	337	--

NASA SUPPORT SERVICES CONTRACTS
\$100 THOUSAND & OVER - FISCAL YEAR 1973

AMES RESEARCH CENTER

Contractor	Contract Number	Services	Manyear Equivalents	Percent Overtime (Manyears)	Estimated Costs (Thousands)		
					R&D	Total	
ARO	NAS2-6745	Engin.	82	--	\$	\$1,255	\$ 1,255
Bendix (Bendix Field Eng)	NAS2-5727	Data Process.	47	--	--	945	945
Computer Sciences	NAS2-6139	Data Process.	68	--	--	1,494	1,494
Computer Sciences	NAS2-6370	Data Process.	21	--	--	419	419
Computer Sciences	NAS2-6912	Data Process.	18	--	--	418	418
Consultants & Designers	NAS2-5751*	Admin.	28	--	300	--	300
Dependable Janitorial Serv.	NAS2-6517	Facil.	37	--	330	--	330
Filmline Products Assoc.	NAS7-788	Tech.	8	--	113	--	113
Informatics	NAS2-6911	Data Process.	27	--	--	629	629
Jones & Elston Maintenance	NAS2-6997	Facil.	14	--	--	153	153
Lockheed Aircraft	NAS2-7054	Engin.	28	--	--	1,460	1,460
Massey Services	NAS2-5488	Tech.	12	--	--	484	484
Massey Services	NAS2-6811	Data Process.	20	--	--	185	185
Medical Resources Foundation	NAS2-6071	Admin.	4	--	115	--	115
Northrop Services	NAS2-6947	Engin.	38	--	--	751	751
Programming Methods	NAS2-6913	Data Process.	23	--	144	408	552
Programming Methods	NAS2-6914	Data Process.	13	--	--	304	304
Programming Methods	NAS2-6935	Data Process.	36	--	46	281	327
Space Age Engineering	NAS2-6461	Tech.	12	--	--	145	145
Sterling, Walter	NAS2-6713	Tech.	16	--	--	240	240
Vinnell	NAS2-6200	Engin.	27	--	--	411	411
Williams & Lutchner	NAS2-6368	Facil.	10	--	115	--	115
Young Patrol Service	NAS2-5530	Facil.	18	--	160	--	160
TOTAL			607	--	\$1,323	\$9,982	\$11,305

* Contract expires in FY 73. Follow-on contractor not selected.

NASA SUPPORT SERVICES CONTRACTS
\$100 THOUSAND & OVER - FISCAL YEAR 1973

FLIGHT RESEARCH CENTER

Contractor	Contract Number	Services	Manyear Equivalents	Percent Overtime (Manyears)	Estimated Costs (Thousands)	
					R&D	Total
Computing & Software	NAS4-1748*	Data Process., Engin.	15	--	\$ --	\$ 306
Electronic Associates	NAS4-1771	Data Process.	6	--	--	114
General Electric	NAS4-1573*	Engin.	2	--	--	360
Hughes Aircraft	NAS4-1721	Facil.	10	--	--	217
Northrop	NAS4-1787	Engin.	2	--	--	210
RCA (RCA Service Co)	NAS4-1946	Engin.	18	--	--	364
Serv-Air	NAS4-1929	Facil., Tech., Admin.	92	--	748	558
Wackenhut Services	NAS4-1677*	Facil., Admin.	22	--	157	22
TOTAL			167		\$905	\$2,151
						\$3,056

* Contract expires in FY 1973. Follow-on contractor not selected.

NASA SUPPORT SERVICES CONTRACTS
\$100 THOUSAND & OVER - FISCAL YEAR 1973

GODDARD SPACE FLIGHT CENTER

Contractor	Contract Number	Services	Manyear Equivalents	Percent Overtime (Manyears)	Estimated Costs (Thousands)		
					R&D	R&D	Total
Advanced Services	NAS5-22068	Facil.	49	4.1	\$	471	\$ 18 \$ 489
Allied Research Associates	NAS5-21617	Data Process., Tech., Admin., Engin.					
Aries	NAS5-11849	Data Process.	29 4	10.3	--	669	669
Bendix (Bendix Field Eng.)	NAS5-10800	Facil., Tech., Admin., Engin.	584	10.3	--	133	133
Bendix (Bendix Field Eng.)	NAS5-23000	Data Process., Facil., Tech., Admin., Engin.					
Computer Sciences	NAS5-11790	Data Process.	2,114 267	10.0 10.1	--	33,996	33,996
Computer Sciences	NAS5-11858	Data Process.	27	--	--	7,320	7,320
Computer Sciences	NAS5-11882	Data Process., Tech., Admin.			--	808	808
Computer Sciences	NAS5-21340	Data Process.	73	--	--	1,330	1,330
Computing & Software	NAS5-11782	Data Process.	115	10.4	--	3,069	3,069
Consultants & Designers	NAS5-11883	Data Process.	707	5.0	632	7,655	8,287
Consultants & Designers	NAS5-11905	Data Process.	6	--	--	112	112
DBA Systems	NAS5-22070	Data Process.	32	--	--	739	739
Grumman Aerospace	NAS5-814	Engin.	13	--	--	468	468
International Business Mach.	NAS5-11944	Data Process.	86	10.5	--	2,777	2,777
International Business Mach.	NAS5-21345	Data Process.	15	--	--	550	550
Jacobs Transfer	NAS5-21246	Admin.	13	--	--	452	452
Joule	NAS5-21402	Admin.	93	--	1,280	206	1,486
KXS Industries			25	--	171	--	171
(KXS Technology Center)	NAS5-11748	Data Process.	76	--	--	1,251	1,251

NASA SUPPORT SERVICES CONTRACTS
\$100 THOUSAND & OVER - FISCAL YEAR 1973
GODDARD SPACE FLIGHT CENTER (CONT'D)

Contractor	Contract Number	Services	Many Year Equivalents	Percent Overtime (Many years)	Estimated Costs (Thousands)	
					R&M	Total
Lawrence, J. H.	NAS5-22000	Facil.	61	--	\$ 232	\$ 1,465
National Health Services	NAS5-11938	Admin.	13	--	267	267
New Mexico State Univ.	NAS5-23001	Engin.	27	--	--	491
Northrop Services	NAS5-22002	Data Process., Facil., Tech., Engin.	149	4.7	--	2,598
Pride	NAS5-22100	Facil.	12	--	130	130
RCA (Astro Electronics)	NAS5-21679	Engin.	5	--	--	200
RCA (RCA Service Co.)	NAS5-10600	Facil., Tech., Admin., Engin.	874	10.0	--	14,918
RCA (RCA Service Co.)	NAS5-10925	Admin.	169	9.5	--	9,019
RCA (RCA Service Co.)	NAS5-21400	Engin.	64	--	--	1,046
Sperry Rand (Space Support)	NAS5-21444	Tech.	61	9.8	--	1,075
Sperry Rand (Univac)	NAS5-11852	Data Process.	143	4.9	--	2,989
Sperry Rand (Univac)	NAS5-11880	Data Process.	26	--	--	743
Sperry Rand (Univac)	NAS5-22076	Data Process.	5	--	--	150
System Development Trans Continental	NAS5-11869	Data Process.	3	--	--	120
Cleaning	NAS5-22110	Facil.	120	--	815	100
Wolf Research & Dev.	NAS5-11889	Data Process.	7	--	193	189
Not Selected	Not Select.	Facil.	19	--	--	193
Not Selected	Not Select.	Data Process.	4	--	100	100
Not Selected	Not Select.	Data Process.	16	--	--	665
Not Selected	Not Select.	Engin.	4	--	--	171
Not Selected	Not Select.	Data Process.	4	--	--	125
Not Selected	Not Select.	Data Process.	10	--	--	315
Not Selected	Not Select.	Data Process.	28	--	305	305
			6,152		\$4,596	\$106,186
						\$110,782

NASA SUPPORT SERVICES CONTRACTS
\$100 THOUSAND & OVER - FISCAL YEAR 1973

HEADQUARTERS

Contractor	Contract Number	Services	Manyear Equivalents	Percent Overtime (Manyears)	Estimated Costs (Thousands)	
					R&M	Total
American Inst. of Aeronautics & Astronautics	NASW-2422	Data Process., Tech., Admin.	79	--	\$ 1,349	\$1,349
Battelle Memorial Institute	NASW-2018	Engin.	13	--	--	600
Boeing	NASW-2011	Engin.	14	--	--	600
Exotech Systems	NASW-2372	Engin.	6	--	--	253
Informatics Tisco	NASW-2431*	Data Process., Facil., Tech., Admin.	221	--	2,971	3,117
National Health Services	NASW-2098	Admin.	8	--	168	168
Oklaheima St. Univ. Education & Research Foundation	NASW-1964	Tech.	41	--	776	776
PRC Data Services	NASW-2056	Data Process.	79	--	1,343	81
Western Electric	NASW-2377	Engin.	10	--	--	700
TOTAL			471		\$5,607	\$2,380
						\$8,987

* Data include work performed under preceding contract NASW-1812.

NASA SUPPORT SERVICES CONTRACTS
\$100 THOUSAND & OVER - FISCAL YEAR 1973

JOHNSON SPACE CENTER

Contractor	Contract Number	Services	Manyear Equivalents	Percent Overtime (Manyears)	Estimated Costs (Thousands)		
					R&D	R&D	Total
A-V					\$	\$	\$
Associated American	NAS9-12350	Tech.	18	5.6	419	--	419
Boeing	NAS9-11999	Admin.	47	4.3	393	--	393
Dynallectron	NAS9-12223	Tech.	149	2.7	--	3,799	3,799
	NAS9-9631	Admin.	219	2.7	120	3,300	3,300
	NAS9-95402	Data Process., Facil., Tech., Admin., Engin.	141	--	440	1,421	1,861
International Business Mach.	NAS9-996	Data Process.	436	7.1	--	15,439	15,439
Kelsey-Seybold	NAS9-9965	Admin.	52	1.9	869	--	869
Klate Holt	NAS9-12444	Facil.	164	1.2	1,140	--	1,140
Linear Standards	NAS9-10500	Facil., Tech., Admin.	27	3.7	--	413	413
Lockheed Electronics	NAS9-11584	Engin.	71	4.2	--	1,226	1,226
Lockheed Electronics	NAS9-12200	Data Process., Engin.	1,420	2.1	1,100	24,163	25,263
Northrop Services	NAS9-13000*	Engin.	489	5.9	181	8,967	9,148
Philco-Ford	NAS9-1261	Admin., Engin.	712	6.7	--	18,024	18,024
Service Technology	NAS9-11000	Facil., Tech., Admin., Engin.	874	4.3	5,775	8,621	14,396
	NAS9-11800	Engin.	337	3.9	--	6,666	6,666
Singer	NAS9-8267	Data Process., Tech., Engin.	119	1.7	--	4,013	4,013
Sperry Rand (Univac)	NAS9-12345	Admin.	36	13.9	42	592	634
Taft Broadcasting	NAS9-11500	Tech.	144	6.3	922	1,339	2,261
Technicolor Graphics	NAS9-10888	Facil.	132	4.5	1,488	31	1,519
Wackenhut Services							
Westheimer Rigging & Heavy Hauling	NAS9-9999	Engin.	19	5.3	--	410	410
TOTAL			5,606		\$12,889	\$98,524	\$111,413

* Data include work performed under preceding contract NAS9-7572.

NASA SUPPORT SERVICES CONTRACTS
\$100 THOUSAND & OVER - FISCAL YEAR 1973

KENNEDY SPACE CENTER

Contractor	Contract Number	Services	Manyear Equivalents	Percent Overtime (Manyears)	Estimated Costs (Thousands)		
					R&M	R&D	Total
Atlantic Technical Services	NAS10-7519	Admin.	48	4.2	\$ 464	\$ ---	\$ 464
Bendix (Launch Support)	NAS10-1600	Facil., Tech., Engin.	1,486	5.1	--	23,816	23,816
Boeing	NAS10-7200	Tech., Admin., Engin.	582	6.5	--	18,980	18,980
Boeing	NAS10-7444	Facil., Tech., Admin.	2,000	6.5	19,748	7,134	26,882
Expedient Services	NAS10-8193	Facil.	71	--	840	--	840
Federal Electric	NAS10-4967	Data Process., Facil., Tech., Admin.	1,271	5.6	1,900	16,722	18,622
General Electric	NAS10-7225	Admin., Engin.	257	8.9	--	5,576	5,576
International Business Mach.	NAS10-6900	Data Process., Tech., Admin., Engin.	215	7.4	--	12,334	12,334
McGregor & Werner	NAS10-7480	Tech.	157	7.0	2,359	--	2,359
Mercury	NAS10-8142*	Facil., Tech., Admin.	32	--	350	--	350
New World Services	NAS10-7393	Tech.	11	--	194	--	194
New World Services	NAS10-7984	Data Process.	42	7.1	559	--	559
Pan American World Airways	NAS10-7038	Engin.	220	2.3	--	3,113	3,113
Pan American World Airways	NAS10-7448	Admin.	70	2.9	835	--	835
TOTAL			6,462		\$27,249	\$87,675	\$114,924

* Data include work performed under preceding contract NAS10-7001.

NASA SUPPORT SERVICES CONTRACTS
\$100 THOUSAND & OVER - FISCAL YEAR 1973

LANGLEY RESEARCH CENTER

Contractor	Contract Number	Services	Manyear Equivalents	Percent Overtime (Manyears)	Estimated Costs (Thousands)		
					R&M	R&D	Total
Ashe, B.D.	NAS1-12080	Facil.	110	--	\$ 788	\$ --	\$ 788
Ashe, B.D.	NAS1-11424	Facil.	12	--	280	--	280
Computer Sciences	NAS1-10972	Data Process.	30	--	--	270	270
Computing & Software	NAS1-10755	Data Process.	116	--	--	1,500	1,500
Electronic Associates	NAS1-12101	Data Process., Engin.	43	--	--	795	795
General Electric	NAS1-9100	Tech., Admin., Engin.	68	--	--	2,035	2,035
Hayes International	NAS1-10902	Engin.	48	--	45	355	400
Hayes International	NAS1-11827	Data Process.	25	--	360	--	360
Industrial Maint. Services	NAS1-9772	Facil., Admin.	41	--	360	--	360
Klate Holt	NAS1-11911	Tech., Admin.	104	--	1,000	--	1,000
LTV Aerospace	NAS1-10900	Data Process., Tech., Admin., Engin.	143	--	--	3,300	3,300
Management Services	NAS8-21771	Admin.	10	--	150	--	150
Modern Machine & Tool	NAS1-9776	Engin.	18	--	--	300	300
Northrop Services	NAS1-10798	Engin.	15	--	--	192	192
R&W Machine	NAS1-11084	Facil.	60	--	--	600	600
R&W Machine	NAS1-11256	Facil.	86	--	405	470	875
Tenco Services	NAS1-11075	Engin.	19	--	--	210	210
Value Engineering	NAS1-11954	Tech., Engin.	14	--	129	114	243
Williams Riggings	NAS1-11599	Admin.	15	--	136	334	470
Wyle Laboratories	NAS1-10613	Data Process., Facil., Admin., Engin.	149	2.0	--	2,390	2,390
TOTAL			1,126		\$3,653	\$12,865	\$16,518

NASA SUPPORT SERVICES CONTRACTS
\$100 THOUSAND & OVER - FISCAL YEAR 1973

LEWIS RESEARCH CENTER

Contractor	Contract Number	Services	Manyear Equivalents	Percent Overtime (Manyears)	Estimated Costs (Thousands)		
					R&D	R&M	Total
Atlantic Maintenance	NAS3-13799	Facil.	83	--	\$ 700	\$ --	\$ 700
Bendix (Bendix Field Eng)	NAS3-16446	Facil., Admin.	29	--	312	--	312
Fisher Assoc. Tech. Consult.	NAS3-16678	Engin.	19	--	--	204	204
International Business Mach.	C-17052C	Data Process.	5	--	--	255	255
Tankaley, W.L. & Assoc.	NAS3-16651	Engin.	27	--	--	498	498
Teledyne Isotopes	NAS3-10268	Facil., Admin., Engin.	132	2.3	864	580	1,444
Tenco Services	NAS3-16524	Facil.	10	--	150	--	150
Wackenhut Services	NAS3-16470	Facil., Admin.	89	3.4	845	--	845
TOTAL			394		\$2,871	\$1,537	\$ 4,408

NASA SUPPORT SERVICES CONTRACTS
\$100 THOUSAND & OVER - FISCAL YEAR 1973

MARSHALL SPACE FLIGHT CENTER

Contractor	Contract Number	Services	Manyear Equivalents	Percent Overtime (Manyears)	Estimated Costs (Thousands)		
					R&D	R&D	Total
Brown Engineering	NAS8-21804	Engin.	347	2.9	\$	\$ 6,759	\$ 6,759
Computer Sciences	NAS8-21805	Data Process.	457	2.8	4,387	2,078	6,465
Computing & Software	NAS8-26034	Data Process.	148	--	--	2,552	2,552
Federal Electric	NAS8-21806	Engin.	232	3.0	--	4,367	4,367
General Electric	NAS8-27750	Data Process., Facil., Tech., Admin., Engin.	78	--	--	1,215	1,215
Global Associates	NAS8-26896	Facil., Tech., Admin., Engin.	305	--	--	5,714	5,714
Hayes International	NAS8-21808	Facil., Tech., Admin.	557	--	4,263	1,358	5,621
Hayes International	NAS8-21809	Engin.	85	2.4	--	1,386	1,386
Management Services	NAS8-21769	Facil., Admin.	299	2.0	2,331	1,206	3,537
Management Services	NAS8-21771	Admin.	26	--	.332	250	582
Mason-Rust	NAS8-26887	Facil., Admin.	309	--	--	4,471	4,471
Northrop Services	NAS8-21810	Engin.	145	2.8	--	3,098	3,098
Planning Research	NAS8-21811	Engin.	37	2.7	--	937	937
Sperry Rand (Space Support)	NAS8-21812	Engin.	433	3.0	--	8,856	8,856
Systemed	NAS8-21642	Admin.	22	--	399	--	399
TOTAL			3,480		\$11,712	\$44,247	\$55,959

NASA SUPPORT SERVICES CONTRACTS
\$100 THOUSAND & OVER - FISCAL YEAR 1973

WALLOPS STATION

Contractor	Contract Number	Services	Manyear Equivalents	Percent Overtime (Manyears)	Estimated Costs (Thousands)		
					R&D	R&D	Total
Computer Sciences	NAS6-1847	Engin.	58	--	\$	\$1,074	\$1,074
Continental Service	NAS6-1744	Facil.	7	--	103	--	103
Dynallectron	NAS6-1802	Tech.	15	--	--	190	190
Dynallectron	NAS6-1919	Data Process.	35	--	73	350	423
Gillespie, William J.	NAS6-1789	Facil.	18	--	285	--	285
Joule Technical	NAS6-1969	Engin.	50	--	--	552	552
Lockheed Aircraft	NAS6-2034	Engin.	24	--	10	331	341
Mears, Harvey	NAS6-2210	Facil.	22	--	207	--	207
National Service	NAS6-1934	Facil.	23	--	200	--	200
National Service	NAS6-2019	Admin.	22	--	156	--	156
National Service	NAS6-2168	Facil.	10	--	104	--	104
RCA (RCA Service Co.)	NAS6-1751	Engin.	38	--	--	470	470
Tenco Services	NAS6-2180	Facil.	15	--	130	45	175
TOTAL			337		\$1,268	\$3,012	\$4,280

NASA-HQ

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APPENDIX C

NASA TECHNICAL
MEMORANDUM

NASA TM X- 64802

THE OCTOBER 1973 NASA MISSION MODEL
COST AND ECONOMIC ANALYSIS

By Shuttle Utilization Planning Office

January 1974

NASA

*George C. Marshall Space Flight Center
Marshall Space Flight Center, Alabama*

TECHNICAL REPORT STANDARD TITLE PAGE

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16. ABSTRACT This document presents the cost and economic results of The October 1973 NASA Mission Model Cost and Economic Analysis performed by the Program Development Directorate, Marshall Space Flight Center, under the direction of the Mission and Payload Integration Office of NASA Headquarters. The purpose of this analysis was to obtain an economic assessment of using the Shuttle to accommodate the payloads and requirements as identified by the NASA Program Offices and the DoD. The 1973 Payload Model represents a baseline candidate set of future payloads which can be used as a reference base for planning purposes. The cost of implementing these payload programs utilizing the capabilities of the Shuttle system is analyzed and compared with the cost of conducting the same payload effort using Expendable Launch Vehicles. There is a net benefit of \$14.1 billion as a result of using the Shuttle during the 12-year period as compared to using an Expendable Launch Vehicle fleet.			
17. KEY WORDS		18. DISTRIBUTION STATEMENT See Document Release Form	
19. SECURITY CLASSIF. (of this report) Unclassified	20. SECURITY CLASSIF. (of this page) Unclassified	21. NO. OF PAGES 56	22. PRICE NTIS

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TECHNICAL MEMORANDUM X-64802

THE OCTOBER 1973 NASA MISSION MODEL
COST AND ECONOMIC ANALYSIS

SECTION I. INTRODUCTION

This report presents results of the cost and economic comparison of using either the Shuttle or an Expendable Launch Vehicle transportation system to accomplish the space mission detailed in The 1973 NASA Payload Model [1]. This study was performed by the Program Development Directorate, Marshall Space Flight Center, under the direction of the Mission and Payload Integration Office of NASA Headquarters.

This analysis employed the basic ground rules, systems analysis techniques, parametric cost estimating models, and economic methodologies used in the coordinated study of Alternative Space Transportations Systems conducted by Aerospace Corporation, Lockheed Missiles and Space Company (LMSC), and Mathematica, Inc. in 1971 under contract with NASA [2-4].

The Aerospace-Lockheed-Mathematica analyses involved the development and application of detailed data and analytical methodology that provided a consistent basis for evaluating the comparative cost and technical performance of alternative space transportation systems in performing future space missions identified for NASA, the Department of Defense, and other major users of outer space. In addition, it identified the technical direction that should be pursued in configuring payload systems for use with the Shuttle.

In the original study, LMSC performed a detailed investigation of the concepts, requirements, and effects of modifying payloads to exploit the potential cost reductions available with the Shuttle system for orbital checkout, retrieval, refurbishment, and repair along with the design implications of relaxed payload weight, volume, and reliability. Aerospace Corporation analyzed the payload requirements and established the best approach for performing the missions at minimum cost. To accomplish this, the Aerospace Corporation translated payload requirements into launch vehicle traffic models and applied the generalized results of the LMSC analysis to specific payload configurations by matching the launch vehicle performance with payloads. Finally, costs were estimated to obtain the best-mix approach.

Mathematica, Inc., by using the results of the Aerospace analysis and by applying discounting techniques to determine present value costs for each option, established the economic position of the alternative launch systems over a wide range of traffic models.

The October 1973 NASA Mission Model Analysis and Economic Assessment [5] prepared by the NASA-Marshall Space Flight Center is an extension of the Aerospace-Lockheed-Mathematica analysis and incorporates: improvements in analytical techniques; better definition of payloads and payload systems; the current Shuttle system configuration; and the latest engineering cost estimates.

Based on economic considerations, the results of the 1973 study indicate that the Space Shuttle system is clearly dominant. A net benefit of \$14.1 billion results by using the Shuttle as compared to using an Expendable Launch Vehicle fleet. This benefit results from lower transportation costs, low-cost payload design, reusability of payloads, and the advantages of Shuttle sortie missions.

This document is intended for NASA planning purposes only. The cost data in this document are based on parametric estimating techniques and should not be construed as NASA budget estimates, which are usually based on detailed engineering estimates. The data were generated to help guide the development of an economical space transportation system (Space Shuttle and Tug) and the sortie payload carrier, the Spacelab.

SECTION II. MAJOR GROUND RULES AND ASSUMPTIONS

The data origins, conditions, and constraints for The October 1973 NASA Mission Model Cost and Economic Analysis are listed below. The ground rules and assumptions fall within the general categories of payloads, payload carriers, facilities, and cost/capture analysis.

Payload Model

- The Payload Model for NASA Shuttle missions in the 1980-1991 period assumed an average NASA level budget of \$3.3 billion (1972 constant dollars).
- Analysis is based on NASA/non-NASA/non-DoD payloads defined in The 1973 NASA Payload Model [1] dated October 1973.
- DoD Payload Model is August 1971 (updated), Option B.

Automated Payloads

- Program content for NASA payloads provided by NASA discipline offices.
- Foreign program content provided by NASA discipline offices and reviewed by the **European Space Research Organization (ESRO)**.
- Non-NASA/non-DoD program content synthesized from discipline office interpretation of current user planning.
- Payload designs and costing utilize data base resulting from LMSC, TRW, and Aerospace Corporation analyses.
- **Redesign of payloads for Shuttle utilization will neither degrade nor upgrade mission objectives.**

Spacelab Payloads

- NASA Spacelab payloads derived from NASA/scientific community working groups and coordinated by the **Joint User Requirements Group (JURG)**.
- Foreign Spacelab missions provided by ESRO.
- 30-day Spacelab missions begin no earlier than CY-1983.

- Three Spacelab/Shuttle configurations considered for capture (lab only, lab/pallet, and pallet only).

- **Spacelab payloads configured to the expendable launch vehicle mode based on the most effective approach to accomplish the same scientific objectives.**

- Spacelab equivalent for the expendable mode accomplished by:

- 3-man Space Station (available in CY-1980).

- Core station (crew, power, and General Purpose Lab).
- Research and applications modules (RAM).
- 90-day crew rotation.
- Experiment time equivalent to Spacelab/Shuttle time.
- T-3M/Big "G" logistics support.

- Automated payloads.

- Sounding rockets.

- Balloons.

Space Shuttle

- Configuration and capability consistent with the latest Shuttle design concept (2 percent c.g. and 32 000-pound landing weight limit).

- Shuttle buildup rate: 14 flights in 1980, 36 flights in 1981, 50 flights in 1982.

- Initial operational capability of Shuttle assumed late CY-1979.

- Turnaround time on ground assumed to be 2 weeks per Shuttle.

- Shuttle reliability consistent with Aerospace Corporation ground rules used in 1971 Mission Model Analysis.

Space Tug

- Retrievable (interim) Tug IOC late CY-1980; full performance Tug with payload retrieval IOC late CY-1983.
- Turnaround time on ground assumed to be same as Shuttle (2 weeks).
- Tug reliability consistent with Aerospace Corporation ground rules used in 1971 Mission Model Analysis.

Spacelab

- Spacelab developed by Europeans.
- Availability assumed at Shuttle IOC.
- Configuration and performance consistent with latest Spacelab design.
- Docking module required for Spacelab missions (except pallet-only mission).
- Turnaround time on ground dependent on experiment complement and flight configuration.

Expendable Launch Vehicles

- For automated missions: Scout, TAT, and Titan derivatives.
- Direct operating costs reflect rate effects.

Launch Sites

- ETR available as required for entire time span.
- WTR available in late CY-1982.
- No polar launches from ETR.

Cost/Capture Analysis

- Low cost effects incorporated where applicable into payload designs for use for both Expendable Launch Vehicle and Shuttle cases.
- Titan solid rocket motors to be recovered and reused in Expendable Launch Vehicle case.
- Capture analysis restrained by Shuttle and Tug delivery/retrieval capability, cargo volume, c.g. limit, landing weight limit, ground turnaround time, Shuttle overhaul, etc.
- 1980 through 1991 time span assumed for analysis.
- Post-1991 (1992-1998) Payload Model synthesized to avoid program "tailoff."
- Payload multiples permitted in both Shuttle and Expendable cases.
- DoD payloads not to be combined with non-DoD payloads.
- Costs include reliability effects of vehicles, carriers, and payloads.
- All costs in 1972 constant dollars.
- Shuttle, Tug, and Spacelab developments, and unit and operations costs, provided by program offices.

SECTION III. COST ESTIMATING METHODS

Throughout the costing and economic portion of The October 1973 NASA Mission Model Cost and Economic Analysis, the objective has been to maintain consistency with previous analyses. However, there were some major revisions to the cost and capture ground rules used in the earlier 1971 Aerospace-Lockheed-Mathematica study.

- Payloads flown on the Expendable Launch Vehicle systems were afforded the benefits of low-cost design to improve cost effectiveness.
- In the Expendable case, solid rocket motors (SRM) used with the Titan vehicles are recovered and reused in the same manner as the SRMs in the Space Shuttle system.
- Low-cost payload design factors were modified based on results of additional studies.
 - Spacelab is included as a basic Shuttle program element.
 - A reduced-capability Space Station is included in the Expendable case to perform many of the sortie equivalent missions.
 - Current Shuttle configuration and FY-74 budget estimates have been included.
 - Summary costs of DoD support missions have been included.
 - The Expendable Vehicle alternative was assumed to have multiple payload capability.

This section describes the methods employed to estimate the various hardware and support elements of the 1973 Mission Model. These elements have been grouped into two major classifications: payload systems and transportation systems.

A. Payload Systems

A payload is defined as a specific complement of instrument and support hardware carried to space to accomplish a given set of objectives called a mission. In the Shuttle case, there are some 986 individual payloads which

are launched in the 1973 Mission Model. In the Expendable Launch Vehicle case, the number of payloads is 821. These payloads are grouped into three major cost tasks: (1) estimating the cost of automated payloads; (2) defining and costing the Spacelab and sortie experiments; and (3) costing the Space Station and experiments assumed as the expendable equivalent of the Space Shuttle sorties. The cost estimating methods for these three areas are discussed below.

1. Automated Payloads. The automated payload costs were estimated with the spacecraft cost model developed by the Aerospace Corporation [2]. The cost model is applicable for automated payloads flown with the Space Shuttle and with the conventional expendable vehicle systems. Cost model estimates were developed for four payload design classes: current expendable (CE), current reusable (CR), low-cost expendable (LCE), and low-cost reusable (LCR). Details concerning the derivation and application of these payload design types are the subject of Section VI of Reference 5.

The automated payload cost model accepts characteristic payload descriptive data and develops a cost estimate for the current expendable payload type. Specific cost factors are applied to the CE cost to derive the CR, LCE, and LCR costs. (The cost factors, called "payload effects factors," are discussed later in this section.) The parametric estimating relationships in the cost model are derived from basic historical automated spacecraft data researched and assimilated by the Air Force SAMSO and the Aerospace Corporation. Estimates are generated at the spacecraft subsystem level and collected along with estimates of supporting functions to form a payload project cost. Costs are projected for the development, production, and operations phases of the project.

2. Sortie Payloads. In previous capture/cost analyses the "sortie type" missions in the mission model were considered to be additional benefits of the Shuttle and were not included in the Expendable Launch Vehicle Mission Model. For this analysis a sortie-equivalent capability is included in the Expendable Mission Model case consisting of a three-man modular Space Station, automated spacecraft, and rocket- and balloon-borne experiments. This sortie-equivalent capability in the Expendable Launch Vehicle case capture/cost analysis can then be compared with analysis of the Shuttle Mission Model which includes Shuttle sortie flights.

Sortie experiment costs are derived from a General Dynamics study [6] which developed a parametric estimating relationship applied across the spectrum of scientific and applications programs. The fundamental difference between these relationships and those used for automated payloads is the data

upon which the estimating relationships are based. Because of the major innovations involved in the sortie experiment concept, a concentrated analysis was required to prepare a new cost and performance data base from earth-based systems, aircraft, and sounding rocket experiment instrumentation. Data for optical systems, for example, consist of large ground-based instruments, automated observatory spacecraft, aircraft astronomy instruments, Skylab Apollo Telescope Mount (ATM) optics, and Large Space Telescope (LST) study data.

The study data, which supplement the historical data points used to construct the sortie experiment CERs, are derived from cost estimates furnished with Spacelab experiment proposals. These studies were conducted by experienced aerospace firms such as TRW, Ball Brothers, Martin-Marietta, and General Dynamics. The results of the studies by different contractors indicate that the cost estimates for instruments of similar characteristics and complexity were generally comparable; this, therefore, provided a measure of confidence in the projected cost values.

The Marshall Space Flight Center documents on payload descriptions [7] resulting from the ongoing General Dynamics-Convair study "Shuttle System Payload Data (SSPD)" provide the basic sortie experiment technical descriptions for the costing effort.

The Spacelab costs used in this analysis are those developed jointly by the NASA and the ESRO. The assumed Spacelab configuration is a modular or building-block design which allows modules and pallets to be procured as required by the mission model. The design, development, test, and engineering (DDT&E) costs of \$334 million include development and delivery of one complete Spacelab by the Europeans as well as additional DDT&E required for NASA facilities, ground support equipment, mockups, trainers, and other miscellaneous costs.

Four additional support modules are procured in the Spacelab investment cost of \$76 million. Additional experiment modules and pallets are purchased as required over a period of years and are charged to the using experiment discipline area as a part of the payload costs. The average Spacelab cost per flight of \$0.66 million includes Spacelab refurbishment and integration costs. These costs and quantities are displayed in Tables 1 and 2 which list major non-recurring investment, unit and operation costs together with quantities of major hardware required.

TABLE 1. 1973 MISSION MODEL NON-RECURRING INVESTMENT
(MILLIONS OF 1972 DOLLARS)

SPACE SHUTTLE CASE	EXPENDABLE CASE
SPACE SHUTTLE DDT&E SHUTTLE INVESTMENT & FAC. (NASA) SHUTTLE INVESTMENT & FAC. (DOD) SPACE TUG DDT&E TUG INVESTMENT SPACELAB DDT & E SUPPORT MODULE INVESTMENT EXPENDABLE L/V NON-RECURRING TOTAL	5394 1345 1065 445 128 334 76 105 8892 SPACE STATION DDT&E & INVESTMENT SPACE STATION LOGISTICS & OPS. RAM MOCKUP & MOCKUP OPS. BIG "G" DDT&E & INVESTMENT RAM DDT&E EXPENDABLE L/V NON-RECURRING TOTAL
SHUTTLE OPS. TUG OPS. INITIAL TUG OPS. PHASED SPACELAB REFURB. & INTEG.	1000 899 61 1297 107 575 3839 BIG "G" UNIT BIG "G" REFURB. & OPS.
9.8 .85 .85 .66	45.0 20.0

TABLE 2. 1973 MISSION MODEL STS HARDWARE AVERAGE UNIT COST
AND NUMBER OF UNITS PER YEAR (MILLIONS OF 1972 DOLLARS)

ITEM	UNIT COST	CY	80	81	82	83	84	85	86	87	88	89	90	91	TOTAL
ORBITERS*	250.0	1	1	1	2	2	1								7
TUGS															
INITIAL	9.9			5		5								1	12**
FINAL	13.2						5								7**
KICKSTAGE	1.4		2	1	2	2	2	1	1	1		2	3	3	16
SPACELAB/PALLETS (MODULARIZED)															
SUPPORT MODULES	19.4							1				2			5
TEN FT EXP MODS	2.1	2													3
SIX FT EXP MODS	1.3	3													5
AFT BULKHEADS	.4	4	1												7
TEN FT PALLETS	.6	6	1												30
FIVE FT PALLETS	.5	17	10	2	2	1			1						15
		7	4	2	2	1									

*BASED ON CURRENT PROCUREMENT PLANNING

**TOTALS REFLECT 1% RISK EACH FLIGHT OF NOT RECOVERING TUG

3. **Sortie Equivalent Payloads.** The McDonnell-Douglas Space Station definition study [8] provides the basis for establishing the development, fabrication, and operations costs of a Space Station used in the Expendable Launch Vehicle case. The Space Station provides an on-orbit experiment laboratory comparable to the capability provided by the Shuttle sortie system. The McDonnell-Douglas study focused on a 6-man and 12-man station, and extrapolation from these configurations to a 3-man size was judged most equivalent to the Spacelab.

The Space Station consists of a power module, a general-purpose experiment module, and a crew habitability module. The DDT&E for the Space Station is projected at \$1 billion. Specially outfitted experiment modules based on the RAM, described in Reference 9, are estimated at \$107 million for DDT&E. Logistics are provided by the Titan IIIM/Big "G" system utilizing crew/cargo modules for crew rotation, supplies, and carry-on experiments. Experiment cost estimates for the sortie equivalent program conducted on the Space Station were derived by NASA working groups who conducted analyses to determine modifications required to adapt sortie experiments to the Space Station. A major modification was the requirement for functional mockups to verify experiments on the ground before being placed in the Space Station.

4. **Payload Effects Factors.** The relaxation of payload weight and volume constraints that are possible through implementation of a reusable Space Shuttle allows reduced-cost payload designs. To estimate the effect on payload design and on production and operations costs of these new launch system concepts, factors based on the LMSC studies [4] were developed. These factors are used to estimate costs for current reusable, low-cost expendable, and low-cost reusable payloads that are flown on the Shuttle. Beginning with this latest study, these factors are also used to derive low-cost expendable payloads which can be economically flown on the current expendable launch vehicles.

The earlier LMSC study addressed design alternatives for three typical payloads: Orbiting Astronomical Observatory (OAO), Synchronous Equatorial Orbiter (SEO), and Small Research Satellite (SRS). These satellites formed the basis for in-depth parametric and engineering designs of payloads suitable for retrieval, refurbishment, and relaunch as well as for low-cost designs. Preliminary point designs were conducted on the three typical payloads for launching by an expendable booster and the Space Shuttle. The design was performed and costed at the subsystem level.

A later LMSC study extended the analysis to include two additional payloads; a communications satellite and an earth observations satellite. These payload studies provide an expanded baseline for payloads effects factors used in the current analysis.

5. "Best Mix" Payloads Derivation. "Best mix" is alluded to in Section VII of The October 1973 NASA Mission Model Analysis and Economic Assessment volume [5] as appropriate for the capture analysis. The term "best mix" is also relevant in the cost analysis sense. "Best mix" defines the optimum selection of payload design type such that the lowest project cost (payload and transportation) is achieved.

For the Shuttle case, the selection of the best mix payloads was accomplished by performing a separate capture/cost analysis for each of the payload types where appropriate. For some programs, it was not feasible to consider certain payload types; i.e., planetary payloads in a reusable mode. Other exceptions were those payloads where no low-cost definition was made, such as the large observatories. The capture/cost results were compared program-by-program, and the lowest cost configuration was selected. Then, another capture analysis was performed to obtain payload assignments and flight schedules for the lowest cost (best mix) of payload types.

The Expendable case was analyzed in the same fashion except only current expendable and low-cost expendable payloads are considered.

B. Transportation Systems

Transportation systems include the expendable launch system for both the Shuttle and Expendable Launch Vehicle case and the Space Shuttle and Space Tug in the Shuttle case.

In the Expendable case [10], 752 vehicle launches, including an allowance for aborted flights, are projected in the 1973 Mission Model utilizing combinations of 11 basic expendable vehicles. The Shuttle case [11] (with aborts) projects 782 Shuttle launches, 314 of which include Space Tugs, plus 88 expendable vehicle launches in the buildup years. Each of these launch vehicle configurations must be considered in terms of DDT&E, investment, and operational costs.

1. Expendable Launch Systems. The DDT&E costs were generated by making point estimates of cost for each specific vehicle configuration. Since most of the current fleet is operational, there is little DDT&E cost involved.

Results of prior studies were used whenever applicable. The non-recurring investment costs consisted chiefly of the additional facilities and equipment necessary to achieve the required launch rate capabilities. Point estimates of cost for these facilities were then made, based on similar costs for existing facilities, as well as the results of prior studies.

In an Expendable Launch Vehicle program, the recurring investment and operations costs dominate the total program cost; therefore, considerable effort was devoted to the estimation of these costs. A computerized cost model [2] developed by the Aerospace Corporation was used for this purpose and required two categories of input data:

1. Quantities of vehicle configurations launched, by year and by launch site (ETR or WTR).
2. Cost data as a function of quantity for vehicle hardware elements (stages, engines, SRMs, etc.) and operations elements of each vehicle configuration in the fleet.

The model processes the first type of data to break vehicles into common modules or stages and to construct smoothed curves for hardware and operations cost elements as a function of production quantity and launch rate. The costs are then determined by entering the cost-rate curve at the appropriate rate value. This program is especially useful in handling the production costs of family concepts such as Titan III, where total family production (and not individual configuration production) is of prime importance.

To obtain comparability between the Shuttle and Expendable Launch Vehicle cases, recoverable solid rocket motors were assumed for the Titan III family in the Expendable case. This technique for recovering and reusing the solid rocket motors on the Titan III vehicles is analogous to the recovery and reuse of the solid rocket motors used to boost the Space Shuttle. An Aerospace Corporation cost study evolved an estimating method [12] used to estimate costs for development, facilities, and operations for recoverable solid rocket motors to be used with expendable vehicles. The method produces estimates consistent with the Shuttle booster solid rocket motor costs when adjusted for size, test requirements, flight rates, and other cost-sensitive elements.

Tables 3 and 4 identify the production costs for each expendable launch vehicle element with its associated launchsite peculiar costs. These costs include provision for significant savings obtained through maximum use of common stages, and production and launch rate effects. In the Shuttle system case (during the Shuttle buildup period), solid booster recovery and reuse is uneconomical because of the low number of launches of Titan III class vehicles.

TABLE 3. 1973 MISSION MODEL EXPENDABLE LAUNCH VEHICLE
AVERAGE UNIT AND LAUNCH SUPPORT COSTS — SHUTTLE CASE
(MILLIONS OF 1972 DOLLARS)

Launch Vehicles	Production Costs	Launch Support Costs	
		ETR	WTR
Scout	2.60	1.03	0.71
Delta 300	5.40	-	3.21
Delta 600	5.55	-	3.09
Delta 900	5.91	-	3.27
Delta 904	6.02	-	3.51
Titan 3B	5.26	0.76	0.78
Titan 3C	15.56	2.21	3.07
Titan 3D	9.75	1.29	1.29
Titan 3D7	10.60	1.29	1.30
Centaur	5.83	1.13	3.91
B II	0.73	0.11	0.11
Agena	5.30	2.05	-

In addition to the recurring operations costs previously discussed, additional costs for operating the ranges (ETR and WTR) are incurred in the operation of expendable launch vehicles. These costs were estimated using the Aerospace Corporation technique and represent annual fixed costs relatively insensitive to launch rate. These costs were categorized by Aerospace as indirect operating costs.

For this study, Aerospace estimates for annual range costs were inflated to 1972 dollars and are as follows:

ETR	\$89 million per year
WTR	\$44 million per year

2. Shuttle Launch Systems. The Shuttle DDT&E investment and operations costs are based upon the approved NASA cost estimates for the Space Shuttle program. These estimates are the results of extensive analyses at all levels of the NASA and are considered to be realistic and achievable values.

TABLE 4. 1973 MISSION MODEL EXPENDABLE LAUNCH VEHICLE
AVERAGE UNIT AND LAUNCH SUPPORT COSTS — EXPENDABLE
CASE (MILLIONS OF 1972 DOLLARS)

Launch Vehicles	Production Cost	Launch Support Cost	
		ETR	WTR
Scout	2.38	0.67	0.71
Delta 300	5.02	2.85	3.98
Delta 900	5.60	-	4.42
Delta 304	5.23	3.03	-
Delta 904	5.54	2.42	4.18
Titan 3B	4.12	0.67	0.72
Titan 3C	12.53	1.65	2.06
Titan 3D	8.65	1.15	1.21
Titan 3D7	9.16	0.95	1.21
Titan 3M	17.05	1.57	-
Centaur	4.84	1.16	1.64
B II	0.73	0.11	0.11
Agena	4.02	1.02	1.71

The Space Shuttle DDT&E cost is projected at \$5.394 billion in 1972 dollars and includes the development and testing of the orbiter, main engine, solid rocket booster, and external tank. In addition, the first two orbiters are purchased in this DDT&E. The investment costs are \$1.345 billion for the NASA and include updating the initial two orbiters to operational configuration, the purchase of three additional orbiters, and the additional launch facility cost at ETR. The DoD investment cost of \$1.065 billion is for procurement of two orbiters and the launch facility cost at WTR.

The Space Shuttle operations cost of \$9.8 million per flight includes the cost of launch; refurbishment of the orbiter, main engine, and solid rocket booster; and purchase of the external tank. This cost has been adjusted for the number of launches required by the 1973 Mission Model and for the impact of two separate launch sites.

The Space Tug costs are based on current contractor and in-house NASA cost estimates for a phased Space Tug program which begins with a reusable Space Tug without payload-retrieval capability deployed in 1981 and is phased into a payload-retrieval version in 1984. Both Tug configurations would make use of a kick stage to increase the Tug capability on certain missions.

The Space Tug DDT&E costs are estimated at \$445 million which include development and testing of both the initial (\$237 million) and final (\$178 million) version of the phased Space Tug, plus development and testing of the kick stage for \$30 million. The investment cost of \$128 million includes the procurement of 12 initial and 7 final-version Space Tug vehicles. The average cost per flight of the Space Tug is estimated at \$0.85 million which includes launch and refurbishment costs.

3. **Transportation Charges.** The technique of carrying multiple payloads on a single vehicle flight, either Shuttle or expendable vehicles, complicates the assessment of transportation charges to the payload project. The transportation charges assigned to a particular payload launched on an expendable vehicle are determined by dividing the total launch costs by the number of payloads assigned to the vehicle, and the transportation costs are thereby shared equally by each payload. In the Shuttle case, transportation costs for a particular payload are computed by dividing the Shuttle operation cost, and Tug if used, by the number of payloads carried to orbit plus the number of payloads returned to earth. For certain sortie payloads, however, where payload configurations were divided into smaller elements on a space-available and weight-available basis, adjustments were made in the accounting technique to charge for transportation on the "up" leg only to obtain a more equitable distribution of transportation charges.

C. Anomalous Results

Review of the program cost summaries of this analysis reveals several anomalous results that occur because of the many parameters considered in the assessment of the "best mix" payload-transportation system to perform the Payload Model. For example, in some cases, payload costs with the Shuttle may exceed costs incurred using the expendable system. The explanation for this is that the advantages of low-cost design obtained through increased payload size may be rejected in the Shuttle case to obtain greater savings through exploiting the Shuttle's cargo capacity with multiple payloads. The effect of this trade-off in some instances results in the application of low-cost design concepts in the Expendable Launch Vehicle case, while in the Shuttle case existing payload designs are used and payload grouping is employed to achieve savings in launch costs.

Although transportation costs generally are lower for the Shuttle than for expendable vehicles, there are some exceptions. In the case of sortie payloads, the primary benefit of the Shuttle sortie mode is providing easy and frequent access to space. Consequently, many payloads are flown a number of times with limited changes in the instrument complement; this increases the transportation costs in the Shuttle mode relative to the sortie equivalent in the Expendable Launch Vehicle case where payloads configured for automated spacecraft or the Space Station are flown less frequently, but operate for longer durations.

SECTION IV. RESULT AND ANALYSIS

A. Study Results

All costs presented in this analysis are identified against three major classifications:

1. Payload system costs.
2. Transportation system costs.
3. Non-recurring investment costs.

The terms "payload system," "transportation system," and "non-recurring investment" are used in a generic sense and include a variety of elements in their cost structure. Figure 1 illustrates several of the more significant cost elements and their relationships to the total program costs for both the Shuttle system and Expendable Launch Vehicle system cases.

In line with this cost structure, summary results are portrayed in Table 5 which show a net benefit to the Shuttle system over the Expendable system of \$14.1 billion. Both payloads and transportation show large cost savings for the Shuttle system over the Expendable Launch Vehicle case. Reflected in the payload savings are capabilities offered by the Shuttle for retrieval and reuse of automated payloads as well as greater weights and volumes which allow for reduced-cost payload designs. Also, payload savings reflect capabilities provided by the Shuttle to conduct sortie experiments in a more efficient manner as compared to conducting an equivalent experiment program in the Expendable mode. The Shuttle offers a transportation savings because the average cost per flight of Expendable Launch Vehicles is significantly greater than Shuttle system cost per flight.

The Non-Recurring Investment category, as shown in Table 5, includes costs for development and procurement of payload delivery and carrier systems. While new systems are required in both cases, the development costs of the Space Transportation System (Shuttle, Tug, and Spacelab) in the Shuttle case far exceed development costs required in the Expendable case. This situation results in a negative benefit of \$4.95 billion to the Shuttle which must be subtracted from the benefits accruing in the payload and transportation areas.

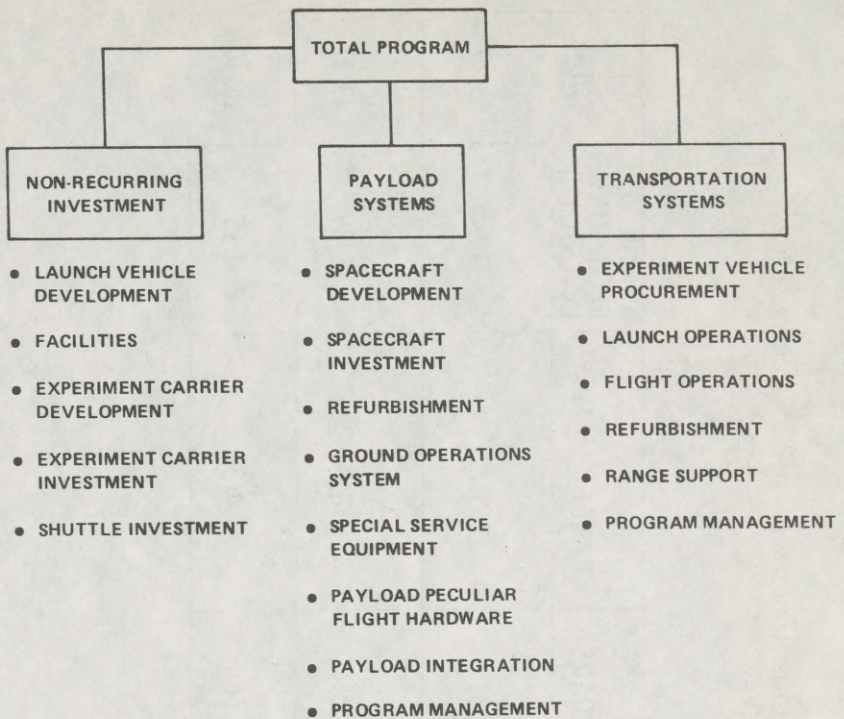


Figure 1. Cost structure.

Summary cost information by payload type and major user for both cases is provided in Table 6 along with number of flights and payloads. In these cases, NASA programs account for slightly over 50 percent of the cost benefits. DoD and non-NASA programs account for the remaining benefits which are distributed approximately equally between them. A further breakdown of the cost data by user within the major organization is provided in Tables 7 and 8. In the Shuttle case, as shown in Table 7, sorties incur only 20 percent of the cost but contribute 50 percent of the net benefits between the Shuttle and Expendable cases. As shown in Table 8 for the Expendable case, approximately 75 percent of sortie equivalent costs are attributed to automated spacecraft. Also in Table 8, it is shown that most of the sortie equivalent missions are flown as NASA payloads. Appendix A of this report contains a breakdown of this information into individual projects by payload and transportation costs.

TABLE 5. 1973 MISSION MODEL SUMMARY COST COMPARISON
(BILLIONS OF 1972 DOLLARS)

	PAYLOADS	TRANSPORTATION	NON- RECURRING INVESTMENT	TOTAL
EXPENDABLE CASE (BEST MIX)	46.31	13.22	3.94	63.47
SHUTTLE	31.65	8.83	8.89	49.37
BENEFITS	14.66	4.39	-4.95	14.10

TABLE 6. 1973 MISSION MODEL SUMMARY COST COMPARISON BY MAJOR USER

VEHICLE & PAYLOAD COMPARISON				PROGRAM COST COMPARISON (1972 \$ IN MILLIONS)							BENEFITS
EXPENDABLE CASE (BEST MIX P/L)		SHUTTLE SYSTEM CASE		EXPENDABLE CASE (BEST MIX P/L)			SHUTTLE SYSTEM CASE				
NO. FLTS.	NO. P/L	NO. FLTS.	NO. P/L	P/L TOTAL	L/V TOTAL	PROG. TOTAL	P/L TOTAL	L/V TOTAL	PROG. TOTAL		
				CATEGORY							
				AUTOMATED S/C							
191.0	211	156.3	221	16604	2502	19106	13432	1898	15330	3776	
81.0	125	73.7	125	4928	1271	6199	4057	890	4947	1252	
231.0	303	271.0	304	11905	3559	15464	9026	2679	11705	3759	
503.0	639	501.0	650	33437	7332	40769	26515	5467	31982	8787	
				SORTIES							
138.0	138	255.7	286	10035	3095	13130	4119	2671	6790	6340	
30.0	30	48.3	50	2828	942	3770	1011	506	1517	2253	
168.0	168	304.0	336	12863	4037	16900	5130	3177	8307	8593	
				TOTAL							
329.0	349	412.0	507	26639	5597	32236	17551	4569	22120	10116	
111.0	155	122.0	175	7756	2213	9969	5068	1396	6464	3505	
231.0	303	271.0	304	11905	3559	15464	9026	2679	11705	3759	
				L/V RANGE SUPP.							
				-	1860	1860	-	187	187	1673	
				SUBTOTAL							
671.0	807	805.0	986	46300	13229	59529	31645	8831	40476	19053	
14*	14*	-	-	-	-	3939	-	-	8892	-4953	
685.0	821	805.0	986	-	-	63468	-	-	49368	14100	
				NON-RECURRING INVEST.							
				GRAND TOTAL							
				*SPACE STATION LAUNCHES & SPACE STATION LOGISTICS							

TABLE 7. 1973 MISSION MODEL PAYLOAD AND TRANSPORTATION COST BY USER —
SHUTTLE CASE (BILLIONS OF 1972 DOLLARS)

	AUTOMATED SPACECRAFT			SORTIE			L/V RANGE SUPPORT		TOTAL		
	P/L	TRANS	TOTAL	P/L	TRANS	TOTAL	TRANS		P/L	TRANS	TOTAL
NASA											
OSS	10.61	1.30	11.91	2.22	1.13	3.35	—		12.83	2.43	15.26
OA	2.67	.39	3.06	1.05	.77	1.82	—		3.72	1.16	4.88
OMSF	.14	.13	.27	.36	.29	.65	—		.50	.42	.92
OAST	.01	.08	.09	.49	.48	.97	—		.50	.56	1.06
NASA TOTAL	13.43	1.90	15.33	4.12	2.67	6.79	—		17.55	4.57	22.12
NON-NASA											
U.S. GOV.	1.66	.33	1.99	0	0	0	—		1.66	.33	1.99
DOMESTIC - COM.	1.96	.41	2.37	.07	.10	.17	—		2.03	.51	2.54
FOREIGN	.44	.15	.59	.94	.40	1.34	—		1.38	.55	1.93
NON-NASA TOTAL	4.06	.89	4.95	1.01	.50	1.51	—		5.07	1.39	6.46
DOD	9.03	2.68	11.71	0	0	0	—		9.03	2.68	11.71
L/V RANGE SUPP.	—	—	—	—	—	—	.19		—	.19	.19
	26.52	5.47	31.99	5.13	3.17	8.30	.19		31.65	8.83	40.48

TABLE 8. 1973 MISSION MODEL PAYLOAD AND TRANSPORTATION COST BY USER —
EXPENDABLE CASE (BILLIONS OF 1972 DOLLARS)

	AUTOMATED SPACECRAFT			SORTIE EQUIVALENT						L/V RANGE SUPPORT		TOTAL	
	P/L	TRANS	TOTAL	AUTOMATED SPACECRAFT		SPACE STATION		TOTAL	TRANS	P/L	TRANS	P/L	TRANS
				P/L	TRANS	P/L	TRANS						
NASA													
OSS	13.26	1.68	14.94	6.00	.70	0	0	6.70	0	—	19.26	2.38	21.64
OA	3.04	.64	3.68	1.84	.39	.45	.43	3.11	.43	—	5.33	1.46	6.79
OMSF	.30	.11	.41	0	0	.61	.78	1.39	.78	—	.91	.89	1.80
OAST	.01	.07	.08	0	0	1.14	.79	1.93	.79	—	1.15	.86	2.01
NASA TOTAL	16.61	2.50	19.11	7.84	1.09	2.20	2.00	13.13	2.00	—	26.65	5.59	32.24
NON-NASA													
U.S. GOV.	2.17	.48	2.65	0	0	0	0	0	0	—	2.17	.48	2.65
DOMESTIC - COM.	2.20	.65	2.85	0	0	.06	.22	.28	.22	—	2.26	.87	3.13
FOREIGN	.56	.14	.70	2.77	.72	0	0	3.49	0	—	3.33	.86	4.19
NON-NASA TOTAL	4.93	1.27	6.20	2.77	.72	.06	.22	3.77	.22	—	7.76	2.21	9.97
DOD	11.90	3.56	15.46	0	0	0	0	0	0	—	11.90	3.56	15.46
L/V RANGE SUPP.	—	—	—	—	—	—	—	—	—	1.86	—	1.86	1.86
	33.44	7.33	40.77	10.61	1.81	2.26	2.22	16.90	2.22	1.86	46.31	13.22	59.53

Annual cost runouts consistent with the user breakdown discussed above are contained in Appendices B and C of this report. The cost results summarized in Appendix B identify the annual funding requirements needed to accomplish the NASA portion of the 1973 Payload Model with the Shuttle system. The average annual cost of \$1.6 billion over the 12-year operational period used for this comparative economic study is consistent with the concept of projecting a constant total agency budget level of about \$3.3 billion for the future.

Cost benefits are divided into automated mission and sortie mission in Tables 9 and 10, respectively. These data show approximately a 50-percent split in benefits between sortie and automated missions.

For the automated missions, as shown in Table 9, NASA and DoD account for approximately 43 percent each of the cost benefits with non-NASA missions accounting for the remaining 14 percent. The NASA Office of Space Science (OSS) is the principal benefactor for automated missions showing some \$3 billion in cost benefits or more than 80 percent of the NASA automated benefits. Foreign automated missions account for a minimal amount of the total benefits.

For the sortie missions shown in Table 10, the benefits are divided between NASA and non-NASA missions with NASA missions accounting for approximately 73 percent of these benefits. It should be noted that the DoD does not utilize the sortie mode.

Tables 9 and 10 show that foreign benefits are dominated by sortie missions because many of the foreign automated payloads were not included in this analysis since they will be launched on European launch vehicles rather than the Space Shuttle.

Table 11 summarizes the cost benefits as presented in Tables 9 and 10. In addition, expendable launch range support cost and non-recurring investment are included to exhibit the net benefit of \$14.1 billion.

B. Economic Analysis

The October 1973 NASA Mission Model Cost and Economic Analysis, as described in the preceding sections of this report, is structured as an "equal-capability" analysis to evaluate the most cost-effective transportation system for performing a specific payload model. In the "equal-capability" approach a projected space program utilizing the Shuttle is compared to the same program

TABLE 9. 1973 MISSION MODEL, AUTOMATED MISSION BENEFIT ANALYSIS BY USER
(BILLIONS OF 1972 DOLLARS)

	SHUTTLE SYSTEM CASE	EXP. SYSTEM CASE	BENEFITS
OSS	11.91	14.94	3.03
OA	3.06	3.68	.62
OMSF	.27	.41	.14
OAST	.09	.08	-0.01
NASA TOTAL	(15.33)	(19.11)	(3.78)
U. S. GOVERNMENT	1.99	2.65	.66
DOMESTIC COMM.	2.37	2.85	.48
FOREIGN	.59	.70	.11
NON-NASA TOTAL	(4.95)	(6.20)	(1.25)
DOD	11.71	15.46	3.75
TOTAL	31.99	40.77	8.78

TABLE 10. 1973 MISSION MODEL, SORTIE BENEFIT ANALYSIS BY USER
(BILLIONS OF 1972 DOLLARS)

	SHUTTLE SYSTEM CASE	EXPENDABLE CASE (BEST MIX P/L)	BENEFITS
OSS	3.35	6.70	3.35
OA	1.82	3.11	1.29
OMSF	.65	1.39	.74
OAST	.97	1.93	.96
NASA TOTAL	6.79	(13.13)	(6.34)
U. S. GOVERNMENT	0	0	0
DOMESTIC COMM.	.17	.28	.11
FOREIGN	1.34	3.49	2.15
NON-NASA TOTAL	(1.51)	(3.77)	(2.26)
DOD	0	0	0
TOTAL	8.30	16.90	8.60

TABLE 11. 1973 MISSION MODEL, SUMMARY BENEFIT ANALYSIS BY USER
(BILLIONS OF 1972 DOLLARS)

	SHUTTLE SYSTEM CASE	EXP. SYSTEM CASE	BENEFITS
OSS	15.26	21.64	6.38
OA	4.88	6.79	1.91
OMSF	.92	1.80	.88
OAST	1.06	2.01	.95
NASA TOTAL	(22.12)	(32.24)	(10.12)
U. S. GOVERNMENT	1.99	2.65	.66
DOMESTIC COMMER.	2.54	3.13	.59
FOREIGN	1.93	4.19	2.26
NON-NASA TOTAL	(6.46)	(9.97)	(3.51)
DOD	11.71	15.46	3.75
L/V RANGE SUPPORT	.19	1.86	1.67
TOTAL	40.48	59.53	19.05
NON-RECURRING INVESTMENT	8.89	3.94	-4.95
GRAND TOTAL	49.37	63.47	14.10

performed by current Expendable vehicles. The preparation of an analysis of this type involves a comprehensive assessment of many interrelated parameters and economic considerations including investment and operations costs, vehicle performance, reliability, and the impact of payload servicing, maintenance, and reusability.

In assessing the economic merits of the competing systems, it is necessary to establish the effect of the timing as well as the magnitude of the costs. This is accomplished through applying present value techniques to the life cycle cost streams of the competing systems.

The Mathematica Corporation applied an infinite investment horizon in the present value calculations for their study which postulated that some form of transportation system will always be required in space, and future systems will benefit from the technology developed for the present system. Since a new system will be introduced only when it demonstrates an economic advantage over the system in use, the value of technological improvement itself is enduring and does not diminish or depreciate in time as does the mechanical device that represents its implementation.

As previously reported, the results of The October 1973 NASA Mission Model Cost and Economic Analysis indicate a net benefit of \$14.1 billion over 12 years in absolute dollars (undiscounted) in favor of the Shuttle over the Expendable system. Figure 2 illustrates the effect of applying various social discount rates to the life cycle net benefit streams of the competing systems. At a 10-percent discount rate, the Shuttle retains a significant advantage over the Expendable in terms of net present value. The averages increases markedly as the discount rate decreases. It should be observed that some economic analysts consider the 10-percent discount rate a conservative criterion to apply to public investment projects of this type and argue in favor of a 5- to 7.5-percent rate as more realistic for analysis in constant year dollars.

Another economic test applied to this analysis was the calculation of the internal rate of return obtained by the Shuttle investment relative to the Expendable. The results of this analysis show an internal rate of return of about 19 percent for the Shuttle system.

As shown in Figure 3, sensitivity analyses have been made of the allowable non-recurring costs of the Shuttle under various conditions. Shuttle non-recurring costs include DDT&E, investment, and facilities. The allowable non-recurring cost of the Shuttle is the maximum cost that could be incurred at a specified rate of return (for example, 10 percent). In the 1973 Mission

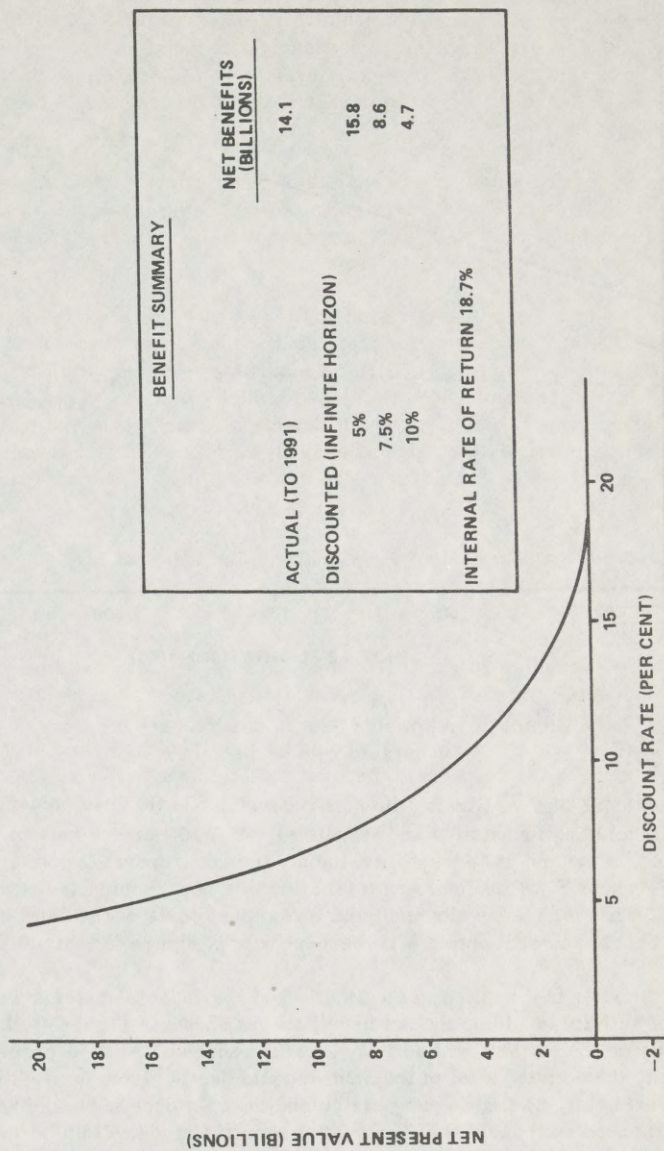


Figure 2. Discounted benefits (1972 dollars, 1972 base year).

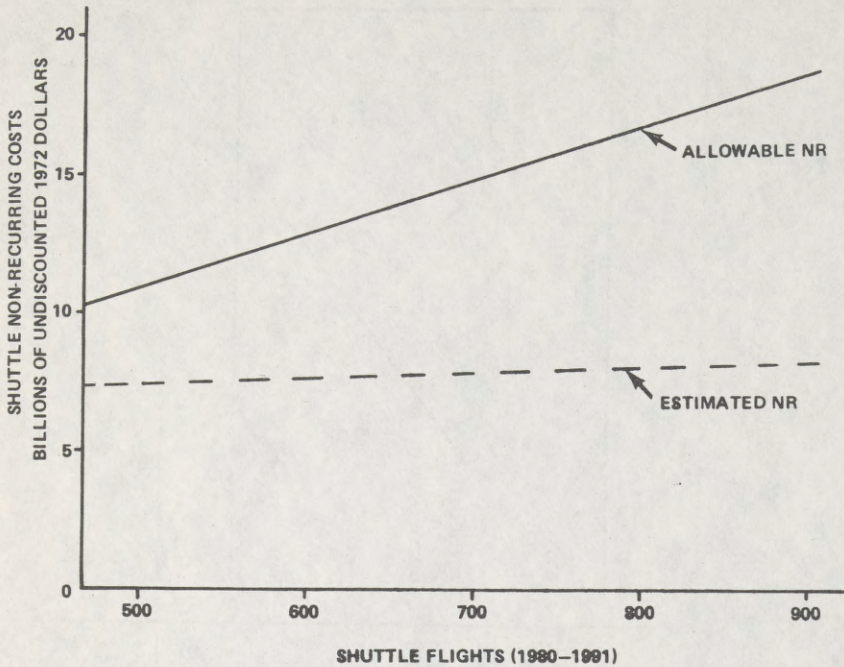


Figure 3. Allowable Shuttle non-recurring costs (10-percent rate of discount).

Model with 725 Shuttle flights, the non-recurring Shuttle development cost is \$7.8 billion (including investment and facilities). If a 10-percent rate of return is specified on the non-recurring investment, the non-recurring cost growth would be about \$7.4 billion for a total allowable non-recurring cost of \$15.2 billion. That is, the development and investment costs of the Shuttle could nearly double and still obtain a 10-percent rate of return for this mission model.

Another test applied to the Shuttle and Expendable systems was the effect of flight activity levels on the net benefits. As shown in Figure 4, the net benefits will decline as the flight activity level is reduced. At a 10-percent rate of discount, the activity level of the Shuttle could decline from 60 flights per year to approximately 24 flights per year before the cost benefit breakeven point is reached (zero net benefits). Thus, at an annual flight level 60 percent below the 1973 Mission Model, the Shuttle would remain a sound investment with a 10-percent rate of return.

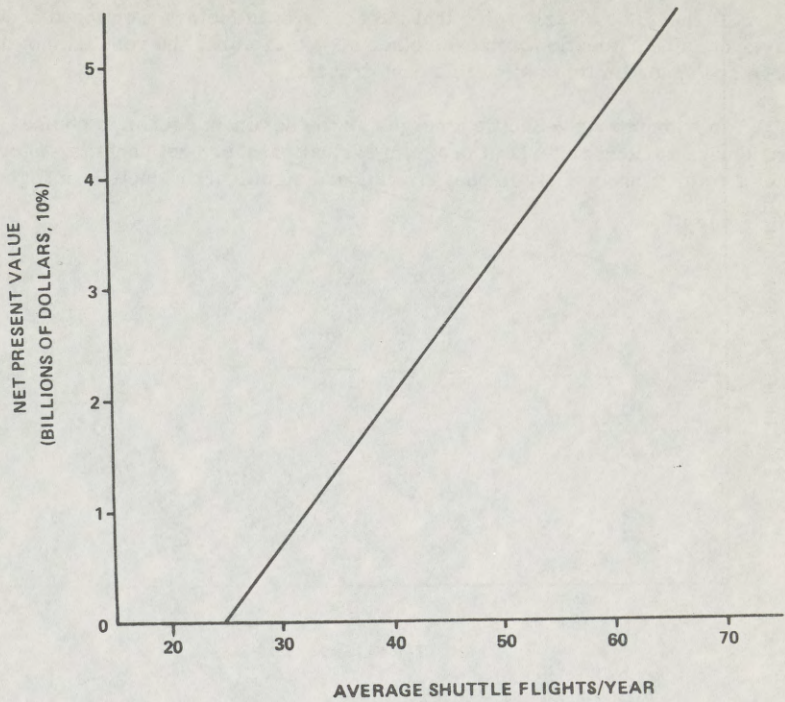


Figure 4. Net present value versus Shuttle flights (10-percent rate of discount).

The procedure for adjusting the flight activity levels in the mission model is to first divide program costs into fixed and variable components. Fixed costs are those costs that are independent of variations in the activity level. Variable costs are those costs that would vary with the flight activity level. A roughly linear relationship is found to exist between changes in variable program costs and flights. For example, as the Shuttle flight levels are reduced by a given percentage, variable program costs would be reduced by the same percentage.

Another economic sensitivity analysis performed on this model established the allowable increase in the cost per flight of the Space Shuttle. A 10-percent rate of return could still be achieved if the cost per flight were to grow from \$9.8 million to between \$20 to \$25 million. Of course, this assumes that the increases are limited to the cost per flight only.

It should be clearly noted that the cost growth factors mentioned above may occur in combination with each other and, therefore, the results shown above are upper limits to allowable cost growth.

In summary, the Shuttle emerges as the dominant economic choice considering various criteria of program evaluation; i.e., net benefits, internal rate of return, uncertainty in cost growth, and significant reduction in flight rates.

APPENDIX A - 1973 MISSION MODEL SUMMARY COST COMPARISON
FOR EACH MISSION MODEL PAYLOAD^a

VEHICLE & PAYLOAD COMPARISON					PROGRAM COST COMPARISON (1972 \$ IN MILLIONS)										BENEFITS	
EXPENDABLE CASE (BEST MIX P/L)					SHUTTLE SYSTEM CASE					EXPENDABLE CASE (BEST MIX P/L)					SHUTTLE SYSTEM CASE	
NO.	TYPE	NO.	NO.	NO.	NO.	NO.	NO.	NO.	NO.	NO.	NO.	NO.	NO.	NO.	NO.	NO.
FLTS.	L/V	P/L	FLTS.	NEW	REF.	CODE NO.	NAME	P/L TOTAL	L/V TOTAL	PROG. TOTAL	P/L TOTAL	L/V TOTAL	PROG. TOTAL	P/L TOTAL	L/V TOTAL	PROG. TOTAL
NASA ASTRONOMY																
12.0	TAT3	12	6.1	3	9	AST-1A	EXPLORER-LO	272	111	383	203	69	272	272	69	111
4.0	TAT3	4	3.1	2	2	AST-1B	EXPLORER-SYNC	84	36	120	67	38	105	105	38	15
6.0	T3B/A	6	2.9	0	6	AST-3	SOLAR PHYSICS	446	72	518	298	31	329	329	31	189
1.0	T3B/A	1	.5	0	1	AST-4	HEAO C	42	11	53	12	5	17	17	5	36
5.0	T3D	5	3.0	3	6	AST-5	HEAO D&E	849	60	909	536	32	568	568	32	341
6.0	T3D/B2	6	3.9	2	10	AST-6	LST	1190	76	1266	688	41	729	729	41	537
4.0	T3D7	4	3.3	2	5	AST-7	LSO	688	47	735	418	34	452	452	34	283
4.0	T3C	4	2.6	2	2	AST-8	LRO	194	64	258	116	30	146	146	30	112
3.0	T3D	3	1.4	2	2	AST-9A	F. X-RAY TELE	348	31	379	235	15	250	250	15	129
2.0	T3D7	2	2.6	2	1	AST-9B	F. X-RAY TELE	469	25	494	292	27	319	319	27	165
27.0	EXP L/V	27	30.1	8	25	AST-10	STELLAR SORTIE	2697	375	3072	849	315	1164	1164	315	1908
6.0	T3C	6	23.1	4	21	AST-11	SOLAR SORTIE	881	102	983	493	241	734	734	241	249
80.0		80	82.6	30	90		SUBTOTAL	8150	1010	9160	4207	878	5085	5085	878	4075
NASA SPACE PHYSICS																
6.0	TAT3	6	4.2	2	4	PHY-1A	EXPLORER-UPPER	198	59	257	145	47	192	192	47	65
6.0	TAT3/TE	6	3.3	2	4	PHY-1B	EXPLORER-MED	134	54	188	92	38	130	130	38	58
6.0	T3B/A	6	5.0	6	0	PHY-1C	EXPLORER-HI	384	75	459	337	61	398	398	61	61
2.0	TAT9	2	2.0	2	0	PHY-2A	GRAV/REL.	192	25	217	187	20	207	207	20	10
2.0	T3D/C	2	2.0	2	0	PHY-2B	GRAV/REL.	144	34	178	144	23	167	167	23	11
2.0	T3C	2	1.5	1	1	PHY-3A	ENVIR. PERT	261	30	291	228	18	246	246	18	45
2.0	T3D/C	2	3.0	1	1	PHY-3B	ENVIR. PERT	248	34	282	181	35	216	216	35	66

a. Payload cost estimates based on parametric techniques, do not represent NASA budget estimates for specific projects.

APPENDIX A — 1973 MISSION MODEL SUMMARY COST COMPARISON
FOR EACH MISSION MODEL PAYLOAD⁴ (Continued)

VEHICLE & PAYLOAD COMPARISON						PROGRAM COST COMPARISON (1972 \$ IN MILLIONS)													
EXPENDABLE CASE (BEST MIX P/L)				SHUTTLE SYSTEM CASE		EXPENDABLE CASE (BEST MIX P/L)										SHUTTLE SYSTEM CASE		BENEFITS	
NO.	TYPE	NO.	P/L	NO.	FLTS.	NO P/L	NEW	REF.	CODE NO.	NAME	P/L TOTAL	L/V TOTAL	PROG. TOTAL	P/L TOTAL	L/V TOTAL	PROG. TOTAL			
NASA SPACE PHYSICS (CONT'D)																			
1.0	T3D7/C/B2	1		1.0	1	0	PHY-4		PHY-4	HELIOCENTRIC & INT.	108	19	127	112	12	124	3		
3.0	T3D7/C	3		1.8	2	3	PHY-5		PHY-5	COSMIC RAY LAB.	821	71	892	438	19	457	436		
4.0	T3D7	4		25.0	4	18	PHY-6		PHY-6	HIGH ENERGY SORTIE	539	53	592	381	282	643	-51		
17.0	EXP. L/V	17		30.0	5	25	PHY-7		PHY-7	ATMOS. & SPACE PHY. SORTIE	1879	173	2062	499	313	812	1240		
51.0		51		78.8	28	56				SUBTOTAL	4808	627	5535	2744	848	3592	1843		
NASA PLANETARY																			
2.0	T3D7/C	2		2.0	2	0	PL-7		PL-7	MARS SURF. SAMPLE	581	36	617	558	23	581	36		
2.0	T3D7/C	2		4.0	2	0	PL-8		PL-8	MARS SAT SAMPLE	341	34	375	289	44	333	42		
5.0	T3D7/C/B2	5		3.5	5	0	PL-10		PL-10	INNERPLANETARY F/O	355	99	454	340	49	389	65		
2.0	T3D7/C	2		2.0	2	0	PL-11		PL-11	VENUS RADAR MAPPER	440	42	482	412	48	480	22		
2.0	T3D7/C/B2	2		4.0	2	0	PL-12		PL-12	VENUS BOUY. STATION	515	38	553	473	46	519	34		
2.0	T3D7/C	2		2.7	2	0	PL-13		PL-13	MERCURY ORB.	260	34	314	266	31	287	17		
2.0	T3D7/C	2		2.0	2	0	PL-14		PL-14	VENUS LARGE LANDER	191	34	225	180	23	203	22		
1.0	T3D7/C/B2	1		1.0	1	0	PL-17		PL-17	PIONEER SAT PROBE	143	19	162	143	20	183	-1		
1.0	T3D7/C/B2	1		0.5	1	0	PL-18		PL-18	PIONEER SAT/URAN.	139	19	158	139	16	155	3		
2.0	T3D7/C	2		2.0	2	0	PL-19		PL-19	MARINER JUP. ORB.	481	49	530	463	51	514	16		
2.0	T3D7/C/B2	2		2.0	2	0	PL-20		PL-20	PIONEER JUP. PROB.	178	38	216	185	23	208	8		
2.0	T3D7/C/B2	2		4.0	2	0	PL-21		PL-21	MARINER SAT. ORB.	335	38	373	299	64	363	10		
2.0	T3D7/C/B2	2		4.0	2	0	PL-22		PL-22	MARINER URAN PROBE.	333	38	371	333	66	399	-28		
2.0	T3D7/C/B2	2		4.0	2	0	PL-23		PL-23	JUP SATELLITE ORB.	552	38	590	495	64	559	31		
2.0	T3D7/C	2		2.0	2	0	PL-26		PL-26	COMET ENCKE REND.	130	34	164	130	38	168	-4		

a. Payload cost estimates based on parametric techniques, do not represent NASA budget estimates for specific projects.

APPENDIX A — 1973 MISSION MODEL SUMMARY COST COMPARISON
FOR EACH MISSION MODEL PAYLOAD^a (Continued)

VEHICLE & PAYLOAD COMPARISON										PROGRAM COST COMPARISON (1972 \$ IN MILLIONS)												
EXPENDABLE CASE (BEST MIX P/L)					SHUTTLE SYSTEM CASE					EXPENDABLE CASE (BEST MIX P/L)				SHUTTLE SYSTEM CASE				BENEFITS				
NO.	FLTS.	TYPE	NO.	P/L	NO.	FLTS.	NO P/L	NEW	REF.	CODE NO.	MISSIONS NAME	P/L TOTAL	L/V TOTAL	PROG. TOTAL	P/L TOTAL	L/V TOTAL	PROG. TOTAL	P/L TOTAL	L/V TOTAL	PROG. TOTAL		
NASA PLANETARY (CONT'D)																						
1.0		T3D7/C/B2	1		0.5		1	0		PL-27	COMET HALLEY F/B	51	19	70	50	6	56				14	
2.0		T3D/C	2		2.0		2	0		PL-28	ASTEROID REND.	72	34	106	69	23	92				14	
34.0			34		42.2		34	0			SUBTOTAL	5117	643	5760	4824	635	5459				301	
LUNAR																						
2.0		T3B/C	2		1.0		2	0		LUN-2	AUTO. LUNAR ORB.	217	24	241	208	13	221				20	
2.0		T3D/C	2		2.0		2	0		LUN-3	AUTO. LUNAR ROVER	318	34	352	318	23	341				11	
1.0		T3C	1		0.5		1	0		LUN-4	HALO SAT.	182	15	197	167	6	173				24	
2.0		T3D/C	2		2.0		2	0		LUN-5	LUNAR SAMPLE RETURN	364	34	388	364	23	387				11	
7.0			7		5.5		7	0			SUBTOTAL	1081	107	1188	1057	65	1122				66	
LIFE SCIENCE																						
12.0		TAT3	24		11.8		2	22		LS-1	LIFE SCIENCE MODULE	297	111	408	144	134	278				130	
17.0		RAM	17		28.0		2	26		LS-2	LIFE SCIENCE SORTIES	805	781	1386	356	292	648				738	
29.0			41		39.8		4	48			SUBTOTAL	902	882	1794	500	426	926				868	
NASA EARTH OBSERVATIONS																						
3.0		T3B/C	3		2.4		1	3		EO-3A	EARTH OBS SAT - A	391	47	438	349	25	374				64	
4.0		T3B/C	4		1.6		1	2		EO-3B	EARTH OBS SAT - B	394	51	445	258	17	275				170	
4.0		T3B/C	4		3.1		2	3		EO-3C	EARTH OBS SAT - C	439	54	493	318	42	360				133	
1.0		T3B/C	1		0.3		1	0		EO-3D	EARTH OBS SAT - D	137	13	150	75	3	78				72	
2.0		T3D/C	3		1.6		3	0		EO-4A	SEOS R&D.	227	38	265	245	19	264				1	
5.5		T3D/C	6		1.5		6	0		EO-4B	SEOS OPERATIONAL	217	95	312	256	17	273				39	

a. Payload cost estimates based on parametric techniques, do not represent NASA budget estimates for specific projects

APPENDIX A - 1973 MISSION MODEL SUMMARY COST COMPARISON
FOR EACH MISSION MODEL PAYLOAD^a (Continued)

VEHICLE & PAYLOAD COMPARISON										PROGRAM COST COMPARISON (1972 \$ IN MILLIONS)										
EXPENDABLE CASE (BEST MIX P/L)					SHUTTLE SYSTEM CASE					EXPENDABLE CASE (BEST MIX P/L)					SHUTTLE SYSTEM CASE					BENEFITS
NO.	FLTS.	TYPE	NO.	P/L	NO.	FLTS.	NO P/L	NEW	REF.	CODE NO.	MISSIONS NAME	P/L TOTAL	L/V TOTAL	PROG. TOTAL	P/L TOTAL	L/V TOTAL	PROG. TOTAL	TOTAL		
NASA EARTH OBSERVATIONS (CONT'D)																				
11.0		EXP L/V	14	7.1		14	0			EO-5	SPECIAL "PURP" SAT	181	120	301	163	77	240	61		
2.0		TAT9	2	1.6		2	0			EO-6	TIROS N-P	185	30	215	220	17	237	-22		
0.5		T3D/C	1	0.3		1	0			EO-7	SYNC. MET. SAT	61	9	70	47	3	50	20		
12.0		T3D/C	12	5.0		6	6			OA-1EO	EARTH OBS SORTIE	830	164	794	145	52	395	399		
**		RAM	**	5.0		1	11			OA-12G	CLOUD PHYSICS SORTIE	123	211	334	78	52	78	256		
45.0			50	29.5		38	25				SUBTOTAL	2985	832	3817	2154	324	2634	1193		
EARTH AND OCEAN PHYSICS																				
1.0		TAT9/TE	1	1.0		1	0			EO-3	SEASAT-8	214	18	232	203	10	213	19		
1.0		T3C	1	1.0		1	0			EO-4	GEOPAUSE	153	27	180	153	28	181	-1		
1.0		T3D	1	1.0		1	0			EO-5	GRAV. GRAD.	216	10	226	216	12	228	-2		
12.0		SC7	12	6.1		2	0			EO-6	MINI-LAGEOS	6	40	46	6	39	45	1		
6.0		TAT3	9	5.5		3	6			EO-8	VECTOR MAG.	137	59	196	91	57	148	48		
3.0		TAT3	3	1.7		1	2			EO-9	MAG. MON. SAT.	83	26	109	72	20	92	17		
12.0		EXP L/V	12	70.0		12	12			OA-1EP	EARTH & OCEAN PHY. SORTIE	722	155	877	290	104	290	587		
36.0			39	26.3		21	20				SUBTOTAL	1531	335	1866	1031	270	1197	669		
COMMUNICATION & NAVIGATION																				
6.0		T3B/A	6	4.0		5	6			OA-1CN	COMM/NAV. SORTIE	492	72	564	187	42	187	377		
6.0			6	4.0		5	6				SUBTOTAL	492	72	564	187	42	187	377		

a. Payload cost estimates based on parametric techniques, do not represent NASA budget estimates for specific projects.

APPENDIX A — 1973 MISSION MODEL SUMMARY COST COMPARISON
FOR EACH MISSION MODEL PAYLOAD^a (Continued)

VEHICLE & PAYLOAD COMPARISON										PROGRAM COST COMPARISON (1972 \$ IN MILLIONS)												
EXPENDABLE CASE (BEST MIX P/L)					SHUTTLE SYSTEM CASE					EXPENDABLE CASE (BEST MIX P/L)					SHUTTLE SYSTEM CASE					BENEFITS		
NO.	FLTS.	TYPE	NO.	P/L	NO.	FLTS.	NO P/L	REF.	CODE NUMBER	MISSIONS		P/L	TOTAL	L/V	TOTAL	P/L	TOTAL	L/V	TOTAL		PROG.	TOTAL
		L/V					NEW			NAME												
SPACE PROCESSING																						
18.0		RAM	18		49.5	2	41		SP-1	SPACE PROC. SORTIE	323		218		541		350		518		868	
18.0			18		49.5	2	41			SUBTOTAL	323		218		541		350		518		868	
SPACE TECHNOLOGY																						
6.0		T3D	6		7.8	1	5		ST-1	LDEF	6		70		76		6		83		89	
17.0		RAM	17		46.0	4	42		ST-2	SPACE TECH. SORTIE	1144		791		1935		491		480		971	
23.0			23		53.8	5	47			SUBTOTAL	1150		861		2011		497		583		1060	
329.0			349		412.0	174	333			NASA TOTAL	26639		5597		32236		17551		4589		22120	
NON-NASA																						
6.0		T3B/A	6		2.5	6	0		NN/D-2C	TDRS	167		72		239		150		31		181	
9.0		T3D/C	19		14.9	12	7		NN/D-1	INTELSAT	611		158		769		474		183		657	
3.0		T3D/C	6		3.0	6	0		NN/D-2A	U. S. DOMSAT A	44		52		96		52		39		91	
10.5		T3D/C	14		5.2	14	0		NN/D-2B	U. S. DOMSAT B	557		202		759		516		61		577	
2.0		T3D/C	4		2.2	3	1		NN/D-3	DISASTER WARNING	103		34		137		88		26		124	
4.0		T3D/C	10		4.2	10	0		NN/D-4	TRAFFIC MGMT	158		75		233		154		56		210	
4.2		T3D/C	11		7.2	3	8		NN/D-5	FOREIGN COMSAT	165		77		242		114		84		198	
3.0		T3D/C	3		1.3	3	0		NN/D-6	COMM. R & D	564		58		622		513		16		529	
9.0		TAT3	9		8.0	3	6		NN/D-8	ENVIR. MONT. SAT.	271		95		386		170		90		260	
2.0		T3D/C	6		3.8	2	4		NN/D-9	FOREIGN SYNC	166		39		205		120		44		164	
4.5		T3D/C	8		5.6	3	5		NN/D-10	GEOSYNCH OPS SAT	170		86		256		153		65		218	
12.0		T3B/C	12		8.8	3	9		NN/D-11	EARTH RES. SAT. A	1097		164		1261		798		116		914	
1.5		T3D/C	4		1.7	4	0		NN/D-12	EARTH RES. SAT. B	277		34		311		251		20		271	

^a Payload cost estimates based on parametric techniques, do not represent NASA budget estimates for specific projects.

APPENDIX A — 1973 MISSION, MODEL, SUMMARY COST COMPARISON
FOR EACH MISSION, MODEL, PAYLOAD^a (Concluded)

VEHICLE & PAYLOAD COMPARISON										PROGRAM COST COMPARISON (1972 \$ IN MILLIONS)										
EXPENDABLE CASE (BEST MIX P/L)					SHUTTLE SYSTEM CASE					EXPENDABLE CASE (BEST MIX P/L)					SHUTTLE SYSTEM CASE					BENEFITS
NO.	FLTS.	TYPE	NO.	P/L	NO.	FLTS.	NO	P/L	REF.	CODE NO.	MISSIONS NAME	P/L TOTAL	L/V TOTAL	PROG. TOTAL	P/L TOTAL	L/V TOTAL	PROG. TOTAL	TOTAL		
NON-NASA (CONT'D)																				
1.3		T3D/C	4		2.0		4		0	NN/D-13	FOREIGN SEOS	227	24	251	206	23	229	22		
9.0		T3B/A	9		3.3		6		3	NN/D-14	GLOBAL EARTH & OCEAN	351	101	452	288	36	324	128		
**		RAM	**		10.1		2		8	NN/D-15	U.S. DOMM SPACE PROC - SORTIE	61	217	278	68	106	174	104		
18.0		EXPL/V + RAM	18		12.0		6		6	NN/D-16A	FOREIGN APPL. - SORTIE	1605	486	2090	536	125	661	1428		
**		RAM	**		17.0		5		12	NN/D-16C	FOREIGN GPL - SORTIE	56	80	136	42	178	220	- 84		
12.0		EXPL/V	12		9.2		2		9	NN/D-16B	FOREIGN SCIENCE - SORTIE	1106	160	1266	365	97	462	804		
111.0			155		122.0		97		78		NON-NASA TOTAL	7756	2213	9969	5068	1396	6464	3606		
DOD																				
231.0			303		271.0		171		133		DOD TOTAL	11905	3550	15464	9028	2679	11705	3756		
671.0			807		805.0		442		544		SUBTOTAL	46300	11369	57669	31645	8644	40289	17380		
14.0		EXP L/V	14		-		-		-		SPACE STATION & SPACE STATION LOGISTICS	***	***	***	-	-	-	-		
-		-	-		-		-		-		EXP. L/V BASE SUPP	-	1860	1860	-	187	187	1673		
685.0			821		805.0		442		544		NASA, NON-NASA, DOD TOTAL	46300	13229	59529	31645	8831	40476	19053		
										*INCLUDES 80 EXPENDABLE LAUNCH VEHICLES										
										**SHARED WITH NASA PROCESSING										
										***INCLUDED IN NON RECURRING INVESTMENT COSTS										

a. Payload cost estimates based on parametric techniques, do not represent NASA budget estimates for specific projects.

APPENDIX B — 1973 MISSION MODEL PAYLOAD AND TRANSPORTATION COST — SHUTTLE CASE

TOTALS (MILLIONS OF 1972 DOLLARS)

	72	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	TOTAL
U.S.																		
PAYLOAD	0	67	244	549	740	787	750	888	1144	1188	1114	1004	865	719	841	992	960	12832
TRANS.	0	0	0	17	57	99	140	87	157	225	286	275	208	182	198	247	248	2426
TOTAL	0	67	244	566	797	886	890	975	1301	1413	1400	1279	1073	901	1039	1239	1208	15258
U.A.																		
PAYLOAD	0	26	98	191	367	428	502	223	156	168	230	240	177	164	201	338	407	3722
TRANS.	0	0	0	12	37	66	104	86	103	91	105	100	105	76	82	84	83	1154
TOTAL	0	26	98	203	404	514	606	312	259	259	335	340	282	240	283	422	490	4876
UMSF																		
PAYLOAD	0	2	9	36	37	49	24	23	31	35	41	36	35	39	36	38	43	500
TRANS.	0	0	0	0	0	31	36	27	29	32	33	34	30	43	43	42	40	426
TOTAL	0	2	9	36	37	80	60	50	60	67	74	70	65	82	79	80	89	926
UAST																		
PAYLOAD	0	5	21	35	53	68	24	22	45	38	22	21	46	38	22	21	46	497
TRANS.	0	0	0	3	6	24	53	48	42	48	42	57	42	57	42	57	42	563
TOTAL	0	5	21	38	59	92	77	70	87	86	64	78	88	95	64	78	88	1060
NASA TOT																		
PAYLOAD	0	100	372	811	1197	1202	1100	1168	1376	1429	1407	1301	1123	960	1100	1389	1456	17551
TRANS.	0	0	0	32	100	240	333	248	331	396	466	466	385	358	363	430	419	4569
TOTAL	0	108	372	843	1297	1502	1433	1416	1707	1825	1873	1767	1508	1318	1463	1819	1875	22120

APPENDIX B - 1973 MISSION MODEL PAYLOAD AND TRANSPORTATION COST - SHUTTLE CASE (Continued)

TOTALS (MILLIONS OF 1972 DOLLARS) (Concluded)

	72	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	TOTAL
NASA TOTAL																		
PAYLOAD	0	100	372	811	1197	1202	1100	1168	1376	1429	1407	1301	1123	960	1100	1389	1456	17551
TRANS.	0	0	0	32	100	240	933	246	331	396	466	466	385	358	365	430	419	4569
TOTAL	0	100	372	843	1297	1502	1433	1416	1707	1825	1873	1767	1508	1318	1465	1819	1875	22120
NON NASA																		
PAYLOAD	0	26	61	166	303	318	279	312	382	386	386	406	480	443	419	370	324	5088
TRANS.	0	0	0	19	51	57	201	84	108	113	97	108	104	160	117	161	107	1396
TOTAL	0	26	61	185	354	385	380	402	490	499	483	514	584	603	536	531	431	6484
DOD																		
PAYLOAD	0	0	27	352	698	814	812	789	769	721	538	467	435	451	523	724	850	9026
TRANS.	0	0	0	52	134	152	133	172	251	271	224	192	224	219	193	218	204	2679
TOTAL	0	0	27	404	832	1066	945	961	1020	992	762	659	659	670	716	942	1054	11705
GRAND TOTAL																		
PAYLOAD	0	126	460	1329	2198	2424	2191	2272	2527	2536	2331	2174	2038	1854	2042	2483	2830	31643
TRANS.	0	0	0	103	285	459	267	509	690	780	787	766	713	737	675	89	738	8644
TOTAL	0	126	460	1432	2483	2953	2458	2779	3217	3316	3118	2940	2751	2591	2717	3292	3360	40289
L/V RANGE SUPPORT																		
TOTAL	0	0	0	0	0	56	51	12	0	0	0	0	0	0	0	0	0	166
NON-RECURRING INVESTMENT																		
TOTAL	1909	1288	1491	1509	1060	1046	520	80	64	51	29	7	12	20	6	0	0	8892
GRAND TOTAL																		
TOTAL	1909	1414	1951	2941	3543	4055	3129	2874	3281	3367	3147	2947	2763	2611	2723	3292	3360	49347

APPENDIX B — 1973 MISSION MODEL PAYLOAD AND TRANSPORTATION COST — SHUTTLE CASE (Continued)

AUTOMATED PAYLOAD COSTS (MILLIONS OF 1972 DOLLARS)

	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	TOTAL
USS																		
PAYLOAD	0	47	187	439	587	616	637	775	966	971	882	794	700	580	713	870	845	10610
TRANS.	0	0	0	17	57	79	88	31	74	118	160	149	104	59	86	138	135	1295
TOTAL	0	47	187	456	644	695	725	807	1040	1089	1042	943	804	639	799	1008	980	11905
UA																		
PAYLOAD	0	12	44	112	266	303	430	169	92	103	164	174	110	97	132	269	338	2672
TRANS.	0	0	0	12	37	55	51	29	27	17	34	31	37	8	16	22	19	386
TOTAL	0	12	44	124	303	418	481	189	119	120	198	205	147	105	148	291	357	3058
UMSF																		
PAYLOAD	0	0	0	17	13	10	8	14	8	8	12	8	8	12	8	8	12	144
TRANS.	0	0	0	0	0	10	15	6	9	11	12	13	9	12	11	11	15	134
TOTAL	0	0	0	17	13	20	23	19	17	19	24	21	17	24	19	19	27	278
UAST																		
PAYLOAD	0	0	0	0	0	0	1	0	1	0	1	0	1	0	1	0	1	6
TRANS.	0	0	0	3	6	3	11	7	0	6	0	16	0	15	0	16	0	83
TOTAL	0	0	0	3	6	3	12	7	1	6	1	16	1	15	1	16	1	89
NASA TOTAL																		
PAYLOAD	0	59	231	568	866	959	876	954	1067	1082	1059	976	819	689	854	1147	1198	13432
TRANS.	0	0	0	32	100	157	165	64	110	152	206	209	150	94	113	187	169	1898
TOTAL	0	59	231	600	966	1136	1041	1018	1177	1234	1265	1185	969	783	967	1334	1365	15330

APPENDIX B - 1973 MISSION MODEL PAYLOAD AND TRANSPORTATION COST - SHUTTLE CASE (Continued)

AUTOMATED PAYLOAD COSTS (MILLIONS OF 1972 DOLLARS) (Concluded)

	72	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	TOTAL
NASA TOTAL																		
PAYLOAD	0	59	231	568	866	989	876	954	1067	1082	1059	976	819	689	854	1147	1196	13432
TRANS.	0	0	0	32	100	147	165	66	110	152	206	209	150	94	113	187	169	1898
TOTAL	0	59	231	600	966	1136	1041	1018	1177	1234	1265	1185	969	783	967	1334	1365	15330
NON NASA																		
PAYLOAD	0	13	23	112	226	224	218	260	305	305	300	327	404	380	358	319	263	4057
TRANS.	0	0	0	19	51	47	69	54	66	83	47	59	52	115	74	114	52	890
TOTAL	0	13	23	131	277	301	287	314	371	388	347	386	456	495	432	413	315	4947
DDU																		
PAYLOAD	0	0	27	352	698	814	812	789	769	721	538	467	435	451	523	724	850	9026
TRANS.	0	0	0	52	134	172	133	174	251	271	224	192	224	219	193	218	204	2579
TOTAL	0	0	27	404	832	1066	945	957	1020	992	762	659	659	670	715	942	1054	11705
GRAND TOTAL																		
PAYLOAD	0	72	281	1032	1790	2117	1906	1999	2141	2108	1897	1770	1658	1520	1735	2180	2109	26515
TRANS.	0	0	0	184	588	784	687	880	1127	1184	977	848	838	824	808	899	829	9987
TOTAL	0	72	281	1216	2378	2901	2593	2879	3268	3292	2874	2618	2496	2344	2543	3079	2938	36502

APPENDIX B — 1973 MISSION MODEL PAYLOAD AND TRANSPORTATION COST — SHUTTLE CASE (Concluded)

SORTIE COSTS (MILLIONS OF 1972 DOLLARS)

	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	TOTAL
USS																		
PAYLOAD	0	20	57	110	153	121	113	112	178	217	232	210	165	139	128	122	115	2222
TRANS.	0	0	0	0	0	40	52	59	83	107	126	126	104	123	112	119	113	1131
TOTAL	0	20	57	110	153	161	165	169	261	324	358	336	269	262	240	231	228	3353
UA																		
PAYLOAD	0	14	54	79	101	95	72	65	64	65	66	66	67	67	69	69	69	1050
TRANS.	0	0	0	0	0	31	53	65	76	74	71	69	68	68	66	62	64	768
TOTAL	0	14	54	79	101	126	125	129	140	139	137	135	135	135	135	131	133	1818
UMSF																		
PAYLOAD	0	2	9	19	24	19	16	17	25	27	29	28	27	27	28	30	31	356
TRANS.	0	0	0	0	0	41	21	21	20	21	21	21	21	31	32	31	31	292
TOTAL	0	2	9	19	24	60	37	38	45	48	50	49	48	58	60	61	62	648
UAST																		
PAYLOAD	0	5	21	35	53	38	23	22	44	38	21	21	45	38	21	21	45	491
TRANS.	0	0	0	0	0	41	42	41	42	42	42	41	42	42	42	41	42	480
TOTAL	0	5	21	35	53	79	65	63	86	80	63	62	87	80	63	62	87	971
NASA TOTAL																		
PAYLOAD	0	41	141	243	331	273	224	214	309	347	348	325	304	271	246	242	260	4119
TRANS.	0	0	0	0	0	13	168	184	221	244	260	257	235	264	252	243	250	2671
TOTAL	0	41	141	243	331	286	392	398	530	591	608	582	539	535	498	485	510	6790
NUN NASA																		
PAYLOAD	0	13	38	54	77	64	61	57	77	81	86	79	76	63	61	61	61	1011
TRANS.	0	0	0	0	0	40	32	31	42	30	50	49	52	45	43	57	55	506
TOTAL	0	13	38	54	77	104	93	88	119	111	136	128	128	108	104	118	116	1517
UNAND TOTAL																		
PAYLOAD	0	54	179	297	408	337	285	274	386	428	434	404	380	334	307	313	321	5130
TRANS.	0	0	0	0	0	113	200	213	263	274	310	306	287	309	295	310	305	3177
TOTAL	0	54	179	297	408	450	485	487	649	702	744	710	667	643	602	603	626	8307

APPENDIX C-1973 MISSION MODEL PAYLOAD AND TRANSPORTATION COST-EXPENDABLE CASE

TOTALS (MILLIONS OF 1972 DOLLARS)

	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	TOTAL
USS																		
PAYLOAD	0	51	213	556	891	1086	1159	1432	1788	1760	1609	1468	1356	1377	1585	1539	1386	19256
TRANS.	0	0	0	27	107	127	130	147	206	230	234	210	178	182	213	198	166	2387
TOTAL	0	51	213	583	998	1213	1289	1581	1994	1990	1843	1678	1534	1559	1798	1737	1552	21643
UA																		
PAYLOAD	0	18	92	279	462	604	421	368	302	323	348	327	303	289	311	4	9	5331
TRANS.	0	8	0	27	86	112	115	93	94	111	120	116	109	109	117	125	123	1457
TOTAL	0	18	92	306	548	716	536	461	396	434	468	443	412	398	428	534	600	6788
UMSF																		
PAYLOAD	0	4	16	51	58	26	49	51	60	67	75	67	64	70	67	70	77	902
TRANS.	0	0	0	9	34	37	62	63	68	73	79	75	76	75	76	80	85	892
TOTAL	0	4	16	60	92	63	111	114	128	140	154	142	140	145	143	150	162	1794
UAST																		
PAYLOAD	0	12	53	85	127	70	54	51	106	87	47	46	106	87	47	46	106	1150
TRANS.	0	0	0	9	34	43	59	57	64	71	75	72	72	72	73	76	88	861
TOTAL	0	12	53	94	161	113	113	110	170	158	122	118	178	159	120	122	188	2011
NASA TOT																		
PAYLOAD	0	85	374	971	1538	1836	1683	1900	2256	2237	2079	1908	1829	1823	2010	2064	2046	26639
TRANS.	0	0	0	72	261	349	366	364	432	485	508	473	435	438	479	479	456	5597
TOTAL	0	85	374	1043	1799	2185	2049	2264	2688	2722	2587	2381	2264	2261	2489	2543	2502	32236

APPENDIX C--1973 MISSION MODEL PAYLOAD AND TRANSPORTATION COST--EXPENDABLE CASE (Continued)

TOTALS (MILLIONS OF 1972 DOLLARS) (Concluded)

	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	TOTAL
NASA TOTAL																		
PAYLOAD	0	85	374	971	1534	1836	1883	1900	2256	2237	2079	1908	1829	1823	2010	2064	2046	26639
TRANS.	0	0	0	72	261	349	366	364	432	485	508	473	435	438	479	479	456	5597
TOTAL		85	374	1043	1799	2185	2249	2264	2688	2722	2587	2381	2264	2261	2489	2543	2502	32236
NON NASA																		
PAYLOAD	0	2	39	245	388	414	405	511	605	618	605	616	679	700	703	652	568	7756
TRANS.	0	0	0	33	93	130	154	163	168	182	185	183	205	200	188	170	157	2213
TOTAL	0	2	39	278	481	544	559	682	773	800	790	799	884	900	891	822	725	9969
DOU																		
PAYLOAD	0	0	28	361	671	942	881	933	1050	1024	849	774	762	756	838	986	1048	11905
TRANS.	0	0	0	45	120	253	270	314	320	302	275	286	289	280	278	258	272	3559
TOTAL	0	0	28	406	791	1195	1151	1246	1370	1326	1124	1060	1051	1036	1116	1244	1320	15464
GRAND TOTAL																		
PAYLOAD	0	87	441	1577	2597	3172	2969	3352	3911	3879	3533	3298	3270	3279	3551	372	3662	46300
TRANS.	0	0	0	150	474	732	790	840	920	969	968	942	929	918	945	97	885	11369
TOTAL	0	87	441	1727	3071	3904	3759	4192	4831	4848	4501	4240	4199	4197	4496	469	4547	57669
L/V RANGE SUPPORT																		
TOTAL	0	0	0	0	0	155	255	153	153	155	155	155	155	155	155	155	155	1860
NON-RECURRING INVESTMENT																		
TOTAL	133	382	628	688	533	346	403	212	228	165	73	61	57	51	51	57	69	3939
GRAND TOTAL																		
TOTAL	133	469	1069	2415	3604	4425	4117	4554	5214	5168	4729	4456	4411	4403	4702	4821	4771	63468

APPENDIX C-1973 MISSION MODEL PAYLOAD AND TRANSPORTATION COST-EXPENDABLE CASE (Continued)

AUTOMATED PAYLOAD COSTS (MILLIONS OF 1972 DOLLARS)

	72	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	TOTAL
USS																		
PAYLOAD	0	51	204	478	677	738	734	894	1162	1173	1032	975	947	939	1093	1147	1018	13260
TRANS.	0	0	0	24	94	128	96	104	145	162	165	141	121	120	135	133	117	1684
TOTAL	0	51	204	502	771	866	830	994	1307	1335	1197	1116	1068	1059	1229	1280	1135	14944
UA																		
PAYLOAD	0	12	41	113	261	476	475	219	151	143	175	186	162	147	167	233	310	3041
TRANS.	0	0	0	14	47	91	55	33	32	45	53	50	42	44	51	55	58	637
TOTAL	0	12	41	127	308	567	530	252	183	188	228	236	204	191	219	288	363	3678
UMSF																		
PAYLOAD	0	8	0	19	18	46	21	24	20	20	23	20	20	24	19	20	24	297
TRANS.	0	0	0	2	6	9	8	9	9	8	9	8	9	8	9	9	8	111
TOTAL	0	8	0	21	24	55	29	33	29	28	32	28	29	32	28	29	32	408
UAST																		
PAYLOAD	0	0	0	0	0	0	1	0	1	0	1	0	1	0	1	0	1	6
TRANS.	0	0	0	2	6	5	5	3	5	6	5	5	5	5	6	5	5	70
TOTAL	0	0	0	2	6	5	6	3	6	6	6	5	6	5	7	5	6	76
NASA TOTAL																		
PAYLOAD	0	63	245	610	956	1210	1031	1134	1334	1336	1231	1181	1130	1110	1280	1400	1353	16604
TRANS.	0	0	0	42	153	203	164	151	191	221	232	204	177	177	202	220	183	2502
TOTAL	0	63	245	652	1109	1413	1195	1285	1525	1557	1463	1385	1307	1287	1482	1620	1536	19106

APPENDIX C--1973 MISSION MODEL PAYLOAD AND TRANSPORTATION COST--EXPENDABLE CASE (Continued)

AUTOMATED PAYLOAD COSTS (MILLIONS OF 1972 DOLLARS) (Concluded)

	72	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91 TOTAL
NASA TOTAL																	
PAYLOAD	0	63	245	610	956	1210	1031	1139	1334	1336	1231	1181	1130	1110	1280	14	0 1353 16604
TRANS.	0	0	0	42	153	203	164	151	191	221	232	204	177	177	202	2	2 183 2502
TOTAL	0	63	245	652	1109	1413	1195	1284	1525	1557	1463	1385	1307	1287	1482	16	2 1536 19106
NON NASA																	
PAYLOAD	0	0	4	102	203	234	423	301	377	375	374	422	497	515	501	433	367 4928
TRANS.	0	0	0	19	59	81	84	88	89	97	97	105	129	125	117	98	88 1271
TOTAL	0	0	4	121	262	315	507	389	466	472	471	527	626	640	618	531	450 6199
DOU																	
PAYLOAD	0	0	28	361	671	942	881	932	1050	1024	849	774	762	756	833	986	1048 11905
TRANS.	0	0	0	45	120	233	270	311	320	302	275	286	289	280	278	258	272 3559
TOTAL	0	0	28	406	791	1175	1151	1245	1370	1326	1124	1060	1051	1036	1115	1244	1320 15464
GRAND TOTAL																	
PAYLOAD	0	63	277	1073	1830	4306	2135	2370	2761	2735	2454	2377	2389	2381	2619	2819	2768 33437
TRANS.	0	0	0	106	332	537	518	550	600	620	604	595	595	582	597	558	538 7132
TOTAL	0	63	277	1179	2162	4923	2653	2920	3361	3355	3058	2972	2984	2963	3215	3377	3306 40769

APPENDIX C-1973 MISSION MODEL PAYLOAD AND TRANSPORTATION COST-EXPENDABLE CASE(Concluded)

SORTIE EQUIVALENT COSTS (MILLIONS OF 1972 DOLLARS)

	72	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	TOTAL
USS																		
PAYLOAD	0	0	9	78	214	348	425	540	626	587	577	493	409	438	492	392	368	5996
TRANS,	0	0	0	3	13	49	34	41	61	68	69	69	57	62	77	65	49	703
TOTAL	0	0	9	81	227	377	459	581	687	655	646	562	466	500	569	457	417	6699
UA																		
PAYLOAD	0	6	51	166	201	128	146	147	151	180	173	141	141	142	144	176	162	2290
TRANS,	0	0	0	13	39	51	60	58	62	66	67	66	67	65	66	70	70	820
TOTAL	0	6	51	179	240	209	206	203	213	246	240	207	208	207	210	246	237	3110
UMSF																		
PAYLOAD	0	4	16	32	40	30	28	28	40	47	52	47	44	46	48	50	52	605
TRANS,	0	0	0	7	28	48	54	56	59	65	70	67	67	67	67	71	77	781
TOTAL	0	4	16	39	68	58	82	82	99	112	122	114	111	113	115	121	130	1386
UAST																		
PAYLOAD	0	12	53	85	127	30	53	51	102	87	46	46	105	87	45	46	105	1144
TRANS,	0	0	0	7	28	58	54	54	59	65	70	67	67	67	67	71	77	791
TOTAL	0	12	53	92	155	128	107	103	164	152	116	113	172	154	113	117	182	1935
NASA TOTAL																		
PAYLOAD	0	22	129	361	582	646	652	766	922	901	848	727	699	713	730	664	693	10035
TRANS,	0	0	0	30	108	146	202	213	241	264	276	269	258	261	277	277	273	3095
TOTAL	0	22	129	391	690	772	854	979	1163	1165	1124	996	957	974	1007	941	966	13130
NUN NASA																		
PAYLOAD	0	2	35	143	185	100	182	216	228	243	231	194	182	185	202	219	201	2828
TRANS,	0	0	0	14	34	49	70	77	79	85	88	78	76	75	71	72	74	942
TOTAL	0	2	35	157	219	229	452	293	307	328	319	272	258	260	273	291	275	3770
GRAND TOTAL																		
PAYLOAD	0	24	164	504	767	806	834	982	1150	1144	1079	921	881	898	932	883	894	12863
TRANS,	0	8	0	44	142	135	272	293	320	349	364	347	334	336	345	349	347	4037
TOTAL	0	24	164	548	909	1001	1106	1272	1470	1493	1443	1268	1215	1234	1280	1232	1241	16900

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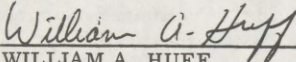
APPROVAL

THE OCTOBER 1973 NASA MISSION MODEL COST AND
ECONOMIC ANALYSIS

By Shuttle Utilization Planning Office

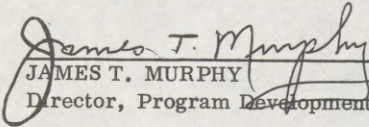
The information in this report has been reviewed for security classification. Review of any information concerning Department of Defense or Atomic Energy Commission programs has been made by the MSFC Security Classification Officer. This report, in its entirety, has been determined to be unclassified.

This document has also been reviewed and approved for technical accuracy.



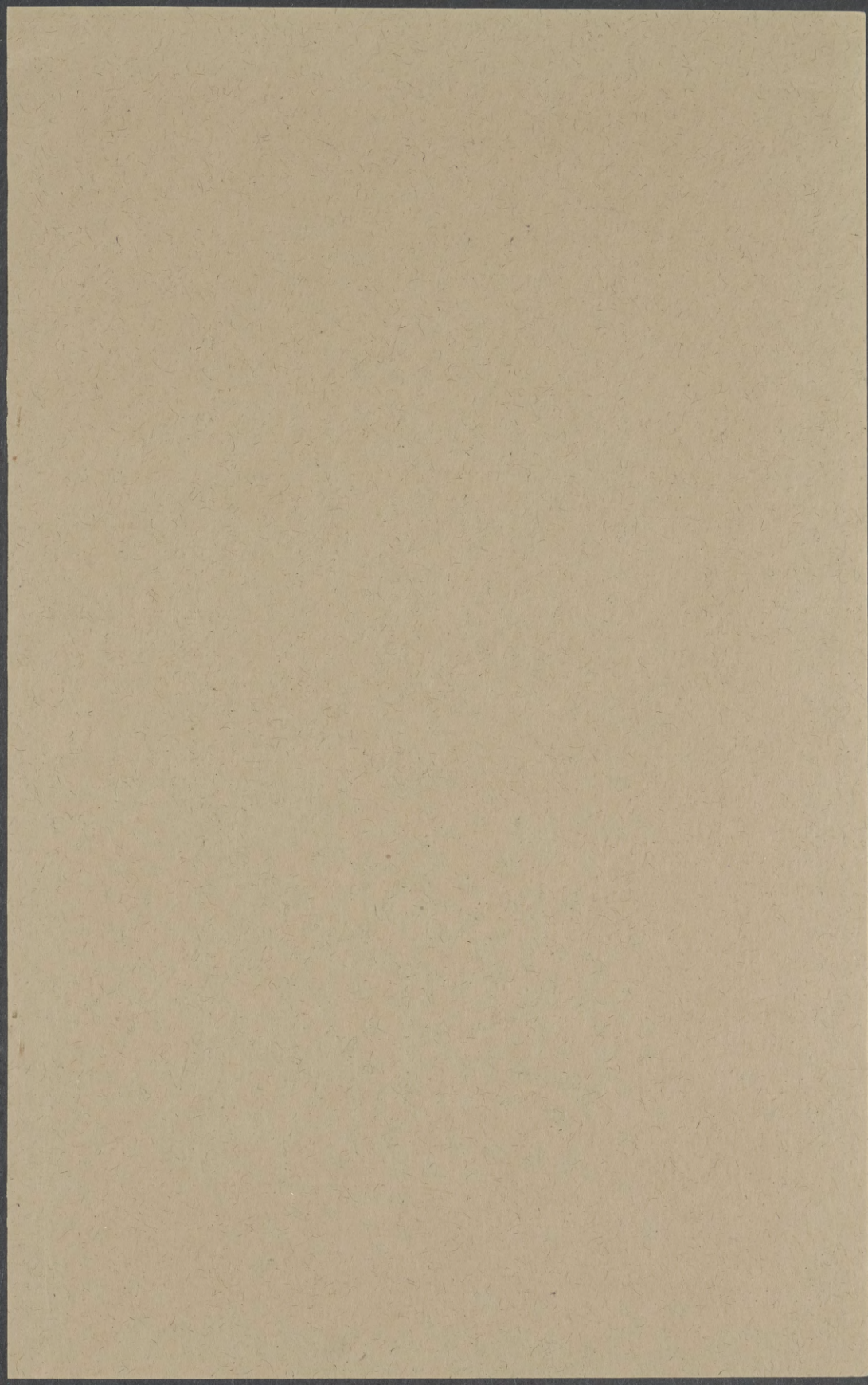
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