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National Aeronautics and Space Administration

BUDGET ESTIMATES

FISCAL YEAR 1965

Volume VI

SPACE SCIENCE AND APPLICATIONS PROGRAMS

RESEARCH AND DEVELOPMENT

CONSTRUCTION OF FACILITIES

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1965 ESTIMATES

SPACE SCIENCE AND APPLICATIONS PROGRAMS

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RESEARCH AND DEVELOPMENT
SUMMARY BY BUDGET ACTIVITY

Budget Activities and Programs	Fiscal Year 1963	Fiscal Year 1964	Fiscal Year 1964 Supplemental	Fiscal Year 1965
MANNED SPACE FLIGHT..	$1,503,583,000	$2,649,800,000	$141,000,000	$3,011,900,000
Gemini.....	288,090,000	383,800,000	---	308,400,000
Apollo.....	1,183,965,000	2,243,900,000	141,000,000	2,677,500,000
Advanced missions..	11,391,000	22,100,000	---	26,000,000
Completed missions.	20,137,000	---	---	---
SPACE APPLICATIONS...	$96,958,000	$103,300,000	---	$86,100,000
Meteorology.....	54,051,000	67,800,000	---	37,500,000
Communications.....	32,075,000	13,500,000	---	12,600,000
Other applications.	10,832,000	22,000,000	---	36,000,000
UNMANNED INVESTIGATIONS IN SPACE...	$489,951,000	$602,700,000	---	$649,800,000
Spacecraft development and operations.....	384,222,000	477,600,000	---	521,600,000
Launch vehicle development.....	105,729,000	125,100,000	---	128,200,000
SPACE RESEARCH AND TECHNOLOGY.....	$255,962,000	$298,100,000	---	$283,300,000
Launch vehicles and spacecraft.....	88,547,000	111,900,000	---	104,400,000
Propulsion and space power.....	167,415,000	186,200,000	---	178,900,000
AIRCRAFT TECHNOLOGY..	$15,598,000	$22,100,000	---	$37,000,000
SUPPORTING OPERATIONS	$152,742,000	$250,000,000	---	$313,900,000
Tracking and data acquisition.....	122,142,000	210,000,000	---	267,900,000
Facility, training, and research grants.....	30,600,000	40,000,000	---	46,000,000
TOTAL PLAN.....	$2,514,794,000	$3,926,000,000	$141,000,000	$4,382,000,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1965 ESTIMATES

RESEARCH AND DEVELOPMENT SUMMARY
OF BUDGET ACTIVITIES BY PROGRAM

Budget Activities and Programs	Fiscal Year 1963	Fiscal Year 1964	Fiscal Year 1964 Supplemental	Fiscal Year 1965
MANNED SPACE FLIGHT	$1,503,583,000	$2,649,800,000	$141,000,000	$3,011,900,000
Gemini.....	288,090,000	383,800,000	---	308,400,000
Apollo.....	1,183,965,000	2,243,900,000	141,000,000	2,677,500,000
Advanced missions	11,391,000	22,100,000	---	26,000,000
Completed missions	20,137,000	---	---	---
SPACE APPLICATIONS	$96,958,000	$103,300,000	---	$86,100,000
Meteorology.....	54,051,000	67,800,000	---	37,500,000
Communications...	32,075,000	13,500,000	---	12,600,000
Other applications	10,832,000	22,000,000	---	36,000,000
Advanced technological satellites...	(8,668,000)	(18,500,000)	---	(31,000,000)
Technological utilization..	(2,164,000)	(3,500,000)	---	(5,000,000)
UNMANNED INVESTIGATIONS IN SPACE	$489,951,000	$602,700,000	---	$649,800,000
Spacecraft development and operations.....	384,222,000	477,600,000	---	521,600,000
Geophysics and astronomy....	(147,689,000)	(186,200,000)	---	(190,200,000)
Lunar and planetary exploration..	(222,802,000)	(270,800,000)	---	(300,400,000)
Bioscience.....	(13,731,000)	(20,600,000)	---	(31,000,000)
Launch vehicle development....	105,729,000	125,100,000	---	128,200,000

Budget Activities and Programs	Fiscal Year 1963	Fiscal Year 1964	Fiscal Year 1964 Supplemental	Fiscal Year 1965
SPACE RESEARCH AND TECHNOLOGY	$255,962,000	$298,100,000	---	$283,300,000
Launch vehicles and spacecraft.	88,547,000	111,900,000	---	104,400,000
Space vehicle systems.....	$(43,990,000)	$(49,000,000)	---	$(38,800,000)
Electronic systems.....	(17,071,000)	(28,700,000)	---	(28,400,000)
Human factor systems.....	(9,790,000)	(13,200,000)	---	(16,200,000)
Basic research	(17,696,000)	(21,000,000)	---	(21,000,000)
Propulsion and space power.....	167,415,000	186,200,000	---	178,900,000
Nuclear-electric systems.....	(39,893,000)	(44,700,000)	---	(48,100,000)
Nuclear rockets.	(69,465,000)	(82,700,000)	---	(58,000,000)
Chemical propulsion....	(49,722,000)	(45,800,000)	---	(59,800,000)
Space power.....	(8,335,000)	(13,000,000)	---	(13,000,000)
AIRCRAFT TECHNOLOGY	$15,598,000	$22,100,000	---	$37,000,000
SUPPORTING OPERATIONS	$152,742,000	$250,000,000	---	$313,900,000
Tracking and data acquisition.....	(122,142,000)	(210,000,000)	---	(267,900,000)
Sustaining university program	(30,600,000)	(40,000,000)	---	(46,000,000)
TOTAL.....	$2,514,794,000	$3,926,000,000	$141,000,000	$4,382,000,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1965 ESTIMATES

SUMMARY OF RESEARCH AND DEVELOPMENT BUDGET PLAN BY PROGRAM

	Fiscal Year 1963	Fiscal Year 1964	Fiscal Year 1964 Supplemental	Fiscal Year 1965
MANNED SPACE FLIGHT..	$1,503,583,000	$2,649,800,000	$141,000,000	$3,011,900,000
Gemini.....	288,090,000	383,800,000	---	308,400,000
Apollo.....	1,183,965,000	2,243,900,000	141,000,000	2,677,500,000
Advanced missions..	11,391,000	22,100,000	---	26,000,000
Completed missions.	20,137,000	---	---	---
SPACE SCIENCE AND APPLICATIONS.....	$615,345,000	$742,500,000	---	$776,900,000
Geophysics and astronomy.....	147,689,000	186,200,000	---	190,200,000
Lunar and planetary exploration.....	222,802,000	270,800,000	---	300,400,000
Sustaining university program.....	30,600,000	40,000,000	---	46,000,000
Launch vehicle development.....	105,729,000	125,100,000	---	128,200,000
Bioscience.....	13,731,000	20,600,000	---	31,000,000
Meteorological satellites.....	54,051,000	67,800,000	---	37,500,000
Communications satellites.....	32,075,000	13,500,000	---	12,600,000
Advanced technological satellites	8,668,000	18,500,000	---	31,000,000
ADVANCED RESEARCH AND TECHNOLOGY.....	$271,560,000	$320,200,000	---	$320,300,000
Basic research.....	17,696,000	21,000,000	---	21,000,000
Space vehicle systems.....	43,990,000	49,000,000	---	38,800,000
Electronic systems.	17,071,000	28,700,000	---	28,400,000
Human factor systems.....	9,790,000	13,200,000	---	16,200,000
Nuclear-electric systems.....	39,893,000	44,700,000	---	48,100,000
Nuclear rockets....	69,465,000	82,700,000	---	58,000,000
Chemical propulsion	49,722,000	45,800,000	---	59,800,000
Space power.....	8,335,000	13,000,000	---	13,000,000
Aeronautics.....	15,598,000	22,100,000	---	37,000,000

	Fiscal Year 1963	Fiscal Year 1964	Fiscal Year 1964 Supplemental	Fiscal Year 1965
TRACKING AND DATA ACQUISITION.....	$122,142,000	$210,000,000	$141,000,000	$267,900,000
TECHNOLOGY UTILIZATION.....	$2,164,000	$3,500,000	---	$5,000,000
TOTAL PLAN.....	$2,514,794,000	$3,926,000,000	$141,000,000	$4,382,000,000

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1965 ESTIMATES

SUMMARY OF CONSTRUCTION OF FACILITIES BUDGET PLAN BY BUDGET ACTIVITY

	Budget Activity	Fiscal Year 1963	Fiscal Year 1964	Fiscal Year 1965
1.	Manned Space Flight.....	$543,809,100	$495,179,000	$234,330,000
2.	Space Applications.....	193,605	3,933,000	---
3.	Unmanned Investigations in Space.....	47,261,650	18,574,200	7,018,000
4.	Space Research and Technology	106,849,300	56,832,800	26,620,000
5.	Aircraft Technology.....	1,697,000	100,000	4,001,000
6.	Supporting Operations.....	42,608,495	98,881,000	9,031,000
	Total Plan.....	$742,419,150	$673,500,000	$281,000,000

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

FISCAL YEAR 1965 ESTIMATES

SUMMARY OF CONSTRUCTION OF FACILITIES BUDGET PLAN BY LOCATION BY PROGRAM OFFICE

	Fiscal Year 1963	Fiscal Year 1964	Fiscal Year 1965
Office of Manned Space Flight....	$543,809,100	$488,315,000	$224,910,000
John F. Kennedy Space Center, NASA.....	296,479,100	279,236,000	89,520,000
Manned Spacecraft Center.....	25,369,500	35,172,000	25,166,000
Marshall Space Flight Center...	41,740,500	28,980,000	15,288,000
Michoud Plant.....	28,910,000	8,688,000	6,534,000
Mississippi Test Facility.....	78,407,000	93,656,000	61,991,000
Various Locations.....	72,903,000	42,583,000	26,411,000
Office of Space Science and Applications.....	$47,455,255	$21,710,700	$7,359,000
Ames Research Center.....	930,000	---	---
Goddard Space Flight Center....	18,902,355	17,032,500	500,000
Jet Propulsion Laboratory.....	10,208,050	2,998,200	3,314,000
John F. Kennedy Space Center, NASA.....	8,659,000	1,680,000	1,741,000
Lewis Research Center.....	1,186,500	---	---
Various Locations.....	6,799,350	---	---
Wallops Station.....	770,000	---	1,804,000
Office of Advanced Research and Technology.....	$110,378,650	$56,179,300	$27,591,000
Ames Research Center.....	13,711,000	11,044,000	6,081,000
Electronics Research Center....	---	---	10,000,000
Flight Research Center.....	1,757,000	1,157,000	---
Jet Propulsion Laboratory.....	---	---	400,000
Langley Research Center.....	10,094,300	8,204,300	4,454,000
Lewis Research Center.....	44,630,000	18,634,000	810,000
Nuclear Rocket Development Station.....	14,835,000	3,240,000	---
Various Locations.....	25,351,350	13,900,000	5,846,000

	Fiscal Year 1963	Fiscal Year 1964	Fiscal Year 1965
Office of Tracking and Data Acquisition.....	$40,776,145	$96,805,000	$6,140,000
Goddard Space Flight Center....	2,915,000	---	800,000
John F. Kennedy Space Center, NASA.....	---	4,000,000	---
Various Locations.....	34,470,395	92,300,000	5,340,000
Wallops Station.....	3,390,750	505,000	---
Facility Planning and Design.....	---	10,490,000	15,000,000
TOTAL PLAN.....	$742,419,150	$673,500,000	$281,000,000

OFFICE OF SPACE SCIENCE AND APPLICATIONS GEOPHYSICS AND ASTRONOMY PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The fundamental objective of the Geophysics and Astronomy Program is to extend our knowledge and understanding of the space environment of the Earth, the Sun and its relationships to the Earth, the geodetic properties of the Earth, and the fundamental physical nature of the universe. Much of the space research accomplished under this program has been devoted to understanding the environment of the Earth. Sounding rockets, balloons, aircraft, and Explorer class satellites have been used for exploration of the Earth's upper atmosphere and ionosphere. Investigation of the Earth's magnetosphere and the great radiation belt have been conducted with Explorer-class satellites and large sounding rockets. These spacecraft will continue to be used together with Geophysical Observatories in an effort to obtain a comprehensive picture of the Earth's environment and to determine its variations with changes in solar activity. This basic understanding of the Earth's environment is important to the operation of manned and unmanned spacecraft and contributes to our knowledge of meteorology and communications. We also gain knowledge which will help us understand what we measure in the exploration of other planets.

Studies of the Earth's space environment have demonstrated the controlling effect that the Sun has on this environment, and they provide many important clues to the nature of the Sun. However, a comprehensive study of the Sun requires the use of astronomical instruments pointed at the Sun. Since much of the electromagnetic radiation emitted by the Sun is absorbed or distorted by the Earth's atmosphere, sounding rockets and Solar Observatories are being used to place the instrumentation above the atmosphere. To complement these observations, Explorer spacecraft are being launched into highly elliptical Earth orbits which take them into interplanetary space to monitor the arrival of solar protons, measure the solar wind, and explore the interplanetary magnetic field. These observations, together with the information on the space environment near Earth, will contribute to a vastly improved understanding of the Sun as a star, as a controlling influence on life here on Earth, and as a hazard to man's survival in space.

Through accurate tracking of satellites, it is possible to obtain data on the figure and structure of the Earth and to study the nature of the Earth's gravitational field and its interactions with the gravitational fields of nearby celestial bodies. These data are needed to develop a reference basis for all measurements of positions and maps of the Earth. They also provide a basis for calculation of orbits and trajectories of manned and unmanned spacecraft. Data from various satellites and space probes have been used to give improved calculation of the figure and structure of the Earth and its gravitational potential. The accuracy of these

data is vastly improved when satellites are specifically instrumented to facilitate accurate tracking. Explorers will be flown with such instrumentation in a program which will continue the work initiated by the Department of Defense under Project ANNA.

While the preponderance of the space program is concerned with our own solar system, some of the most interesting and potentially most important discoveries await us in our investigation of the rest of the universe. The Sun is the only star which is close enough so that it can be studied in great detail, but observation of other stars and interstellar material can tell us much about the nature, evolution and natural laws of the universe that we cannot learn from the study of a single star, our Sun. Here again astronomical observations are hindered by the Earth's atmosphere; so sounding rockets, balloons, aircraft, and satellites are used to carry instrumentation up through the atmosphere. Astronomical Observatories represent our major effort in this area; but work with sounding rockets, balloons, aircraft, and Explorers have already demonstrated that observations in the ultraviolet, X-ray, gamma ray, and radio regions of the electromagnetic spectrum can give us much information that cannot be obtained from the largest Earth based telescopes.

SUMMARY OF RESOURCES REQUIREMENTS:

	1963	1964	1965
Supporting research and technology	$13,581,000	$15,100,000	$14,800,000
Solar observatories	10,900,000	18,800,000	22,100,000
Astronomical observatories	39,250,000	47,700,000	51,000,000
Geophysical observatories	39,634,000	53,300,000	55,400,000
Explorers	32,811,000	34,200,000	31,900,000
Sounding rockets	11,513,000	17,100,000	15,000,000
Total costs	$147,689,000	$186,200,000	$190,200,000

BASIS OF FUND REQUIREMENTS:

Supporting Research and Technology

	1963	1964	1965
Solar physics	$1,633,000	$2,200,000	$2,200,000
Astronomy	2,087,000	2,600,000	2,600,000
Geophysics	9,065,000	8,800,000	8,500,000
Interdisciplinary	796,000	1,500,000	1,500,000
Total costs	$13,581,000	$15,100,000	$14,800,000

The supporting research and technology efforts are conducted by universities, NASA installations, and other government and non-government research

organizations under the scientific and administrative coordination of the Office of Space Science and Applications. The program includes theoretical and laboratory research, ground based observations, aircraft and balloon flight experiments, and advanced work leading to the development of satellite and rocket borne instrumentation. Data which have been obtained from various flight projects and ground based observation are correlated under this program to take advantage of all available information in arriving at conclusions. The cataloging and preservation of such data are also funded under this program.

In the field of solar physics, ground based monitoring is financed in conjunction with the work done by the National Bureau of Standards to complement the observations made with sounding rockets and Solar Observatories. Development of advanced instrumentation for future Orbiting Solar Observatories (OSO) and Advanced OSO spacecraft is also funded under this program. Laboratory and theoretical studies are conducted to interpret the data obtained and to provide a basis for solar flare predictions.

Astronomical research and technology efforts have consisted mostly of work directed at the development of instruments for future Explorer and Observatory flights. Observations from balloons and from the X-15 aircraft have also been funded from this program. The X-15 has been equipped with a three axis gyroscopically stabilized platform capable of pointing instruments at a predetermined portion of the sky. Ultraviolet photography experiments will be flown on this platform. This program also supports theoretical studies in geodesy, celestial mechanics, and stellar astrophysics. Some advanced work toward gravitational and relativity experiments is also funded.

The geophysics portion of the program covers a range of scientific disciplines supporting the study of the Earth's environment. It provides for theoretical and laboratory studies and instrumentation development in planetary atmospheres, space chemistry, meteoroids and micrometeoroids, energetic particles, magnetodynamics, and ionospheric and radio physics. The flight program has produced a considerable amount of data in these fields. The university groups, NASA field centers, and other research organizations participating in this program are correlating these data and incorporating the knowledge obtained in the planning and development of future flight experiments.

Interdisciplinary efforts include support of the Space Science Board, the National Data Center, and development of instrumentation useable in more than one of the scientific disciplines. The National Data Center will serve as a national repository for data resulting from world wide atmospheric and space research.

Solar Observatories

	1963	1964	1965
Orbiting Solar Observatory:			
Spacecraft.....	$3,824,000	$5,400,000	$4,700,000

	1963	1964	1965
Experiments	$3,387,000	$5,300,000	$5,600,000
Ground operations	---	300,000	100,000
Delta launch vehicles	2,289,000	3,700,000	2,700,000
Subtotal costs (OSO)	$9,500,000	$14,700,000	$13,100,000
Advanced Orbiting Solar Observatory:			
Spacecraft	$1,400,000	$4,100,000	$7,000,000
Experiments	---	---	2,000,000
Subtotal costs (AOSO)	$1,400,000	$4,100,000	$9,000,000
Total costs	$10,900,000	$18,800,000	$22,100,000

OSO I, launched in 1962, was the first of the observatory class of satellites. It provided the first monitoring of the Sun's extreme ultraviolet and X-ray radiation for a period of several rotations of the Sun. Seven similar spacecraft are scheduled for launch at approximately nine month intervals beginning in early 1964 and extending through 1968.

The spacecraft points an experimental package at the Sun to an accuracy of one minute of arc. Other experiments are carried in the spinning wheel which stabilizes the spacecraft. These experiments look at the Sun once with each revolution of the wheel.

Fiscal year 1963 and prior year funds provided for development of the first spacecraft and its experiments, for most of the development of the second spacecraft and its experiments, and for major development work on the third spacecraft and its experiments.

Fiscal year 1964 funds provide for final analysis of data from the first flight and for final preparations to launch the second spacecraft and analyze the data from its experiments. They provide for continuation of the development of the third observatory. Work is being initiated on the spacecraft and experiments for the fourth and fifth observatories.

Fiscal year 1965 funds will complete the analysis of data from the first two observatories and provide for final preparations for launch of the third and fourth. Major development work will be continued on the fifth observatory and development of the sixth observatory will be initiated. Long lead-time development of experiments for the seventh observatory will also be funded.

Fiscal year 1963 and prior year funds provided for procurement of the Delta launch vehicles for the first three observatories except for the final preparations for launch of the second and third. These preparations and the funding of the fourth vehicle are provided in fiscal year 1964. Fiscal year 1965 funds provide for the fifth launch vehicle.

The total of eight observatories, including launch vehicles, will cost about $76,000,000 of which $10,705,000 was funded prior to fiscal year 1963. These observatories will provide the primary means of space flight research in solar physics until Advanced Orbiting Solar Observatory (AOSO) becomes operational.

AOSO is scheduled for its first flight in 1968. This observatory which is now in its initial stage of development will be capable of much more detailed observation of the Sun than OSO. While OSO looks at the Sun as a whole with limited capability to identify radiation from specific parts of its atmosphere, AOSO will have a capability for detailed study of solar activity pinpointed to specific areas of the Sun. It is being designed to point on command to within five seconds of arc of any desired point on the Sun and to track that position with a precision of one second of arc. The greater focal length of its instruments will greatly improve the resolution of the cellular structure of the Sun. It will point all of its instruments at the Sun, and its polar orbit will place it in continuous sunlight for most of its useful life.

Fiscal year 1962 funds provided for preliminary studies by three firms, leading to detailed proposals for development of the AOSO spacecraft. Fiscal year 1963 and fiscal year 1964 funds finance the contract for detailed design, program definition, and construction of breadboard models of critical subsystems by Republic Aviation Corporation. Fiscal year 1965 funds provide for initiating hardware development of subsystems for the spacecraft and for initiating design and breadboard of flight experiments.

This observatory is expected to make a major contribution to our understanding of the nature of the Sun, to the determination of its effects on the environment of the Earth, and to the ability to make long range predictions of its hazard to man's survival in space.

Astronomical Observatories

	1963	1964	1965
Spacecraft	$32,325,000	$30,400,000	$31,100,000
Experiments	5,569,000	9,400,000	6,500,000
Atlas Agena vehicles	1,356,000	7,900,000	13,400,000
Total costs	$39,250,000	$47,700,000	$51,000,000

The Orbiting Astronomical Observatory (OAO) was initiated in 1960 provide a stabilized platform above the Earth's atmosphere capable of pointing astronomical observing equipment at any selected region of the sky with extreme accuracy and for extended periods of time. Such a platform makes it possible to view the stars, nebulae, interstellar matter, and the planets in regions of the electromagnetic spectrum which are obscured by the Earth's atmosphere. It also eliminates the interference caused by the distortion of light by the Earth's atmosphere and the light of the night sky caused by reflection of light by particles in the atmosphere.

The first spacecraft, scheduled for launch in 1965, will carry two astronomical measurement assemblies. One will map the sky in the ultraviolet portion of the spectrum, recording emissions from up to 50,000 stars and large nebulae in four ultraviolet spectral bands. The other assembly will be used to determine the stellar energy distribution and measure the emission line intensities of diffuse nebulae in about the same spectral region.

The second spacecraft will carry a 36-inch telescope to make absolute spectrophotometric measurements of stars and nebulae in the ultraviolet. It can be used for a variety of astronomical problems and to observe any celestial object except the Sun, Venus, Mercury, or objects fainter than 11th magnitude.

The third spacecraft will carry a telescope designed to make studies of interstellar gas and dust clouds from which stars are believed to be formed. Since most of the interstellar atoms absorb only in the far ultraviolet, this instrument will provide information in a field which cannot be studied successfully by ground based observations.

The third spacecraft will also carry a small experiment designed to study X-ray emission of a wide assortment of celestial objects and to obtain information on interstellar absorption of helium and the heavier elements. This experiment is being developed through the University College, London.

Experiments for the fourth and fifth spacecraft have not yet been selected. Consideration will be given to observations in other regions of the electromagnetic spectrum as well as adaptation of ultraviolet instrumentation to the solution of new astronomical problems.

OAO spacecraft are scheduled for launch at one year intervals beginning in 1965. Fiscal year 1963 and prior year funds provided for development of the spacecraft components and initiated assembly of the prototype spacecraft. They provided for the major development work on experiments for the first two spacecraft. Also funded was the initial development effort on the primary experiment for the third spacecraft.

Fiscal year 1964 funds provide for completing the construction of the first two spacecraft and for integrating the flight experiments and testing the complete systems. They also provide for initiating the procurement of the third spacecraft and for major development work on its primary experiment. In addition, initial funding is provided for advance development of experiments for future flights.

Fiscal year 1965 funds provide for the final preparations to launch the first spacecraft and for integration and test of the second spacecraft and its experiments. Work will be continued on the construction of the third spacecraft and its experiments, and the construction of a fourth spacecraft and its experiments will be initiated.

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Two Atlas Agena vehicles with modifications to accommodate the size and weight of the OAO are being procured. Funding for the first vehicle will be completed in fiscal year 1965 while final preparation of the second vehicle will be funded in fiscal year 1966. Procurement of the third vehicle will be initiated in fiscal year 1966.

The development and operation of the OAO including spacecraft, experiments, and launch vehicles for five flights is estimated to cost about $282,000,000. The cost of the project prior to fiscal year 1963 was $43,434,000. The experiments to be conducted under this project have the potential of providing data which may completely change our present scientific theory on the nature, evolution, and processes of the universe.

Geophysical Observatories

	1963	1964	1965
Spacecraft	$23,969,000	$35,000,000	$22,700,000
Experiments	6,987,000	9,100,000	19,900,000
Ground operations	1,422,000	1,400,000	1,900,000
Atlas Agena vehicles	4,890,000	4,800,000	5,200,000
Thor Agena vehicles	2,366,000	3,000,000	5,700,000
Total costs	$39,634,000	$53,300,000	$55,400,000

The Orbiting Geophysical Observatory (OGO) project was initiated in 1960 to develop and operate a series of satellites capable of supporting a large number of diversified but correlated scientific and technological investigations within the Earth's upper atmosphere, the magnetosphere, and cislunar space. These investigations will provide a portion of the scientific base for a better understanding of the Earth as a planet, Sun-Earth relationships, hazards to manned and unmanned space flight, and the complex phenomena of our solar system.

OGO spacecraft will be launched into two general types of orbits: one, highly eccentric orbit passing through the magnetosphere, and the other, a near circular orbit which will pass over the polar regions at relatively low altitudes to obtain data on the upper atmosphere and ionosphere. Later spacecraft may be placed in highly eccentric polar orbits to facilitate correlation of the radiation belt and magnetic field phenomena with conditions in the polar atmosphere and ionosphere. Atlas Agena launch vehicles are required for the highly eccentric orbits. Thor Agena launch vehicles will be used for circular orbit missions.

The first spacecraft, which is scheduled to be launched into a highly eccentric orbit in mid 1964, will carry twenty scientific experiments. The largest portion of this payload will obtain data associated with magnetic fields and energetic particles. There are included, however, a number of experiments for studying phenomena in the disciplines of astronomy, solar physics, the atmosphere and the ionosphere.

The second OGO spacecraft, scheduled for launch in 1965, will also carry twenty experiments. This low altitude polar mission is primarily oriented toward obtaining data relating to the Earth's atmosphere and ionosphere. Subsequent launchings are scheduled at an average rate of two per year throughout the decade, to provide coverage of changing conditions throughout a solar cycle.

Fiscal year 1963 and prior year funds provided for spacecraft and ground system development and construction of a prototype and three flight spacecraft, A through C. They also provided for the development and construction of experiments for the first four flights.

Fiscal year 1964 funds provide for completion of the integration and testing of spacecraft A and for most of the work to prepare B and C for launch. They provide for analysis of data from the first flight and for continued preparation of experiments for B, C, and D. Fiscal year 1964 funds also provide for initiation of the procurement of spacecraft D, E, and F and for initial development of experiments for E.

Fiscal year 1965 funds will continue the preparation of spacecraft D, E, and F and continue the preparation of experiments for C, D, and E. They will initiate development of experiments for F and G and provide for analysis of data from B and C.

Procurement of the first two Atlas Agena vehicles was initiated in fiscal year 1962 and will be completed in fiscal year 1965. Procurement of the first Thor Agena vehicle was initiated with fiscal year 1963 funds. Fiscal year 1965 funds provide for completion of this procurement and initiation of the procurement of one more vehicle of each type.

The project, including launch vehicles, is estimated to cost about $370,000,000. This will provide for eleven flights and will conduct over 200 individual experiments. Costs will average about $50,000,000 per year through fiscal year 1968.

Explorers

	1963	1964	1965
Atmosphere and ionosphere Explorers	$5,467,000	$7,700,000	$5,300,000
Magnetosphere and interplanetary Explorers	5,190,000	5,600,000	6,800,000
Astronomical and astrophysical Explorers	---	1,500,000	7,000,000
Delta launch vehicles	14,100,000	11,700,000	7,500,000
Scout launch vehicles	4,954,000	6,600,000	4,300,000
Thor Agena launch vehicles	3,100,000	1,100,000	1,000,000
Total costs	$32,811,000	$34,200,000	$31,900,000

Explorers are small satellites designed to carry a specific group of experiments into orbits especially selected for the experiments involved. They have the advantage of a comparatively short leadtime and can be launched by Delta and Scout launch vehicles. This class of satellites is also employed in international cooperative programs because their relatively simple design enables a cooperating country with little or no experience to participate in the program.

Explorer class satellites fall into three general categories on the basis of the types of missions they perform.

Atmosphere and Ionosphere Explorers. These satellites are launched to low altitude orbits to obtain as much coverage as possible of the Earth's atmosphere and ionosphere. Successful satellites in this category have included Explorer VIII which made direct measurements of ion and electron temperature and pressure in the ionosphere, Explorer IX and XIX which were used to measure atmospheric density, Ariel I which carried experiments of the United Kingdom to correlate ionosphere measurements with measurements of solar radiation, the Canadian Alouette I which made the first topside soundings of the ionosphere, and Explorer XVII which made the first comprehensive measurements of atmospheric composition and also made comprehensive direct measurements of atmospheric temperature, pressure, and density.

Presently ready for launch are (1) an ionosphere Explorer which will perform topside soundings of the ionosphere using six fixed frequencies, (2) a beacon Explorer which will transmit signals to be received by ground stations in 24 nations to study ionospheric propagation, and (3) a second United Kingdom satellite which will record galactic noise, the vertical distribution of ozone in the atmosphere, and the quantitative particle flux of micrometeoroids. Fiscal years 1964 and 1965 funds provide for preparing these spacecraft for launch and for analysis of data. Two spacecraft of each type have been built. The launch schedules for the second spacecraft in each case will be dependent on the results of the first.

A cooperative effort with Italy was initiated with fiscal year 1963 funds to launch a series of satellites from a floating platform in the Indian Ocean. These satellites, launched into an equatorial orbit, will explore the equatorial regions of the atmosphere and ionosphere.

Fiscal year 1964 funds provide for initiation of a cooperative effort with France to study the ionosphere in the very low radio frequencies. They also provide for continuation of efforts with Canada, the United Kingdom, and Italy as well as additional flights of the Explorer IX and Explorer XVII types of spacecraft.

Fiscal year 1965 funds do not provide for any new and different spacecraft in this area of research, but they provide for analysis of data and for support of the cooperative launchings with the United Kingdom, Italy, and France. They also provide for a continuing program with Canada to

monitor the ionosphere with launchings at the rate of one flight per year throughout the decade. Additional Explorers are expected to be launched to monitor the atmosphere during the latter part of the decade.

Magnetosphere and Interplanetary Explorers. Explorer satellites flown to date have provided a substantial amount of information on cosmic radiation, the great radiation belt, the Earth's magnetic field, and the effects of solar events on the environment of the Earth. Explorers XII and XIV, which traversed the Earth's magnetosphere out to about 11 and 15 Earth radii, respectively, provided information on the great radiation belt and the Earth's magnetic field. Explorer XV was launched to study the artificial radiation belts created by the high altitude nuclear explosions. Another satellite of this type is to be launched in 1964, to continue to follow the decay of the artificial belt. The first of a series of interplanetary Explorers was successfully launched on November 26, 1963. These satellites will monitor the arrival of solar protons in the interplanetary medium between the Earth and the Moon's orbit, measure the solar wind, and explore the interplanetary magnetic field. The series will provide data needed for Apollo and extend our knowledge of energetic particles and magnetic fields in interplanetary space. Fiscal year 1964 funds provided for the development of two Injun Explorers by the State University of Iowa to measure the downward flux of solar corpuscular radiation into the Earth's atmosphere. Additional Explorers for which funds are provided in fiscal year 1964 and fiscal year 1965 are planned to be designed by other university groups to study interactions of the atmosphere with magnetic and radiation phenomena. About four satellites per year are planned for these areas of research through the decade.

Astronomical and Astrophysical Explorers. A radio astronomy receiver flown on a sounding rocket has demonstrated the feasibility of obtaining useful data on the Sun, the planets, the stars, and interstellar matter using radio receivers and relatively small antennae which can be deployed from small spacecraft. Fiscal year 1964 and fiscal year 1965 funds provide for the development of a radio astronomy Explorer. They also provide for instrumentation of Explorer spacecraft for geodetic missions to continue the work initiated by the Department of Defense under Project ANNA. This effort is planned under a joint working group to meet the requirements of the Department of Defense and the Department of Commerce as well as those of NASA. Fiscal year 1965 funds also provide for work on the extension of astronomical observations into the X-ray region of the electromagnetic spectrum using a small telescope on an Explorer. About three Explorers per year are planned for astronomical and astrophysical investigations throughout the decade.

Launch Vehicles. Scout and Delta launch vehicles will be used in the foreseeable future to launch Explorer satellites. The Delta vehicles will continue to be required for spacecraft in the 500 pound class and for the more highly eccentric orbits. Scout launch vehicles will be used for the smaller spacecraft and lower orbits. Between the two vehicles, 9 or 10 launchings per year are planned throughout the decade. The cost of the program beyond fiscal year 1965 including spacecraft, support and launch vehicles will average about $39,000,000 per year.

Sounding Rockets

	1963	1964	1965
Experiments	$4,348,000	$9,000,000	$6,000,000
Rocket procurement	2,884,000	2,900,000	3,400,000
Attitude control systems	763,000	1,600,000	1,700,000
Rocket development	300,000	300,000	400,000
Engineering support	480,000	600,000	500,000
Instrumentation	2,738,000	2,700,000	3,000,000
Total costs	$11,513,000	$17,100,000	$15,000,000

Sounding rockets are small unguided vehicles which are used to make vertical profile measurement of the Earth's atmosphere, ionosphere and magnetosphere; to conduct chemical experiments in the upper atmosphere; to recover meteorite samples for laboratory study; to make short duration observations of the Sun, stars, and planets; and to test instrumentation and techniques in a space environment for later use on satellites. Sounding rocket experiments can be prepared with short leadtime. They also provide a means of exploring that part of the upper atmosphere which lies between maximum balloon altitude and minimum satellite altitudes. Their vertical profiles complement the orbital paths of satellites in completing the complex picture of the environment of the Earth. Instrumentation and techniques proved out on sounding rockets provide a test of feasibility for satellite experiments and greatly improve the chances of obtaining useful data.

The fiscal years 1964 and 1965 budgets support a level of about 115 flights each as compared with 78 flights supported by the fiscal year 1963 budget. In addition to the greater number of flights, greater use will be made of larger vehicles as more emphasis is placed on flights with astronomical instruments and geophysical experiments designed to correlate two or more measurements.

In studies of the atmosphere, flights are planned using spectrometers to analyze the composition of the atmosphere and the chemical reactions caused by the interaction of solar radiation with the atmosphere. Rocket payloads designed to collect cosmic dust and upper atmospheric gases are being developed. Studies of atmospheric structure will be continued, employing chemical releases and small spheres. Chemical releases will also be used to induce chemical reactions as a basis for studying the composition of the atmosphere and to simulate the reactions caused by natural phenomena.

Flights will be made to study the quiet ionosphere during solar minimum as a part of the International Quiet Sun Year. Rockets will be launched containing two capsules to demonstrate the feasibility of obtaining ionospheric measurements by transmissions between two closely spaced spacecraft.

Studies of the sun will be made with spectrographs, coronagraphs, and spectroheliographs. These flights are closely associated with the development of instrumentation for OSO and AOSO.

Astronomical observations of the stars, planets, and interstellar matter will be made in the ultraviolet, X-ray, and radio regions of the electromagnetic spectrum. These flights will provide useful preliminary information for experiments to be flown on planetary spacecraft, the OAO, and radio astronomy Explorers.

Sounding rockets will continue to be used throughout the decade in conjunction with satellite observation to obtain a comprehensive picture of the environment of the Earth during the rise of the solar cycle and as an aid in the development of astronomical instrumentation. The cost of the program is expected to average about $17,000,000 per year.

OFFICE OF SPACE SCIENCE AND APPLICATIONS LUNAR AND PLANETARY PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The objective of lunar and planetary exploration is to obtain significant scientific data from the moon, other bodies of the solar system and from interplanetary space. In the area of lunar exploration, an immediate objective of the program is to obtain scientific information and design data required for manned lunar landings. By acquisition of more general knowledge, the program seeks to explain the origin, early history, and mechanisms of development of the solar system. Determination of the interplanetary and planetary space environments and the development of spacecraft capable of carrying scientific payloads are prime objectives providing the means to accomplish the scientific objectives of the flight program.

Lunar Program

A principal scientific objective of the lunar program is the exploration of the moon and its environs for information on the surface structure, physical properties of the surface, and mechanisms of formation of the surface features. Information pertaining to the history of the earth-moon system and perhaps on the origin of other planetary bodies may be uncovered from the study of lunar surface. The moon, lacking in atmosphere, has not been subjected to the erosions of wind and water and may, therefore, preserve a record of the early history of the solar system which may be lost forever on extraterrestrial bodies which have appreciable atmospheres.

Ground-based observations and research are continuing in the areas of lunar mapping, environmental data collection, and preparation of scientific models primarily for manned systems engineering and operations planning. Four Ranger flights planned for the present calendar year will yield greatly improved lunar topographical data with television pictures from 1,000 miles distance through to lunar impact. Following Ranger, the Surveyor series of lunar landing spacecraft are planned for 1965 and 1966 to obtain a variety of detailed information from the surface of the moon such as surface physical and chemical properties, texture and hardness, lunar seismic activity and meteorite environment. The Lunar Orbiter series of spacecraft is planned to yield high resolution photography of the lunar surface and to provide data on the mass distribution of the moon in 1966.

Planetary Program

With the success of the Mariner II mission to Venus in 1962, the United States achieved an unqualified "first" in space exploration. Many useful scientific data were obtained as the Mariner II spacecraft flew by the planet. A Mariner fly-by mission to Mars is planned for 1964 with a 500-pound spacecraft to obtain television pictures of the planet and attempt to detect atomic oxygen and hydrogen in the Martian atmosphere. Work is currently underway leading to an improved fly-by mission to Mars in 1966 using the Centaur launch vehicle. Pioneer missions are planned to commence in 1965 to measure interplanetary phenomena at great distances from the earth.

SUMMARY OF RESOURCES REQUIREMENTS:

	1963	1964	1965
Supporting research and technology	$ 22,205,000	$ 19,000,000	$ 18,100,000
Manned space science	---	4,200,000	11,000,000
Ranger	88,816,000	52,200,000	10,800,000
Surveyor lander	66,386,000	98,600,000	136,000,000
Lunar orbiter	4,000	20,000,000	49,300,000
Mariner	42,777,000	59,100,000	54,100,000
Pioneer	2,614,000	17,700,000	21,100,000
Total costs	$222,802,000	$270,800,000	$300,400,000

BASIS OF FUND REQUIREMENTS

Supporting Research and Technology

	1963	1964	1965
Lunar and planetary science	$13,039,000	$12,300,000	$11,500,000
Advanced technical development	6,097,000	4,400,000	4,100,000
Advanced studies	3,069,000	2,300,000	2,500,000
Total costs	$22,205,000	$19,000,000	$18,100,000

Supporting research and technology provides the lunar and planetary programs the capability to carry out vital work not specifically a part of currently approved flight missions.

Much of the supporting scientific research involves exploring the moon and planets with equipment based on Earth. In many areas information on the solar system can be gathered more readily in this way than from flight missions. Earth-based research complements the flight programs by providing additional data for comparisons of experimental results. The combined attack on the mystery of Venus by Mariner II and infrared measurements at

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Palomar is a good example of how basic scientific research complements flight experiments. This work is of further value in isolating those areas where flight missions are necessary to obtain data which cannot be obtained by earth measurements.

Supporting research provides the background information around which flight experiments are designed. Promising experiments receive their initial funding under the program and many eventually become flight experiments. The Mariner II magnetometer which discovered that Venus did not have an appreciable magnetic field originated in the supporting research and technology program, as did the plasma probe and magnetometer for the calendar year 1964 Mars fly-by missions and the lunar seismometer and alpha-particle scattering experiments selected for soft-landing missions on Surveyor.

Recent ground-based investigations have led to the conclusion that the Martian atmosphere may be far more tenuous than was previously expected. This problem must be solved before entry capsules can be designed to enter the Martian atmosphere and successfully report conditions on the surface.

The advanced technical development program focuses on three areas where improvements in the engineering arts will most increase the probability of successful planetary missions: communications, guidance and control, and sterilization of planetary spacecraft and entry capsules. Maintaining communications over 100 million mile distance requires very powerful transmitters and very sensitive receivers on earth, and a sensitive yet durable system aboard the spacecraft. Communications can be maintained only if the guidance and control system of an interplanetary spacecraft functions properly to hold the spacecraft in the proper attitude. The system must operate without failure and without repair over periods approaching nine months in order to assure success of missions to Mars.

One of the major objectives of NASA is the search for extraterrestrial life. Spacecraft to be landed or impacted on the planets must be more than surgically sterile to prevent contaminating the planets with earthly organisms. One of the most difficult problems encountered has been sterilizing electronic components without reducing their reliability and useful lifetime. Sterilization technology must improve significantly before planetary landing missions are attempted.

The advanced studies effort is essential to future lunar and planetary mission planning. Studies of space flight mechanics and planetary trajectories establish favorable launch opportunities and the energies required. Comparing these energy requirements with launch vehicle performance yields control weights for spacecraft planning. Missions studied in fiscal year 1963 included a spacecraft to examine the Sun from inside the orbit of Mercury, and Voyager, a spacecraft which would orbit Mars or Venus and land a capsule there.

Under the overall direction of the Office of Space Science and Applications, this work is carried out in universities, industrial research laboratories, and NASA field centers. Funds requested for fiscal year 1965 will support a continuation of about the same level of effort being carried out in the current fiscal year.

Manned Space Science

	1963	1964	1965
Supporting research and technology.....	---	$1,200,000	$2,100,000
Manned satellite science.....	---	900,000	3,100,000
Manned lunar science.....	---	2,100,000	5,800,000
Total costs.....	---	$4,200,000	$11,000,000

Manned space science supporting research and technology will provide scientific data for the engineering and operational development of manned spacecraft systems, especially Apollo. This continues environmental data collection activities previously funded under the manned spacecraft program and certain activities previously funded as a part of the unmanned lunar program. Work will be conducted to evaluate the hazards of solar flares, radiation, and micrometeoroids as they may effect astronauts and manned spacecraft on lunar missions. Efforts leading to the determination of suitable lunar landing sites for Apollo flights, including estimation of lunar surface bearing strength, will be continued. These supporting research activities include the conduct of ground-based research, coordination of data collection efforts on unmanned flight projects, and the preparation of scientific models, charts, and maps for engineering and operations planning.

Manned satellite science and manned Lunar science projects provide for planning and development of scientific investigations to be performed by man in space. The experience of the Office of Space Science and Applications in the field of scientific experiment development is being utilized through the management of this project to assure that the maximum scientific benefit is realized from man's unique capabilities as a scientific observer. Specific experiments will be developed through the various field centers both in-house and by contract.

Fiscal year 1964 funds are being used for the design, development and procurement of experiments and scientific equipment for early Gemini and Apollo flights and for the scientific training of the current astronauts. The Gemini experiments include investigations of the Earth and its upper atmosphere in which the human observer can make a unique contribution. The increased capability of the Gemini spacecraft will permit expansion of the experimental work accomplished in project Mercury. Experiments in the fields of astronomy and biology are also under development for Gemini. By the close of fiscal year 1964 the preliminary selection of promising scientific experiments for project Apollo will have been made and development will be underway

on those investigations that will require several years to prepare for conduct in space.

The fiscal year 1965 funds are required to continue development of Gemini scientific apparatus and to procure flight hardware. Background training to be provided in the various scientific disciplines will enhance the effectiveness of the astronauts as scientific observers on both Gemini and Apollo missions. The procedures for conducting investigations will be ground tested by the astronauts in mission simulation sequences. Design and development of Apollo scientific equipment will be well underway and procurement of prototype and long lead time flight equipment will be initiated. Since astronaut stay-time on the lunar surface will be limited, a wide variety of light-weight, portable, and highly refined equipment is planned to permit optimum observation of surface phenomena and the collection and preservation of samples of surface features. Long-life instruments, equipped for Moon-to-Earth data transmission, will be developed for emplacement by astronauts at points of interest near the landing site. Consistent with recommendations of the Space Science Board of the National Academy of Sciences, NASA will, through this project, develop criteria for the selection of scientist astronauts for lunar missions. A very small level of effort is planned to continue definition of scientific investigations appropriate for extended missions near Earth and on the Moon.

	Ranger		
	1963	1964	1965
Spacecraft	$32,100,000	$29,100,000	$ 7,000,000
Experiments	14,500,000	5,700,000	1,400,000
Ground operations	9,800,000	6,200,000	400,000
Launch vehicles	32,416,000	11,200,000	2,000,000
Total costs	$88,816,000	$52,200,000	$10,800,000

The specific objective of the next four Ranger flights (Rangers A-D) is to obtain television pictures of the lunar surface which will benefit both the scientific program and the United States manned lunar program. These pictures should be at least an order of magnitude better in resolution than any available earth-based photography.

The failure of Ranger V, which was launched in October 1962, led to an extensive redesign and retest effort in order to increase the probability of success on future flights. This effort, which caused the launch schedule for Ranger A to slip to the first quarter of 1964, has now been completed and test results on the current spacecraft have been very encouraging, indicating that the objectives of the redesign have been attained.

Instead of the hard-landing capsule and bus experiments of the early Rangers, the payload for the next series will consist of six television cameras mounted in a "tower" on the bus. Improvements have been incorporated into the bus to attain high reliability. The television system will begin

operation at approximately 1,000 miles above the lunar surface and will continue until impact, with the quality of the last pictures sufficient to identify an object a few feet in diameter.

Five additional flights beyond the ninth were planned but have been cancelled in the interest of economies in the total NASA program. This series of flights was planned to impact the lunar surface with survivable capsules.

The Office of Space Science and Applications, NASA Headquarters, is responsible for the overall management of the Ranger program. Responsibility for project management is assigned to the Jet Propulsion Laboratory. The spacecraft was designed by the Jet Propulsion Laboratory and is being fabricated by the Laboratory as an in-house effort. The television system is being procured from the Astro-Electronics Division of Radio Corporation of America.

Fiscal year 1963 funds were used primarily to conduct the extensive redesign and retest effort on the Ranger A-D series and to initiate procurement of long lead time flight equipment. In addition, some of the funds were used to complete and launch Ranger V and to develop a prototype hard-landing photographic capsule. Fiscal year 1964 funds are being used for the assembly, test and launching of Rangers A-C and were used for six months of effort on five impacters prior to cancellation. The fiscal year 1965 funds will be used for final testing and launch of the ninth Ranger and for post launch data evaluation.

Surveyor Lander

	1963	1964	1965
Spacecraft	$45,386,000	$57,200,000	$64,400,000
Experiments	4,021,000	4,700,000	11,600,000
Ground operations	3,079,000	4,700,000	6,000,000
Launch vehicles	13,900,000	32,000,000	54,000,000
Total costs	$66,386,000	$98,600,000	$136,000,000

The Surveyor spacecraft is being developed to accomplish the first soft landings on the Moon. On the lunar surface, it will survey various landing areas of interest as possible sites for later manned landings and make measurements to improve our understanding of the nature of the Moon. Landed Surveyors will transmit to Earth a variety of data, such as high-resolution television pictures of the lunar terrain and surface texture, measurements of the surface hardness and other physical and chemical properties, lunar seismic activity, and the meteorite environment near the surface.

The Surveyor mission requires the development of a technology far more advanced than that employed in the Mariner II and Ranger spacecraft. Not only must Surveyor navigate through the space between the Earth and the Moon,

but it must land softly on the Moon, essentially by backing down a multi-stage rocket to a landing 240,000 miles and 66 hours removed from the launching site.

The Surveyor spacecraft system is being developed for NASA by the Hughes Aircraft Company under contract to the Jet Propulsion Laboratory. Major contractors are Thiokol/Elkton for the main retro-rocket, Thiokol Reaction Motors Division for the vernier propulsion system, and Ryan Electronics for the attitude and velocity-sensing radars.

Current year funds have been primarily devoted to developmental testing and refinement of components and subsystems, system testing of the proof-test spacecraft, and hovering and drop tests from a balloon which simulate the final landing on the Moon.

Fiscal year 1965 funds will be used for completion of system functional testing, environmental testing (thermal-vacuum, shock, and vibration), mission-simulation testing, field crew training by mock operations, and tests of dynamic models on Centaur development flights. Development of the basic Surveyor spacecraft system is expected to be essentially completed and test flights started during fiscal year 1965.

Lunar Orbiter

	1963	1964	1965
Spacecraft.....	$4,000	$20,000,000	$31,600,000
Ground operations.....	---	---	2,200,000
Launch vehicles.....	---	---	15,500,000
Total costs.....	$4,000	$20,000,000	$49,300,000

The primary mission of the Lunar Orbiter is to conduct photoreconnaissance of the Moon. From its orbit, the satellite will make scientific measurements of the Moon and its environs in addition to its photographic mission. Analysis of the Lunar Orbiter's orbit will help determine the mass distribution of the Moon. Only a lunar satellite can provide this information on mass distribution which is central to any discussion of the origin of the Earth-Moon system, and is relevant to reconciliation of the conflicting theories of the origin of the solar system. Irregularities in lunar mass distribution are closely linked with questions of the seismic activity of the Moon, its radioactivity, and the character of the lunar surface. The Orbiter data will be very valuable in evaluating and correlating the scientific observations made by the Surveyor Lander. The Orbiter photography will be used to screen out obviously undesirable sites in which to place the Surveyor and then to team with the landed Surveyor in the verification of suitable sites for the Apollo landings.

Early planning for a lunar orbiter had considered an Atlas-Centaur launched spacecraft. In 1963, advances in spacecraft technology and the growth in payload capability of the Atlas-Agena launch vehicle made a lunar

orbiter in the 800 pound class feasible. Consequently, the decision was made to design a spacecraft for the Atlas-Agena launch vehicle. The first orbiter is planned to be launched early in calendar year 1966 with following flights at the approximate rate of one each quarter.

Project management responsibility has been assigned to Langley Research Center and launch vehicle systems management to Lewis Research Center. Proposals for design and fabrication of the Orbiter spacecraft were requested from industry in October 1963, and the Boeing Company was selected in December 1963.

Funds provided in fiscal year 1964 are being utilized to initiate the spacecraft development contract and will carry the spacecraft through design and prototype fabrication. Fiscal year 1965 funding will provide for fabrication of flight hardware and the initial payment on Atlas-Agena launch vehicles. The ten-flight program is estimated to cost about $225 million.

Mariner

	1963	1964	1965
Spacecraft	$29,802,000	$27,300,000	$25,100,000
Experiments	1,333,000	8,100,000	8,600,000
Ground operations	6,830,000	10,000,000	9,500,000
Launch vehicles	4,812,000	13,700,000	10,900,000
Total costs	$42,777,000	$59,100,000	$54,100,000

Mariner is the United States' program to explore the planets. Flights to the planets are extremely difficult space missions because existing launch vehicle systems are strained to the utmost by energy requirements, and the state of the art of spacecraft technology by flight duration. System lifetimes on the order of nine months must be attained, yet redundancy which is desirable for reliability must be minimized due to weight limitations. Planetary exploration will proceed in three phases: fly-by missions, fly-by missions with landing capsules or probes, and spacecraft which include both a landing module and an orbiting module.

Launch vehicle capability has restricted the early Mariners to fly-by missions. The Atlas-Agena launch vehicle which provided 447 pounds for the highly successful Mariner II in 1962, has been improved so that over 500 pounds are available for the 1964 Mars mission. Mariner spacecraft are attitude stabilized, relying on Earth, Sun, and star sensors for orientation, and on solar panels for power. The spacecraft measures micrometeoroid impacts, fields, and particle fluxes in interplanetary space enroute. The 1964 Mariner will take television photographs of the Martian surface as it flies by and attempt to detect atomic oxygen and hydrogen in the atmosphere.

Development of the Centaur launch vehicle to operational status will permit a greatly improved fly-by mission in 1966, which will build on data from the earlier flights through the use of more sophisticated instrumentation.

The Jet Propulsion Laboratory is responsible for management of the Mariner program and will build the spacecraft in-house. Lewis Research Center has responsibility for procurement of both the Atlas-Agena and Centaur launch vehicles used in the Mariner program.

There have been reports of ten attempts to fly spacecraft to the planets by the Soviet Union and two by the United States. The Russians succeeded in ejecting only two from Earth orbit into interplanetary trajectory, and these both failed before they reached their objectives. The United States achieved the world's only planetary success when Mariner II's microwave radiometers made their measurements on Venus on December 14, 1962. The funds appropriated for fiscal year 1963 paid for the final test and checkout of Mariners I and II, and started work on the two 1964 flights to Mars.

The fiscal year 1964 funds will complete parts procurement, functional and type approval tests, fabrication of the spacecraft, and systems tests for the 1964 Mars launches, as well as preliminary design and long lead time procurement for the 1966 mission. The fiscal year 1965 requirement is for the final assembly, test, checkout, and launch of the two Mars spacecraft in late calender year 1964. Tracking will continue after launch for nine months until encounter. The balance of the fiscal year 1965 resources will be applied to the design and development of the spacecraft for the calender years 1966 and 1968-1969 missions.

Pioneer

	1963	1964	1965
Spacecraft.....	$1,839,000	$11,000,000	$ 7,900,000
Experiments.....	725,000	2,300,000	4,200,000
Ground operations.....	50,000	300,000	900,000
Launch vehicles.....	---	4,100,000	8,100,000
Total costs.....	$2,614,000	$17,700,000	$21,100,000

Pioneer missions will use small spacecraft, with long lifetimes, designed to measure interplanetary phenomena. In conjunction with the Interplanetary Monitoring Probe, which measures the near-Earth environment and the planned Mariner missions, Pioneer will enable the United States to obtain simultaneous scientific data at widely separated points in space, measuring magnetic fields, solar plasma, cosmic rays, radio propagation, and interplanetary dust during the International Quiet Sun Year and beyond. Correlation with similar measurements made in near-Earth orbit will enable us to understand better these phenomena and their interrelation.

In addition, Pioneer will monitor solar phenomena near the low point of solar activity, and will make measurements during the buildup of activity, and as the maximum approaches. These data will contribute to scientific knowledge of the origin of the Sun; its dynamics, composition, and effect on the Earth's environment. An immediate use for this knowledge will be research directed toward developing a method for predicting solar flares which would be a hazard to manned space flight.

Pioneer takes advantage of recent and planned improvements in the reliable Delta launch vehicle. Thrust augmentation will add to the existing capability of the Delta, and it is planned that a spacecraft of about 140 pounds will be injected into an interplanetary orbit. The first four Pioneer missions will alternate between orbits which close to within 75,000,000 miles of the Sun and orbits which go outside Earth's orbit to 110,000,000 miles from the Sun. The expected lifetime will be at least six months, so that a reasonable launch rate will permit simultaneous measurements from two Pioneers, as well as comparison of Pioneer data with Interplanetary Monitoring Probe, and occasionally with Mariner spacecraft. Relatively simple design will ensure high reliability in the Pioneer spacecraft, which will be largely a refinement of existing technology.

Responsibility for project management rests with Ames Research Center. Under the technical direction of Ames, Space Technology Laboratories will build the spacecraft under a fixed price, incentive fee contract. The Jet Propulsion Laboratory will provide tracking and data acquisition services, while Goddard Space Flight Center is responsible for systems management of the launch vehicle procured from the Douglas Aircraft Company.

Fiscal year 1963 funds were used for spacecraft design and system development. Fiscal year 1964 funds are being used to initiate procurement of the first four spacecraft and launch vehicles. During 1964 the prototype will be developed, tested, integrated with the scientific experiments and qualified for flight.

The fiscal year 1965 request completes purchase of the first four launch vehicles and almost all of the spacecraft. Final qualification of the first flight spacecraft should be completed early in 1965 and the initial launch should occur in the second quarter of calendar year 1965. These funds will also pay for possible design modifications to the Pioneer spacecraft and selection and development of new experiments to fly on the second block of three spacecraft, the last of which would fly in 1967. The total program of seven flights is estimated to cost about $70 million.

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OFFICE OF SPACE SCIENCE AND APPLICATIONS SUSTAINING UNIVERSITY PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

With its establishment, NASA was charged with expanding human knowledge of phenomena in the atmosphere and space and preserving the role of the United States as a leader in aeronautical and space-related science and technology. As would be expected in any undertaking of this complexity and sophistication, the need for knowledge of almost infinite variety was immediately recognized, and it soon became apparent that the existing sponsored research activities could not utilize fully the abilities of our universities. Accordingly, the Sustaining University Program was planned and initiated in fiscal year 1962 to increase university participation in aeronautical and space science and engineering endeavors and to broaden NASA's sponsored research activities.

Universities are the traditional source of both new knowledge and highly trained manpower. Only through a carefully designed program can the supply of scientific talent and the development of significant and relevant research capabilities keep pace with the demands of the national space effort. The program objectives are to: (1) increase the future supply of scientists and engineers required in space-related science and technology; (2) build laboratories urgently needed for space research in selected universities; and, (3) improve the universities' role in support of NASA by encouragement of creative multidisciplinary investigations, development of new capabilities, and consolidation of space-oriented activities. These three aspects of the Sustaining University Program are complementary to project sponsored research and to each other.

The training aspect produces skilled manpower, research scientists, technicians and instructors. By September 1964, about 2,000 future scientists and engineers will be in training in the NASA program at a cumulative cost through fiscal year 1964 of nearly $36 million. Adequate facilities are essential if the scientists' already difficult undertakings are not to be hampered further by unsuitable environments. Acquisitions initiated through this aspect of the program and funded in fiscal year 1964 and prior years are intended to add approximately 855 thousand square feet of laboratories at a cumulative cost, of about $29 million. Additionally, by supporting high quality research at selected institutions not currently participating in the space program, the number of universities and scientists involved in attacking some of the fundamental problems facing NASA has grown significantly. Through this portion of the program, some $18 million at 70 institutions will have been invested by the end of fiscal year 1964 to obtain research results which will help to determine the long-range course of space technology.

SUMMARY OF RESOURCES REQUIREMENTS:

	1963	1964	1965
Training	$14,145,000	$20,000,000	$25,000,000
Facilities	10,249,000	12,000,000	10,000,000
Research	6,206,000	8,000,000	11,000,000
Total costs	$30,600,000	$40,000,000	$46,000,000

BASIS OF FUND REQUIREMENTS:

	1963	1964	1965
Training	$14,145,000	$20,000,000	$25,000,000

The rapid development of the space program continues to place increasingly severe demands on the supply of highly trained scientists and engineers. The demand is in two general directions: those technical personnel required to participate directly in the solution of immediate problems confronting current space activities and those required to conduct future research, teach new students in order to replenish the manpower pool, and evaluate and organize the vast amounts of scientific data acquired through increasing space experimentation.

The predoctoral research training program is designed to produce 1,000 Ph.D's annually. This type of program has been strongly recommended by the President's Science Advisory Committee as necessary and reasonable. The Committee stated that a special effort must be made if the supply of highly trained scientists and engineers is to keep pace with the demand. It was further determined that there are adequate numbers of qualified students available who would not enter graduate research training unless new opportunities were made available. The Committee recommended that the annual output of Ph.D.'s should reach at least 7,500 by the year 1970, an increase of 4,000 Ph.D.'s over the present annual rate.

NASA's predoctoral training program was started with grants to ten universities for the support of ten graduate students at each university for a period of three years, and at a total cost of approximately $2 million. In fiscal year 1963, 786 trainees at 88 universities, which included second grants to the first ten institutions and grants to 78 new institutions, were added at a total cost of about $14 million. Presently, only 886 students are in training, but approximately 1,100 more new students are to be added at a cost of about $20 million from fiscal year 1964 funds. Subsequently, additions of 1,250 students in 1965, 1,300 to 1,400 in 1966 and again in 1967 will be made to attain a level of nearly 4,000 students in training. In spite of this emphasis on training, the first graduates will not become available until 1965. It should be noted that no amount of money injected at some later date will produce scientists or engineers in six months to ease some suddenly recognized

manpower crisis.

The training program provides three-year predoctoral opportunities to selected graduate students at qualified universities offering Ph.D. degrees in space-related areas. As recipients of these traineeships, young, high-calibre scientists and engineers will conduct research in space-related fields while acquiring a high level of individual competence. At the end of this training, the student may remain at a university, carrying out long-range research and teaching the "next generation" or he may participate directly in current research activities of immediate importance to the space program at the university, in industry, or within NASA.

Individual trainees are selected at the university by senior faculty members who may supervise the research training of the students, and are thus in the best position to evaluate the capabilities of the candidates. The stipends granted are comparable to those offered by other sources, and the grants are made through the university to minimize movement of the student. The grant also includes an allowance to the university to strengthen its program in space-related science and technology. It may include such items as small amounts for minor specialized equipment, a modest amount for course-content improvement, an appropriate share of special faculty augmentation, as well as similar items normally covered by income from tuition and fees.

Specialized training for selected students offers the students identification with NASA's goals and problems and involves them directly in the new programs of the space age. In many cases the students' professors are also engaged in space research activities. The students thus have a relationship with NASA through contact with scientists and experiments generated by experienced senior investigators. Such close ties will provide the trainee with additional motivation for the continuation of studies and participation in the national space effort. A by-product of these traineeships is the incentive they provide to undergraduates who look forward to similar participation.

The predoctoral training grants are aimed directly at alleviation of a most critical manpower deficiency. The training program also includes related activities such as postdoctoral conversion of scientists desiring to enter space-related fields, enhancement of the utility of people possessing unique capabilities, and summer seminars for carefully selected students with outstanding potential.

	1963	1964	1965
Facilities.....	$10,249,000	$12,000,000	$10,000,000

Research and training in space-related science and technology at non-profit scientific and educational institutions in support of NASA's mission are often impeded by inadequacy or complete lack of existing laboratory space. Although some research scientists need only limited facilities in order to pursue their theoretical studies, it is an increasingly frequent

requirement that first-line space research of the type needed by NASA necessitates the use of more elaborate equipment, such as computers, electronic testing devices, and environmental simulators. Sufficient laboratory space must be provided for this equipment as well as for the faculty, graduate students, other research personnel and supporting services.

Besides relieving the critical shortage of working space for groups now heavily involved in research pertinent to the NASA mission, these new facilities will make possible the development and assembly of new multidisciplinary research groups which can more effectively respond to NASA's needs than can innumerable dispersed smaller groups. During the next five years a total of some 75 universities heavily engaged in NASA's programs are expected to require over three million square feet of laboratories to accommodate research and training in space-related work. Acquisitions initiated through fiscal year 1964 for this project are adding approximately 855 thousand square feet of laboratory space at a cost of nearly $29 million. A continued, orderly and deliberate acquisition rate to help fulfill part of the remaining needs requires $10 million for construction of an additional 275 thousand square feet of laboratory space. Thus the universities will be in a position to undertake the work of which they are capable and which is required if already established national goals in space are to be realized.

	1963	1964	1965
Research.....	$6,206,000	$8,000,000	$11,000,000

The support of broad programs of space and aeronautical research, specifically tailored to the individual characteristics of each university, affords the maximum opportunity for balancing and strengthening existing work, and for stimulating the development and growth of new ideas and talent. In this manner, the space program obtains the most vigorous, productive and creative contributions a university can provide.

Many of the scientific and technological problems facing NASA require an understanding of the behavior of large and complex systems that resist piecemeal attack, and their solution demands the concerted and cooperative effort that universities can provide by bringing together their many specialists from the varied technical and scientific disciplines. Additionally, by supporting quality research at selected institutions not currently participating in the space program, the number of universities attacking some of the fundamental problems facing NASA is permitted to grow and thus broaden the base of the nation's research capability. By providing new opportunities to these institutions to participate, many excellent research programs have already emerged and new talents and skills have been developed. Through this portion of the program, some $18 million at 70 institutions will have been invested through fiscal year 1964 to obtain research results which will help to determine the long-range course of space technology.

For the continuation and orderly growth of this special-purpose research in fiscal year 1965, approximately sixty projects will be supported at a cost

of $11 million. Forty of these grants will be for the continuation of projects supported in fiscal year 1964, and the remaining 20 will be to universities participating in this research program for the first time.

OFFICE OF SPACE SCIENCE AND APPLICATIONS LAUNCH VEHICLE DEVELOPMENT PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The purpose of the launch vehicle development program is to provide reliable and economical launch vehicles for NASA unmanned flight projects. This is accomplished by (1) an active research and technology effort for the systems, components and techniques that may be required for future projects; (2) developing such launch vehicles as are required to support these projects; (3) procuring launch vehicles to meet the requirements of approved projects; and (4) modifying and improving the existing stable of vehicles and ground systems to support these projects.

The supporting research and technology area, initiated for launch vehicle development in fiscal year 1963, is progressing to fill the need for advanced studies of vehicle technology required for unmanned missions. Effort in fiscal year 1963 was concentrated in special vehicle systems studies. Fiscal year 1964 funds provide for studies of the use of flourine for future vehicles, and on the behavior of liquid fuels in zero gravity condition.

The Scout and Delta vehicles, developed by NASA, are now operational. Development of these vehicles was completed in fiscal year 1963.

Development of the Centaur will continue in fiscal year 1965, with the first operational mission to be accomplished early in calendar year 1965. The second attempted launching of the Centaur vehicle on November 27, 1963, was entirely successful.

The FLOX development project, initiated in fiscal year 1964, will be completed in fiscal year 1966. This project will initially provide a large increase in payload capacity for the Atlas-Centaur and Atlas-Agena vehicles. Later, other launch vehicles which now use liquid oxygen should benefit significantly.

SUMMARY OF RESOURCES REQUIREMENTS:

	1963	1964	1965
Supporting research and technology.....	$ 1,598,000	$ 1,900,000	$ 4,500,000
Centaur development	90,600,000	108,100,000	92,000,000
Scout development	3,648,000	---	---
Delta development	2,183,000	---	---
FLOX development	---	1,900,000	17,500,000
Operational vehicle support.	7,700,000	13,200,000	14,200,000
Total costs.....	$105,729,000	$125,100,000	$128,200,000

BASIS OF FUND REQUIREMENTS:

Supporting Research and Technology

	1963	1964	1965
Fluid behavior studies....	$ ---	$ 500,000	$ 500,000
Solid state technology research.....	---	200,000	500,000
Vehicle system studies....	995,000	900,000	1,500,000
Instrumentation.....	---	---	200,000
Propulsion systems technology	603,000	300,000	1,800,000
Total costs.....	$1,598,000	$1,900,000	$4,500,000

The purpose of this supporting research and technology effort is to generate current information on launch vehicle components, sub-systems, and systems to meet the requirements of unmanned missions. This effort also includes development of certain components, sub-systems, and techniques peculiar to launch vehicles used for unmanned missions.

The launch vehicle supporting research and technology program utilizes data available from the NASA Offices of Advanced Research and Technology and Manned Space Flight Programs, the Department of Defense, the Atomic Energy Commission, and industry to determine the nature and desirability of changes to those launch vehicle systems for which this office has cognizance. Similarly, the needs of planned or tentative flight projects are evaluated to determine the extent to which existing vehicles can be employed or show where modifications or additional development may be required.

Selected components and sub-systems are developed when a clear need, based on the advanced studies, is demonstrated. Design criteria for launch vehicles are developed and updated, and studies are carried out to achieve the most economical use of vehicles.

Fiscal year 1963 funds provided for studies of launch operations analysis, system optimization review techniques, high energy propellants, Titan II/Centaur capability, addition of fluorine to the oxidizer in the Atlas booster (FLOX), and the addition of a third stage to the Saturn IB. These studies have been completed or are progressing satisfactorily. Fiscal year 1964 funds are supporting continuation of the launch operations analysis and system optimization review technique studies. Studies for launch vehicle planning, zero gravity fuel behavior, a kick stage, cryogenic propellants, explosive welding, fluorine-hydrogen technology, spin motor technology, and solid state devices have been or will be initiated.

A major portion of these studies will be continued in fiscal year 1965. New studies intended to be initiated in fiscal year 1965 include improved engine starting techniques, insulation technology, flight instrumentation, sounding rocket systems, and feasibility of achieving high vehicle performance.

Centaur Development

	1963	1964	1965
Vehicle development....	$71,652,000	$ 91,600,000	$86,400,000
Engine development.....	4,340,000	2,000,000	300,000
Support services.....	12,295,000	10,400,000	2,600,000
Propellants.....	2,313,000	4,100,000	2,700,000
Total costs.....	$90,600,000	$108,100,000	$92,000,000

The primary purpose of the Centaur Development project is to provide a high performance launch vehicle for the NASA unmanned Lunar and Planetary exploration projects which are beyond the capabilities of the Atlas-Agena launch vehicle. This project is centered around the development of the Centaur stage which is a high energy upper stage utilizing liquid hydrogen and liquid oxygen. The first stage of this launch vehicle is a modified Atlas. This project also includes the development of a light weight inertial guidance system and other light weight sub-systems for the Centaur stage to permit maximum payload capacity. The Atlas-Centaur can launch a payload of over 2,100 pounds to the moon.

The Office of Space Science and Applications has assigned management of the Centaur project to the Lewis Research Center. Development of the RL-10-A-3 engine is being directed by the Office of Manned Space Flight and the Marshall Space Flight Center. Integration of this engine with the Centaur vehicle is under the direction of the Lewis Research Center. Atlas vehicles which are modified to be the first stage of the Atlas-Centaur are purchased by the Lewis Research Center through the United States Air Force. Prime contractor for the Centaur project is General Dynamics/Astronautics of San Diego, California. Pratt and Whitney Aircraft Corporation of East Hartford, Connecticut and West Palm Beach, Florida acts as an associate contractor in the development and fabrication of the liquid hydrogen-liquid oxygen engine. These engines are also used in the Saturn S-IV stage. Minneapolis-Honeywell of St. Petersburg, Florida is the principal subcontractor to General Dynamics for the development of the Centaur guidance system.

The Centaur development project was initiated by the Advanced Research Projects Agency of the Department of Defense in 1958 as a relatively small scale development project to investigate liquid hydrogen technology. It was transferred to NASA in 1959 and has been increased in scope until it is now a major launch vehicle development program.

After the first attempted launch of the Centaur on May 8, 1962, an intensive investigation was made which resulted in a thorough ground testing program along with changes to the design and reliability concepts.

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This intensive review resulted in significant changes in the structural design of the vehicle; changes in the guidance and propulsion systems were also initiated.

The second test flight of the Atlas-Centaur vehicle was made on November 27, 1963 and was a complete success.

Funding in fiscal year 1965 is intended to complete the development of the single burn capability for the Centaur vehicle and to carry on the development of the two burn capability for later missions. The first operational Centaur is to be launched in fiscal year 1965 as part of the Surveyor project. Other launches are scheduled in fiscal year 1965 for development of a two burn capability, and additional Surveyor flights.

The Centaur Development project is expected to be completed in fiscal year 1966.

Scout and Delta Development

	1963	1964	1965
Scout development.....	$3,648,000	---	---
Delta development.....	2,183,000	---	---
Total costs.....	$5,831,000	---	---

The Scout and Delta development projects were completed in fiscal year 1963. Although the Delta development project was expected to be completed using fiscal year 1962 funds, reorientation of the program required a reprogramming action in fiscal year 1963. Technical direction and management of the Scout vehicle is assigned to the Langley Research Center, and of the Delta vehicle to the Goddard Space Flight Center.

FLOX Development

	1963	1964	1965
Engine and engine testing	---	$1,000,000	$7,500,000
Vehicles and vehicle testing.....	---	900,000	7,000,000
Ground support equipment and services.....	---	---	1,500,000
Propellants.....	---	---	1,500,000
Total costs.....	---	$1,900,000	$17,500,000

NASA began investigating the addition of fluorine to the Atlas propellant system in early calendar year 1963. At that time very preliminary studies indicated that the addition of 30 percent fluorine by weight to the Atlas oxidizer would increase Atlas performance markedly, and require no major modifications to the vehicle or engine system.

The purpose of the FLOX feasibility study was to insure that FLOX was in fact compatible with the Atlas systems without committing the large funding required for a flight program. This study has satisfactorily demonstrated the feasibility of the concept. Results from selected engine components tests indicate no major modifications to the vehicle are required.

Preliminary effort conducted in 1963 indicates this propellant mixture will increase payload capability of the Atlas-Centaur for the Surveyor mission approximately 30%. A similar increase is expected to be realized on the Atlas-Agena missions, such as the Lunar Orbiter and the Advanced Technological Satellite. The Saturn and Thor boosters may also benefit from this technology.

Effort initiated in fiscal year 1964 and sustained in fiscal year 1965 is expected to permit engine component tests to be completed in the fourth quarter of 1964, vehicle component tests completion in the first quarter of 1965, engine tests in the third quarter of 1965, and the first test launch in the first quarter of 1966.

Operational Vehicle Support

	1963	1964	1965
Product improvement and production testing.....	$6,458,000	$ 6,500,000	$ 7,800,000
Maintenance of ground support equipment.....	939,000	3,600,000	2,900,000
System engineering.....	303,000	3,100,000	3,500,000
Total costs.....	$7,700,000	$13,200,000	$14,200,000

Product Improvement

Modifications to improve a launch vehicle system have frequently been required as a result of experience, failures, development breakthroughs in other programs, and improved fabrication techniques. The correction of the system deficiencies for otherwise ready vehicles is reflected hereunder.

Operational vehicle support was initiated in fiscal year 1963. Significantly, in fiscal year 1963, changes were made in the Atlas-Agena vehicle configuration through the development of a standard Atlas vehicle by Department of Defense for use both by the NASA and the Department of Defense. NASA participated in this improvement effort. Improvements to the Agena

guidance system and the Agena vehicle itself were made. National Aeronautics and Space Administration's most reliable operational vehicle, the Delta, was also improved in fiscal year 1963.

The fiscal year 1964 estimates reflect continued support of the standard Atlas development, improvements to the Agena, the Agena guidance system, and improvements in the Scout system. To be able to launch improved and heavier spacecraft, National Aeronautics and Space Administration is utilizing a Department of Defense Thrust Augmented Thor booster with the Delta. Costs of developing the Thrust Augmented Thor booster were borne by the Department of Defense, however, certain other costs necessary to adapt this development to National Aeronautics and Space Administration operational vehicles are reflected in this operational vehicle support account.

The product improvement estimates for fiscal year 1965 are intended to provide additional modifications required in the Scout vehicle, to continue upper stage improvement for the Delta and to provide the National Aeronautics and Space Administration share of the costs estimated for completion of the standard Atlas development. Other improvements for guidance systems, solid propellant motors, inertial reference packages, and sensors will be funded.

Maintenance of Ground Support Equipment

These funds will provide for the periodic routine maintenance, modification, and replacement of damaged or worn out equipment at National Aeronautics and Space Administration launch complexes as required to maintain the launch capability for operational vehicles. The ground support equipment maintained under this account is peculiar to specific launch vehicle needs. In many instances equipment presently in use was developed by the prime contractors as a part of the respective development programs. Modifications to this equipment improve the reliability and assure the compatibility of the ground support systems with the launch vehicle.

Funds in fiscal year 1965 are required for support of the Scout launch facilities at the Pacific Missile Range and at Wallops Island. Delta ground support requirements consist of replacement of umbilical masts and uprating the instrumentation console at Cape Kennedy. Procurement and modification of ground support equipment at Pad 12 for both Agena B and Agena D capability is to be funded to adequately support the planned launch schedule. Also provided is the acquisition of spares to insure against lengthy launch complex non-availability in case of a catastrophic vehicle failure. This insurance is necessary to avoid delays due to long lead time procurements for ground support equipment.

System Engineering:

Each launch of an operational vehicle is monitored by a team consisting of the vehicle contractor and National Aeronautics and Space Administration to ascertain the reliability of vehicle sub-systems and components. The

analysis performed after each launch is reviewed, together with similar analysis of previous launches, for erratic performance and failure modes.

The engineering talent required for these reliability studies and system coordination, as well as the cost of computer usage and such other equipment as required, are contracted for on an annual basis. This capability is necessary throughout the operational lifetime of a vehicle system to insure satisfactory vehicle performance.

Other efforts initiated in fiscal year 1964 include standardization of Scout equipment and procedures and studies for better prediction of rocket performance. Fiscal year 1965 plans include continued vehicle data reduction and analyses, range safety documentation, additional standardization effort, preparation of handbooks and manuals for inspection procedures, and other studies to improve vehicle accuracy and reliability.

The system engineering effort on Delta consists of performing studies of the third stage vehicle destruct system, analysis of the first and second stage telemetry measurements, and effort to maintain reliability. The Agena effort under this project in fiscal years 1964 and 1965 provides for mission parameter studies and systems analysis.

OFFICE OF SPACE SCIENCE AND APPLICATIONS — BIOSCIENCE PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The primary objectives of the Bioscience program are (1) the detection and study of extraterrestrial life, (2) study of the biological effects of space environmental factors on living organisms, and (3) basic studies related to support of manned space flight. A program of basic and applied research is being conducted in each of these areas, proceeding from ground-based laboratory investigations to flight experimentation in the space environment and on Mars and other planetary bodies.

Biological studies are an essential part of the national space program. Experiments are conducted to increase biological knowledge in the unique environment of space and the results are pertinent to the future manned exploration of space. The search for life on other planets and the sterilization of spacecraft to be landed on Mars or other planets are also goals being purposefully pursued by the biologists today.

Experiments which are being readied for flight in the Biosatellite will determine, in the space environment, the effects of weightlessness and radiation singly and combined with each other, and the effect of the lack of a day and night cycle upon animals and plants. These experiments are solicited from the scientific community through the Biosciences Subcommittee of the Space Sciences Steering Committee.

The Supporting Research and Technology program provides the necessary background of theoretical and laboratory research to define the experiments to be carried out in space, to devise the techniques and instruments, and to enable the biologists to interpret the space flight data. The Supporting Research and Technology program uses the facilities of NASA centers, universities, industry and other government agencies. Of the research projects currently sponsored outside of the NASA organization about 50 percent are conducted by universities, 30 percent by industry, and 20 percent by other government agencies.

SUMMARY OF RESOURCES REQUIREMENTS:

	1963	1964	1965
Supporting research and technology.....	$11,772,000	$12,100,000	$11,300,000
Flight program (Biosatellite)...	1,959,000	8,500,000	19,200,000
Total costs.....	$13,731,000	$20,600,000	$31,000,000

BASIS OF FUND REQUIREMENTS:

Supporting Research and Technology

	1963	1964	1965
Exobiology (including sterilization).....	$5,565,000	$5,200,000	$5,000,000
Environmental biology.....	2,307,000	2,900,000	2,800,000
Behavioral biology.....	1,849,000	2,100,000	2,100,000
Physical biology.....	2,051,000	1,900,000	1,900,000
Total costs.....	$11,772,000	$12,100,000	$11,800,000

Exobiology. The search for extraterrestrial life and life-related organic compounds is considered to be one of the prime objectives of the space program. Remote sample collectors and life detectors are being developed using a variety of concepts and methods. Studies are being carried out on the origin and synthesis of living systems and the development of significant steps in early evolution. With the use of a variety of energy sources, most of the fundamental building blocks of living systems have been synthesized from simple non-living matter under conditions similar to those prevailing on this planet several billion years ago. This work is being carried out by the Ames Research Center.

Indirect evidence of the presence of water and carbon dioxide on Mars has been obtained at the Jet Propulsion Laboratory by means of special methods employing ground-based observatories and through the use of the National Aeronautics and Space Administration Stratoscope II flight in March 1963. Further studies by infrared spectroscopy during fly-by of the planets is planned to determine the presence of life-related compounds, and the further development of a high-resolution infrared spectroscope necessary for such studies is planned.

Sampling of the upper air for microorganisms has resulted in the knowledge that it is improbable that life "spills out" into space. This upper air microbiological sampling is continuing and meteor fragments are also being analyzed for the presence of life and organic materials.

A spacecraft sterilization program is underway to develop methods and procedures for reducing the number of microorganisms to a minimum on probes to the moon and Venus and for sterilizing capsules destined for a Martian landing. The techniques developed must permit optimum performance of the instrument and must produce no decrement to the reliability of the mission.

Environmental Biology. The biological effects of space environmental factors on living earth organisms are being studied. All space factors are studied on earth except such unique factors as weightlessness, cosmic radiation, and removal from the effects of the earth's rotation. A biological satellite (Biosatellite) program is designed to study the effects

of these factors and their role in establishing and maintaining normal organization and biological rhythms in living organisms.

The limits of existence of life in extreme environmental conditions are being studied and the extreme parameters of environmental factors in supporting life are being defined. Plants and animals are also being subjected to simulated planetary conditions to determine which organisms could grow on other planets.

Various biological organisms are being studied to develop their application and use in space: (1) in bioregenerative life support systems, (2) as test organisms on other planets, (3) for modifying planetary atmospheres, and (4) for inducing reduced metabolic activity in various specimens.

Behavioral Biology. The effect of the space environment on orientation, behavior, and biological rhythms or organisms is being studied. Neurophysiological, biochemical, and behavioral analyses are being carried out to define brain-behavior relationships of importance to the organism in dealing with stress-producing environmental factors. The molecular basis of acquisition, processing, storage, and retrieval of information on living systems is being studied together with inter-and intra-species communication of intelligent information. Research is in progress on the effects of prolonged confinement in small spaces and other types of environments which produce complex behavioral problems.

Physical Biology. This area is concerned with basic studies of molecular species. Investigations are sponsored in such areas as the mechanism by which freezing and drying affects living cells; structural and functional cellular physiology; physical modeling; major internal physiological systems; molecular organization and differentiation of cells; and behavior of biological systems under controlled space-environmental conditions. Physical biology also embraces studies of energy exchange and nutrition including the development and stability of improved chemically-defined synthetic diets for man, and also for animals which might be utilized in Biosatellite experiments. In this area, 18 volunteer subjects have remained on an all-chemical sustaining diet for three months with no adverse effects. In the area of bioinstrumentation, new and sophisticated instruments are being developed and refined to measure biological, biochemical and biopsychological processes. Research is also being conducted into new methods of biological data processing, storage, and analysis using standard computers, modifying portable digital computers and developing new concepts in computers such as the use of photoconductor phenomena. General support is given to the other Bioscience programs by the sponsorship of conferences, symposia and related communications media.

In the Supporting Research and Technology areas described above, a total of $5,762,000 was expended in the years prior to fiscal year 1963. Most of these funds were spent at Headquarters for research in various biological areas. The balance was spent at the Ames Research Center and the Jet Propulsion Laboratory. The fiscal years 1964 and 1965 efforts include

continuing research in the four basic research areas described above, with special emphasis on exobiology. A portion of the exobiology funds are required for investigations into optimum procedures and methods for the effective sterilization of spacecraft. While the major portion of the funds will be expended through the Headquarters office, important work will be performed at the Ames Research Center and the Jet Propulsion Laboratory. In addition, a small sum will be provided the Goddard Space Flight Center to initiate a few selected tasks of importance to the Bioscience program.

Flight Program (Biosatellite)

	1963	1964	1965
Study contracts.....	$300,000	---	---
Spacecraft.....	---	$6,000,000	$10,200,000
Experiments.....	1,659,000	2,500,000	2,300,000
Ground support.....	---	---	200,000
Launch vehicles.....	---	---	6,500,000
Total costs.....	$1,959,000	$8,500,000	$19,200,000

The Biosatellite program is designed to study the unique environmental factors of space, which include the biological effects of zero gravity or weightlessness, and the effects on biological rhythms of removal of living organisms from the earth's rotation. The effects of weightlessness, combined with a known source of radiation, will be studied to determine what effects, if any, result from this combination. It will then be possible to extrapolate to conditions in deeper regions of space from the great amount of ground-based data on biological effects of radiation.

The Biosatellite experiments include studies at the cellular, tissue, organ, and organism levels as well as studies on fundamental phenomena such as biochemical reactions, protoplasmic streaming, fertilization, embryological development, and growth experiments at the tissue level. The experiments involving organisms would include physiological (including fluid transport), behavioral, reproductive, genetic and overall performance studies. They will include experiments with a wide variety of plants and animals from single cellular organisms to higher plants and animals including primates.

About 175 biological experiments have been submitted by scientists from universities, government, and industry. Panels of scientists have reviewed these experiments, about 40 experiments have been rated as high priority, and many are now being readied for flight. The Ames Research Center is cooperating with experimenters to determine the engineering, life support and telemetry requirements. Breadboard layouts are being made and integration of experiments is being studied.

The experiments are divided into six categories, including (1) primates; (2) mammalian (non-primate); (3) animal, cellular, and egg; (4) plant morphogenesis, photosynthesis and growth; (5) biorhythm, and (6) radiation. The primate experiments include cardiovascular studies involving implants, neurological studies with deep brain probes, the measurement of skeletal calcium loss, and the effects of weightlessness on urinary and gastro-intestinal systems or performance. Pigtail, Rhesus, and squirrel monkeys will be used in orbital flights of from three to thirty days duration.

Six Biosatellites will be flown, with the first flight in late 1965 and additional flights at roughly three-month intervals. The launches will be from the Atlantic Missile Range in a 250 statute mile circular orbit. The spacecraft will weigh from 1,000 to 1,300 pounds and will have a payload capacity of 150 to 200 pounds. The internal atmosphere supplied to the biological specimens will be a mean earth atmosphere, that is, composed of 20 percent oxygen and 80 percent nitrogen at 14.7 pounds per square inch to prevent any effects of unusual atmosphere. Certain experiments will be supplied with specialized temperature or other environmental conditions.

The satellite will be tracked while in orbit by existing networks. Both engineering and experimental data will be telemetered to the ground stations for the biologists to monitor, or to enable the ground personnel to command recovery. The recovery operation is currently under investigation. The two possibilities are air snatch recovery by the Air Force aerial recovery group with back-up by ship-based helicopters, or surface retrieval by surface recovery ships. Aerial recovery is preferred because of the need for rapid access to experimental specimens. The Ames Research Center has been assigned primary responsibility for the Biosatellite project, with support to be supplied by Goddard Space Flight Center for the launch vehicles and for the command and control.

Expenditures in years prior to fiscal year 1963 for work connected with the Biosatellite project total $399,000. The major portion of these funds was expended for the BIOS (Biological Investigation of Space) flight project whose objectives were similar to those of the present Biosatellite project. Funding for fiscal year 1963 provided for the initiation of the Biosatellite project through study contracts with three industrial corporations that subsequently resulted in selection of the General Electric Company, Missile and Space Division as prime spacecraft contractor. Funding for fiscal year 1964 will provide for the initiation of design, fabrication and testing of the spacecraft. Funding for fiscal year 1965 will provide for the continuation of the fabrication and testing of the spacecraft, incremental funding for the development of the experiments to the flight-ready state, and partial funding of the Delta launch vehicles. Total funds required for completion of the Biosatellite project in fiscal year 1967 are estimated at $57.6 million.

OFFICE OF SPACE SCIENCE AND APPLICATIONS METEOROLOGICAL SATELLITES PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The Meteorological Satellites program uses space science and technology to contribute to both the scientific and applications aspects of meteorology. In the scientific aspect, NASA is providing the data required for research which will improve the understanding of the relationship between the earth's weather and events in and beyond the upper atmosphere. NASA, in the applications aspect, is developing weather satellite systems, including spacecraft, and the ground control and data acquisition equipment that effectively contribute to the Weather Bureau's execution of its national weather service function, and the weather dependent operations of the Department of Defense. Thus, specific objectives of the NASA Meteorological Program are: (1) to develop and improve space technology, including sensors and subsystems, which will provide data for use by meteorologists; (2) to carry out flight tests as required to test, calibrate and prove the applicability of the instrumentation; (3) to fulfill special data requirements of the atmospheric science community which can be provided uniquely by satellite instrumentation; and (4) to participate in the operational meteorological satellite systems as required to assist the Weather Bureau in the conduct of the operational system.

The eight TIROS satellites have provided almost continuous cloud cover surveillance since April 1, 1960. The first of the advanced Nimbus spacecraft is being readied for launch early in calendar year 1964, and new TIROS configurations and experiments are being completed for launch in mid-1964 and thereafter.

Data from meteorological sounding rockets have shown that in the altitude region from twenty to sixty miles temperatures and winds change in a manner indicating the vital part that this region plays in linking extraterrestrial events to the earth's weather.

The data to be obtained from operational satellites have known application, but work will continue by the research community on determining additional significance for the data. It is expected that all meteorological data from an operational weather satellite will be useful in the scientific study of the atmosphere. New areas of research have already been opened up in such areas of the atmospheric sciences as the detection and tracking of tropical storms, the heat budget of the earth, infrared radiation characteristics of cloud systems, etc.

SUMMARY OF RESOURCES REQUIREMENTS:

	1963	1964	1965
Supporting research and technology.....	$4,877,000	$6,900,000	$6,600,000
Synchronous meteorological satellite experiments.....	---	---	3,200,000
TIROS.....	19,176,000	16,800,000	5,800,000
Nimbus.....	28,561,000	41,200,000	18,900,000
Meteorological sounding rockets.....	1,437,000	2,900,000	3,000,000
Total costs.....	$54,051,000	$67,800,000	$37,500,000

BASIS OF FUND REQUIREMENTS:

Supporting Research and Technology

	1963	1964	1965
Synchronous meteorological satellite.....	$300,000	$300,000	---
Advanced meteorological system component development.....	2,070,000	2,900,000	2,000,000
Advanced meteorological sensor development.....	1,111,000	1,500,000	$1,900,000
Meteorological systems research.	1,396,000	2,200,000	2,700,000
Total costs.....	$4,877,000	$6,900,000	$6,600,000

The objectives of the supporting research and technology effort continue to be: (1) to develop sensors, controls, and data acquisition and handling systems to implement and improve meteorological systems; (2) to study data from previous satellites and sounding rockets to provide broader bases for system improvements; (3) to evaluate further experiments and uses for a given system; and (4) to study new concepts or applications of meteorological systems for feasibility and value to the program.

In past years, supporting research and technology has supplied the initial work leading to the improved sensors to be flown aboard the TIROS and Nimbus spacecraft. The supporting research and technology effort may be categorized as follows:

Advanced Meteorological System Component Development. This effort developes the supporting equipment for recording and transmitting the information, for providing suitable power, and for stabilizing or aiming, and geographically referencing the position of the sensors' observations.

Advanced Meteorological Sensor Development. This effort leads to sensors which make the physical measurements used to supply meteorological data.

Meteorological Systems Research. This research has as its goal the determination of what physical measurements will provide the meteorological data needed by the research or operational users, what technical developments are necessary to make such measurements feasible, and what data handling will be required prior to transmission to the user.

Fiscal year 1963 funds were applied to continue the developments initiated in fiscal year 1962, and to initiate new studies and developments in the following major areas: synchronous meteorological satellite system studies, satellite radiation studies, day-night TV sensors, studies for satellite system data analysis and transmission, and various component developments such as attitude controls and video recorder systems. Fiscal year 1964 funds are being used to continue these activities and to start work in component and systems development for the synchronous meteorological satellite experiment, for rocket wind measurements, sferics studies, and for studies leading to an interrogation and recording subsystem which will be useful in collecting oceanographic and meteorological data from remote instrumented stations. Also work has started with the fiscal year 1964 funds for digital TV component development. The fiscal year 1965 funds are planned to continue the work in the above areas.

Synchronous Meteorological Satellite Experiments

	1963	1964	1965
Experiments.....	---	---	$3,200,000
Total costs.....	---	---	$3,200,000

The TIROS and Nimbus efforts are aimed at fulfilling the requirements for complete global coverage by meteorological satellite data on a detailed, periodic basis. However, the requirement remains for a system which can provide continuous monitoring of short-lived storms such as squall lines, tornadoes, etc. The feasibility of such a system will be investigated as part of the Advanced Technological Satellite project which will place a satellite in a 22,300 mile orbit so that it appears to be stationary at a given location over the equator. From such a position, a satellite can view tropical and temperate latitudes. With such a satellite instrumented to obtain meteorological data, continuous surveillance can be undertaken of a particular storm as it moves over the surface of the earth.

Several areas requiring technological development have been selected for flights of applicable experiments prior to proceeding to flight project status. Thereby test results will contribute to the definition of the flight project. Experiments are planned for required operating modes of the optical system, in the wide range of light values to be observed, and in the

other optical problems involved. The effects of sensor motion on spacecraft stabilization and station keeping will also be studied.

System studies were begun in fiscal year 1963 and completed in fiscal year 1964 under the supporting research and technology funding. Studies and hardware development for experiments are proposed for fiscal year 1965 so that these experiments will be ready for flight aboard spacecraft beginning in calendar year 1966. Total cost to completion of these experiments is estimated at $16.5 million. Direction of this proposed work will be assumed by the Office of Space Science and Applications of NASA Headquarters with Goddard Space Flight Center implementing the effort.

TIROS

	1963	1964	1965
Spacecraft.....	$7,905,000	$9,800,000	500,000
Ground support.....	1,071,000	3,200,000	$2,000,000
Launch vehicle.....	10,200,000	3,800,000	3,300,000
Total costs.....	$19,176,000	$16,800,000	$5,800,000

The engineering and scientific feasibility and the desirability of meteorological satellites has been demonstrated repeatedly by TIROS. In addition, TIROS continues to provide data toward the accomplishment of the additional project objectives which are: (1) to provide maximum interim operational data for use in weather analysis and forecasting prior to availability of data from operational systems, (2) to provide research and development toward advanced meteorological satellite systems, (3) to measure emitted infrared and reflected solar radiation in selected spectral regions, and (4) to observe cloud cover and patterns, and measure the earth-atmosphere heat balance.

The eight attempted launches have all been successful. Data for operational use have been provided since the first TIROS launch, April 1, 1960. TIROS has achieved a useful lifetime in orbit more than triple the original design lifetime of about four months. These satellites have discovered seventeen hurricanes and typhoons during project operations since July, 1961.

Research based on TIROS data has produced significant results in: (1) determining generally the relationships of the cloud patterns to the field of motion, (2) the genesis and life cycles of tropical storms, (3) identifying areas associated with severe local storms (such as tornadoes) from satellite pictures, (4) identifying and correlating cellular convective cloud patterns with the basic atmospheric parameters, and (5) utilization of satellite pictures in surveillance of ice packs and snow fields and cover.

The successful launch of TIROS VIII on December 21, 1963, with the Automatic Picture Transmission (APT) system aboard, is providing direct local readout to relatively inexpensive ground stations.

During fiscal year 1965, the ninth spacecraft in this series designated TIROS I, the "wheel" configuration, will be tested for providing earth oriented pictures from the spin-stabilized TIROS spacecraft. It is this configuration which when tested is expected to replace the earlier TIROS configuration in the Interim Operational Meteorological Satellite (IOMS) being funded by the Weather Bureau. These Interim Operational Meteorological Satellite launches are planned to begin in fiscal year 1965.

TIROS J will be launched into a low eccentric orbit in fiscal year 1965 to provide data at various altitudes and picture resolutions which will contribute to the technology required for advanced meteorological systems. The last TIROS launch (TIROS K) planned for fiscal year 1965 will be placed into a highly eccentric orbit with apogee at approximately synchronous altitudes. In fiscal year 1966, TIROS L will include one standard TV camera and one automatic picture transmission system for direct readout.

The fiscal year 1963 funds were used to purchase 4 Delta vehicles for TIROS VI, VII, VIII and "I" and an incremental payment for "J". Funds were also used to purchase spacecraft VII and an incremental payment was made on VIII. Also funds for Ground Operations and Support were used for TIROS V, VI, and VII.

The fiscal year 1964 funds provide complete funding for the "J" launch vehicle, an incremental payment for the TIROS "K" and "L" launch vehicles and spacecraft, and will complete the funding of TIROS VIII, "I" and "J". Also, funds are provided for Ground Operations and Support of TIROS VII and VIII. Fiscal year 1965 funds are planned to complete payment on spacecraft and the vehicles for "K" and "L", and to complete funding of Ground Operations and Support for TIROS VIII, "I" and "J".

The direction of the TIROS project is the responsibility of the Office of Space Science and Applications at NASA Headquarters. The project implementation is accomplished at Goddard Space Flight Center. The major contractor is the RCA Astro-Electronics Division.

In the TIROS project, especially as applicable to the operational aspects and development of operational systems, NASA and the Weather Bureau work closely together. The projects costs through fiscal year 1963 were $36,778,000. The project cost to completion including the next four launchings is estimated to be $60,193,000.

Nimbus

	1963	1964	1965
Spacecraft A, backup and B.....	$24,016,000	$30,800,000	$8,900,000
Ground support.....	3,345,000	9,400,000	6,600,000
Launch vehicle.....	1,200,000	1,000,000	3,400,000
Total costs.....	$28,561,000	$41,200,000	$18,900,000

The basic objectives of the Nimbus project are: (1) to develop a significantly improved meteorological satellite to provide data for use by meteorologists; (2) to carry out flight tests to prove the applicability of the instrumentation; (3) to fulfill special data requirements of the atmospheric sciences research community which can be provided uniquely by this instrumentation, functioning as a space meteorological observatory; and (4) to provide the basis for further significant technological advances in meteorological satellites.

The Nimbus spacecraft embodies major steps forward, beyond the basic TIROS, in four areas: (1) Orientation - Nimbus is designed to point down at the earth at all times; (2) Coverage - The satellite has the capability to provide complete global cloud cover data daily; (3) Night Time Cloud Cover Data - Specially developed high resolution infrared radiometers will be used to obtain experimental night cloud cover; and (4) Direct Local Readout - Users equipped with relatively simple, inexpensive ground stations can receive cloud cover pictures of their local area directly from the satellite. (This system is being tested in orbit on TIROS VIII.)

The Nimbus scheduled for launch in the first quarter of calendar year 1964 weighs about 750 pounds, stands ten feet high and is five feet across the sensory ring at the base. The sensory system will include three vidicon cameras, the automatic picture transmission system for direct local readout, and the high resolution infrared radiometers (HRIR) for providing night time cloud cover data. Should it be required, a backup (duplicate) spacecraft for the first Nimbus will be available for launch in fiscal year 1965 (third quarter of calendar year 1964).

The Nimbus B will be ready for launch in fiscal year 1966 and will incorporate redundant advanced vidicon cameras (two sets of these cameras), a redundant automatic picture transmission system, a single high resolution infrared system, and an advanced medium resolution infrared radiometer (MRIR). The greater weight resulting from these additional sensors will require the use of the thrust augmented version of the Thor-Agena launch vehicle.

It is expected that the experience resulting from the Nimbus will play a vital role in the development of operational meteorological satellite systems. Of immediate use will be the broad coverage (near global) day and night cloud cover data available from Nimbus flights.

Fiscal year 1963 funds were used to complete payment for the Thor-Agena "B" vehicle for Nimbus A and an incremental payment was made on the second vehicle. An incremental payment was made on 3 spacecraft and on the associated ground equipment (command data acquisition stations in Alaska and at Goddard plus other accessorial equipment).

In fiscal year 1964 an incremental payment is provided for the second vehicle. The funding for the Nimbus A spacecraft will be completed and an incremental payment on the backup and "B" spacecraft. The Ground Operations and Support funds are to complete the funding of ground equipment, the training of operating personnel and checkout of the ground systems, and for operations and maintenance subsequent to the launch of Nimbus A.

In fiscal year 1965 the funding will be completed for the second launch vehicle and completion of the backup spacecraft. Additional incremental payment will be made for the Nimbus B spacecraft. The fiscal year 1965 funding also provides for Ground Operations and Support for Nimbus A and pre-launch modification and checkout of the ground equipment for the Nimbus B launch.

The cost through fiscal year 1963 has totaled $61,236,000. The estimated cost to completion for the program through Nimbus B as outlined is $130,000,000.

Meteorological Sounding Rockets

	1963	1964	1965
Development of small meteorological sounding rocket system...	$147,000	$1,100,000	$1,100,000
Large meteorological sounding rocket project.....	1,290,000	1,800,000	1,900,000
Total costs.....	$1,437,000	$2,900,000	$3,000,000

For the large meteorological sounding rocket project the objectives are to develop and improve sensors and techniques for measuring the basic meteorological parameters in the region from 40 to 60 miles. The launch sites for these large rockets are located at several different latitudes. This distribution contributes to determining the magnitude and extent of the dynamic and thermodynamic variations of the atmospheric properties in the upper stratosphere and mesosphere.

In fiscal year 1963 fifteen large sounding rockets were launched using three experimental techniques; accoustical grenades, pitot tubes, and sodium vapor. These launches showed the applicability of the measurement techniques, and revealed interesting scientific features found at these altitudes. This included the existence of large wind shears in the area under study.

During the fiscal year 1964 approximately thirty-five of these launches are currently planned. The results are expected to lead to the refinement of measurement techniques, and provide additional scientific data. These launches will be distributed among Wallops Island; Ft. Churchill; John F. Kennedy Space Center, NASA; Ascension Island; and, possible, an Alaskan artic location. The launches from these locations, when possible, will be coordinated to provide measurements of geographical variation in addition to seasonal variations. In fiscal year 1965 funds are planned to provide for additional ground equipment and to pay for 45 large sounding rockets, of which 35 will be launched in fiscal year 1965.

Direction of the large meteorological sounding rocket project is by the Office of Space Science and Applications at NASA Headquarters. Implementation of the project is the responsibility of the Goddard Space Flight Center.

In the project to develop a small meteorological sounding rocket system, the objective is to develop a reliable, simplified, self-sufficient sounding system (rocket vehicle, sensors, and data acquisition) which would provide a capability for routine measurements of the basic meteorological parameters for research and an operational system in the 20 to 40 mile region of the atmosphere.

Data which have already been obtained in connection with previous developmental flights indicate that this region serves as an important link between the higher regions dominated by solar effects, and the lower regions where convection and air mass movement and mixing determine the surface weather. Thus, obtaining more data leading toward further understanding of the atmospheric processes is a step toward the solution of significant problems in weather analysis and forecasting.

The fiscal year 1963 funds paid for seventy-five small meteorological sounding rockets and launch costs. The fiscal year 1964 funds provide for an increment toward development of the small sounding rocket system (motor, sensors, data acquisition equipment, etc.), purchase and flight test of 100 small sounding rockets of various types. The fiscal year 1965 funds are planned for the flight testing of 100 rockets, improvement of the rocket systems, and a start on the design and development of an advanced system.

These launches are coordinated with those from the other national ranges as part of the meteorological rocket network.

Direction of the small meteorological sounding rocket project is the responsibility of the Office of Space Science and Applications in NASA Headquarters. Langley Research Center is responsible for the project implementation.

OFFICE OF SPACE SCIENCE AND APPLICATIONS COMMUNICATIONS SATELLITES PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

Communication satellites make it possible to establish microwave communications over long distances by providing relay stations at altitudes where they are simultaneously in line-of-sight of many points on the Earth's surface. With their use all types of telecommunications can be extended to the entire Earth. This program will support the continuing development, improvement, and expansion of the practical uses of communication satellite systems through research, development, and flight tests.

Launches of communication satellites through the first half of fiscal year 1964 have (1) proved the feasibility of erecting passive satellites in space and of placing active satellites in intermediate and synchronous orbit, and (2) permitted successful conduct of communications experiments with Echo I, Relay I, Telstar I and II, and Syncom II, linking the United States with Europe, United States with Africa, United States with South America, and United States with Japan. As the year 1964 begins, Echo I is still in orbit after 3½ years, Relay I has completed one year of successful operations, and Syncom II has operated successfully for six months since its launch in July 1963. Echo III, Relay II, and Syncom III, to be launched in the last half of fiscal year 1964, will be of greater reliability than their predecessors and will furnish additional lifetime data. In addition, Syncom III will be placed in a synchronous equatorial orbit over the Pacific Ocean whereas Syncom II is in a synchronous orbit included 33° to the equator over the Atlantic.

This program utilizes and advances the practical application of space communication, seeks the full exploitation of the communication satellite potential, and assists in attaining the national goal of the early establishment of an operational global communications satellite system.

SUMMARY OF RESOURCES REQUIREMENTS:

	1963	1964	1965
Supporting research and technology	$3,012,000	$1,700,000	$3,500,000
Echo II	2,299,000	2,600,000	300,000
Relay	13,751,000	2,900,000	1,800,000
Syncom	13,013,000	6,300,000	2,000,000
Early gravity gradient experiment	---	---	5,000,000
Total costs	$32,075,000	$13,500,000	$12,600,000

BASIS OF FUND REQUIREMENTS:

Supporting Research and Technology

	1963	1964	1965
Advanced passive satellite studies.....	$700,000	$500,000	$1,000,000
Research, experimentation, and development.....	2,312,000	1,200,000	2,500,000
Total costs.....	$3,012,000	$1,700,000	$3,500,000

In the Communications Satellites program there is a continuing need for activity in supporting research and technology which will identify and solve critical technical problems, advance the state-of-art, and provide a technical foundation for future improved communications and navigation satellites.

Research on overall communication system problems over the past several years has been concentrated in three areas: integration of communications satellite systems with conventional terrestrial systems; economic factors; and technical aspects of frequency allocation and sharing. The latter effort contributed importantly to the International Telecommunications Union Conference on Space Communications. Additional studies will be conducted in fiscal year 1965 on integration of satellite and terrestrial systems, to determine the influence on design of future communication satellite systems of present and planned routing, signalling, switching, and multiplexing schemes for terrestrial systems. These studies will provide a basis for upcoming international negotiations relating to the integration of satellite and terrestrial systems.

Economic studies in the past have begun to provide valuable information on tradeoffs between various communication satellite systems and between design parameters. These studies will be pursued in fiscal year 1965 as an aid in selecting the best course for research and development.

In fiscal year 1963, three navigation-traffic coordination satellite system feasibility study contracts were initiated and are scheduled for completion in fiscal year 1964. An in-house comparison of the results will then be made with cooperation from potential user agencies. It is anticipated that, through the joint efforts of National Aeronautics and Space Administration and the various government departments or agencies (Federal Aviation Agency, Departments of Commerce, Interior, Treasury, and Defense) having an interest, a recommended national program plan will be developed which will set forth the required future effort.

In fiscal year 1965, investigation effort will continue on satellite systems capable of linking terminals of greatly reduced size and cost making possible communications with aircraft, ships at sea, and small portable emergency land stations. A capability of this sort will be necessary for navigation and air traffic control systems, and will require the use of either a high-powered, fully stabilized satellite or a satellite with moderate power and high-gain, narrow-beam, steerable antennas.

A modest laboratory effort on materials, structures, and erection-system development in advanced passive satellite research has been conducted in the past and will continue during fiscal year 1965. Materials and structures development efforts are directed toward providing for greatly reduced weight and adequate stiffness of space structures to reduce the perturbing and deforming effects of solar pressure and aerodynamic drag. Erection systems will be developed having characteristics required for reliably deploying and erecting these lightweight structures in the space environment.

The fiscal year 1965 program to improve subsystems will provide for continuation of studies on modulation techniques, with emphasis on techniques which improve multiple access capabilities; on raising the conversion efficiency between the satellite's primary power source and transmitter power output; and on improving the characteristics of both satellite and ground receivers.

Echo II

	1963	1964	1965
Spacecraft.....	$1,544,000	$300,000	---
Ground operations and support..	255,000	1,000,000	$300,000
Thor-Agena launch vehicle.....	500,000	1,300,000	---
Total costs.....	$2,299,000	$2,600,000	$300,000

The objectives of Project Echo II are to design, develop, launch, and evaluate a 135-foot diameter spherical passive satellite (Echo II), which will be rigid enough to maintain its suitability as a reliable reflector of radio waves throughout its orbital life of several years, even after the pressurizing gas has escaped. The passive communication satellite will be launched into a 800 statute mile near-polar orbit. A test program involving two ballistic launches from the Atlantic Missile Range to test the satellite deployment and inflation sequence has been completed. The first ballistic flight, which was conducted on January 15, 1962, was unsuccessful. A redesigned payload was launched in the second ballistic test on July 18, 1962. Inflation was successful but the sphere was not a good reflector of radio waves because of insufficient pressure. Accordingly, the satellite inflation system has been redesigned to provide sufficient pressure in the sphere. Flight spacecraft are being prepared for the orbital launch scheduled for the first quarter of calendar year 1964, using a Thor-Agena vehicle.

The launch vehicle will carry a television system of the type used on the ballistic launches to permit observation of satellite separation and inflation during injection into orbit.

The Office of Space Science and Applications, National Aeronautics and Space Administration Headquarters, is responsible for the overall management of Project Echo II. Responsibility for project management is assigned to Goddard Space Flight Center. Vehicle systems management for the Thor-Agena vehicle is assigned to Lewis Research Center. Major contractors are G. T. Schjeldahl Company for the inflatable spheres, Grumman Aircraft Corporation for the canisters and launch support, Douglas Aircraft Corporation for the ballistic launch vehicles and the Thor booster for the orbital launch, and Lockheed for the Agena stage and integration of the launch vehicle. Support is also provided by participation of various Department of Defense tracking facilities.

Fiscal year 1963 and prior years funds amounting to $14.7 million have provided for design, development, fabrication, and evaluation of the spherical satellite; its associated tracking beacons and canister; and partial funding of the orbital launch vehicle. They have also supported all costs for the two ballistic flights. Fiscal year 1964 funds cover spacecraft costs, qualification tests, launch operations of Echo III, remaining launch vehicle costs, and initial operation of the radar and optical stations which will be used to obtain data from which the performance of the satellite in orbit will be assessed. Fiscal year 1965 funds are required to continue the radar and optical coverage of the satellite as well as for data analysis, correlation of that data with ballistic launch, and ground test results. It is estimated that an additional $200,000 will be required after fiscal year 1965 for continued data acquisition, reduction, and analysis.

Relay

	1963	1964	1965
Spacecraft.....	$6,616,000	$ 500,000	---
Ground operations and support..	6,135,000	2,100,000	$1,800,000
Delta vehicle.....	1,000,000	300,000	---
Total costs.....	$13,751,000	$2,900,000	$1,800,000

The mission of Project Relay is to perform experimental narrow band (telephone, etc.) and wide band (television) communications tests between widely separated ground stations by means of intermediate altitude active communications satellites; to measure the effects of the space environment on these satellites; and to determine the useful lifetime of the satellites.

Project Relay provides for the design, development, launch, operation, and evaluation of two intermediate altitude wide band active communications satellites. These satellites include circuits and components to monitor the

important parameters of the satellite while functioning in the space environment. The satellites contain, in addition to power supplies and command and telemetry equipment, two (duplicate, but not simultaneously operating) communication transponders each providing a single television channel or twelve two-way telephone or data channels; and experiment packages to monitor both the radiation environment encountered and the damaging effects of that environment on components designed for satellites.

Relay I was launched into orbit on December 13, 1962. An early failure occurred which prevented operation of the transponders for the first three weeks after launch. Since that time the satellite has been operating successfully for more than a year performing more than 1,800 technical experiments and 125 demonstrations involving ground stations in the United States, Great Britain, France, Germany, Italy, and Japan. During this period more than 550 hours of radiation data have been recorded. An improved satellite has been prepared for launch into orbit in the first quarter of calendar year 1964 to gather further experimental data, evaluate the spacecraft improvements, continue radiation measurements, and provide a measurement of useful satellite lifetime.

The Office of Space Science and Applications, National Aeronautics and Space Administration Headquarters, is responsible for the overall management of Project Relay. Responsibility for project management is assigned to the Goddard Space Flight Center. Vehicle systems management for the Delta vehicle is also a Goddard responsibility. Major contractors are Radio Corporation of America for the satellites; Space Technology Laboratories for satellite preliminary design, systems coordination and planning, test station operation, and experiment review and analysis; Philco Corporation for the West Coast station antenna; American Telephone and Telegraph and International Telephone and Telegraph for ground station operations; and Douglas Aircraft Corporation for the launch vehicles.

Fiscal year 1963 and prior year funds amounting to $39.8 million have provided for spacecraft design, fabrication, test, a major part of the procurement of launch vehicles, launch operations support, ground station operational services, and performance of experiments for Relay I. Fiscal year 1964 funds provide for the final experiments and data handling costs for Relay I, final assembly, test, launch, ground station operation for the first six months of the Relay II, and final incremental funding of launch vehicles. Fiscal year 1965 funds are required to maintain and operate the communications ground stations, to perform communications experiments, to coordinate the overall experimental program, and to gather, reduce, correlate, and analyze the data obtained through the Relay I and II experimental programs. This analysis will result in improved design criteria and techniques for future satellites, both communication and scientific, and in more reliable data as to satellite lifetimes and operational systems design. It is estimated that an additional $500 thousand will be required after fiscal year 1965 for operation of ground stations, data collection, reduction, and analysis.

Syncom

	1963	1964	1965
Spacecraft.....	$5,092,000	$2,700,000	$300,000
Ground operations and support...	3,921,000	500,000	1,700,000
Thrust-augmented Delta (TAD)....	4,000,000	3,100,000	---
Total costs.....	$13,013,000	$6,300,000	$2,000,000

The objectives of Project Syncom are to provide experience in using communication satellites in a synchronous orbit to flight test a new and simple approach to satellite attitude and period control; to develop transportable ground facilities which can be deployed in useful areas; to develop the capability of launching satellites into the synchronous orbit using existing launch vehicles plus apogee kick rockets; and to test the life of communications satellites components at the synchronous orbital altitude.

Project Syncom provides for the design, development, testing, and launching of four active communication satellites into synchronous orbits.

Syncom I was launched on February 14, 1963, but all electronic systems failed during the firing of the apogee kick motor although subsequent optical sightings showed that the spacecraft did achieve a near-synchronous orbit.

Syncom II was launched successfully on July 26, 1963, into a synchronous orbit. As planned, this orbit has a 33 degree inclination to the equatorial plane which results in the satellite describing a slender figure eight path along a preselected longitude on the Earth's surface with excursions of 33 degrees of latitude to the north and south.

The availability of a Thrust-Augmented Delta (TAD) launch vehicle now makes it possible to launch Syncom III and IV into synchronous orbits of low inclination to the equatorial plane. This capability will make it possible for the first time for a satellite to remain virtually stationary with respect to a point on the Earth's equator. The Syncom IV spacecraft would serve as a means of flight testing new design advances in transponders and range and range-rate equipment for orbital determination while making maximum use of other existing hardware.

The Office of Space Science and Applications, National Aeronautics and Space Administration Headquarters, is responsible for the overall management of Project Syncom. Responsibility for project management is assigned to Goddard Space Flight Center. Vehicle systems management for the TAD is also a Goddard responsibility.

The major contractors are the Hughes Aircraft Company for spacecraft, telemetry and command equipment, and the Space Technology Laboratories for range and range-rate equipment. The Department of Defense through the United States Army Satellite Communications Agency has furnished the ground stations with the exception of ground equipment required for telemetry, command, and range and range-rate.

Fiscal year 1963 and prior year funds amounting to $26.1 million provided for spacecraft design and development, a major portion of vehicle costs, communication experiments, and ground and launch support for the first two launches. Fiscal year 1964 funds provided for flight hardware, communication experiments, ground and launch support, operation of Syncom and the balance due for launch vehicles. Fiscal year 1965 funds are required for flight hardware, communication experiments, ground and launch support for Syncom IV and continuation of operation of the others. It is estimated that an additional $2.0 million will be required after fiscal year 1965 to complete the communication experiments, operational support, and data reduction and analysis.

Early Gravity Gradient Experiment

	1963	1964	1965
Spacecraft.....	---	---	$5,000,000

This project includes research, development, and test of gravity gradient stabilized spacecraft, which directly supports the Department of Defense communications satellite program. The spacecraft design will be compatible with the requirements provided to NASA by the Department of Defense; stabilization components will be designed for orbital test into a 6,500 mile circular orbit; and responsibility for flight demonstration of the spacecraft will rest with the Department of Defense.

The fiscal year 1965 funding estimate covers the design and development of spacecraft, but does not include launch vehicle and ground support services as these will be provided by the Department of Defense.

OFFICE OF SPACE SCIENCE AND APPLICATIONS

ADVANCED TECHNOLOGICAL SATELLITES PROGRAM

PROGRAM OBJECTIVES AND JUSTIFICATION:

The objectives of the program are (1) to develop spacecraft technology particularly suited for space applications, (2) to provide capability for experimental testing of the techniques and devices from various engineering and technological disciplines in the space environment, particularly in the higher altitude orbits, and (3) to provide basic technological and scientific data on gravity gradient stabilization in the 6,500 mile orbit which may be extrapolated to the more difficult synchronous orbits. There is an existing and growing need in the Department of Defense and in National Aeronautics and Space Administration for improved spacecraft technology in the areas of stabilization, orientation, and station keeping in the 24 hour orbit. There is a requirement for obtaining engineering data on the 24 hour orbit for use in designing systems for that discrete orbit with its unique features. There is also a requirement of great importance to both the Department of Defense and National Aeronautics and Space Administration for basic information to validate theoretical concepts of gravity gradient stabilization. This information should be amenable to extrapolation to other altitudes and be convertible to engineering handbook type data for use in systems design. It is the purpose of the Advanced Technological Satellites program to meet these requirements.

SUMMARY OF RESOURCES REQUIREMENTS:

	1963	1964	1965
Supporting research and technology	$8,668,000	$2,100,000	$1,100,000
Advanced technological satellites	---	16,400,000	29,900,000
Total costs	$8,668,000	$18,500,000	$31,000,000

BASIS OF FUND REQUIREMENTS:

Supporting Research and Technology

	1963	1964	1965
Advanced synchronous satellites studies.....	$8,668,000	---	---
Stabilization techniques.....	---	$1,500,000	$500,000
Propagation studies.....	---	300,000	300,000
Components development.....	---	300,000	300,000
Total costs.....	$8,668,000	$2,100,000	$1,100,000

In the Advanced Technological Satellites program there is a continuing need for activity in supporting research and technology to identify critical problems and long lead-time development items; to advance the state-of-the-art; and to provide a technical foundation for advanced technological satellites.

Spacecraft components and materials investigation and development will be continued. It is anticipated that newly initiated work in microwave and millimeter-wave components for spacecraft will advance the state-of-the-art, and that investigations of existing components will improve reliability. The program to develop high-gain, steerable spacecraft antenna initiated in fiscal year 1963 has begun to yield promising results and will be continued in fiscal year 1965.

Design of radio propagation experiments at frequencies above ten gigacycles was begun in fiscal year 1964, and development of components necessary to perform the experiments will be carried out in fiscal year 1965. This investigation may extend the useful areas of the radio frequency spectrum.

In fiscal year 1963 and prior years, parametric studies were initiated on passively damped gravity gradient attitude control systems. Rigorous mathematical models have been established and computer analyses have been completed on several three-axis orientation systems. These studies have provided the basis from which conceptual designs for use with satellites in intermediate altitude and synchronous orbits have evolved. In fiscal year 1964, a major advanced technical development effort will be initiated for stabilization components, such as magnetic hysteresis and eddy current libration dampers, extendable gravity gradient booms and associated control mechanisms, and sensors. These efforts will be continued in fiscal year 1965. This program effort is in direct support of planned flight test and demonstration.

Advanced Technological Satellites

	1963	1964	1965
Spacecraft.....	---	$12,700,000	$18,400,000
Ground operations and support..	---	3,700,000	5,600,000
Atlas-Agena vehicle.....	---	---	5,900,000
Total costs.....	---	$16,400,000	$29,900,000

The objectives of the Advanced Technological Satellites project are: (1) to provide a capability for performing varied scientific and technological experiments in the synchronous orbit with a single spacecraft; (2) to conduct a carefully instrumented gravity gradient experiment in a 6,500 mile orbit; (3) to develop the technology for an Earth-oriented satellite in the synchronous orbit; (4) to investigate in space a directed antenna from a spin-stabilized satellite; and (5) to investigate access to a communication satellite by more than one pair of ground stations at a time. This program represents a reorientation of Advanced Syncom, reflecting results of studies which have indicated that the original spacecraft has the potential of being used for more than just communications experiments. It can, in fact, be used for many scientific and space technology investigations. It is planned that the technology accruing from this program will form an important input to future spacecraft design and development in the fields of stabilization, orientation (both gravity gradient and active systems), station-keeping, communications, meteorology, radiation damage, and possibly navigation.

The advanced technological satellites spacecraft will be large structures of the 650 pound class. It is planned to launch a total of five spacecraft with five Atlas-Agena launch vehicles over a period of three years. One spacecraft will be launched into a 6,500 mile orbit without the use of an apogee-kick motor. This spacecraft will be gravity gradient stabilized and will be highly instrumented as a gravity gradient technology experiment. The next two spacecraft will be spin-stabilized, launched in a synchronous equatorial orbit, and will carry communications, meteorological, radiation damage, and other technological and scientific experiments suited for a spinning spacecraft. The last two launches will be devoted to developing technology for an Earth-oriented satellite in a synchronous equatorial orbit. These satellites will also carry technological and scientific experiments suited to the Earth-oriented spacecraft.

The Office of Space Science and Applications, National Aeronautics and Space Administration Headquarters, is responsible for the overall management of the Advanced Technological Satellites project. Responsibility for project management is assigned to Goddard Space Flight Center. Vehicle systems management for the Atlas-Agena vehicle is assigned to Lewis Research Center. Major contractors for the spacecraft have not as yet been selected.

Funding on this project started in fiscal year 1964 under the Advanced Syncom line item of the fiscal year 1964 budget, and a substantial study effort preceeded that in fiscal years 1962 and 1963 under supporting research and technology. Fiscal year 1964 funds pay for the reorientation of the project, for initial funding of the 6,500 mile orbit gravity gradient spacecraft, the synchronous orbit spinning spacecraft, and for procurement of ground station equipment. Fiscal year 1965 funds will be required for incremental funding of the launch vehicles for the 6,500 mile and the 24 hour spinning spacecraft, to continue funding the 6,500 nautical mile and synchronous spacecraft procurements, and to complete procurement of ground station equipment.

It is estimated that approximately $77,000,000 in additional funding will be required after fiscal year 1965 to complete the entire program described, to provide for spacecraft design, development, test, launch; launch vehicles; operational support, and data acquisition, reduction, and analysis.

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1965 ESTIMATES

EARTH ALBEDO AND INFRA-RED SIMULATION SYSTEM FOR THE SPACE ENVIRONMENT SIMULATOR

PROGRAM OFFICE FOR THE INSTALLATION: Office of Space Science and Applications

PROGRAM OFFICE FOR THE PROJECT: Office of Space Science and Applications

AUTHORIZATION LINE ITEM: Goddard Space Flight Center

LOCATION OF PROJECT: Greenbelt, Prince Georges County, Maryland

COGNIZANT NASA INSTALLATION: Goddard Space Flight Center

TYPE OF CONSTRUCTION PROJECT: Alteration

FUNDING:

FY 1963 and Prior Years	---
FY 1964 Estimate	---
FY 1965 Estimate	$500,000
Total Funding Thru FY 1965	$500,000

PROJECT COST ESTIMATE:

	Unit of Measure	Quantity	Unit Cost	Total Cost
Land Acquisition	---	---	---	---
Construction	---	---	---	---
Equipment				$500,000
Lamp units and cooling systems	LS	---	$230,000	230,000
Power controls	LS	---	60,000	60,000
Instrumentation	LS	---	35,000	35,000
160 framework	LS	---	25,000	25,000
Electrical system	LS	---	80,000	80,000
Modify cryogenic system	LS	---	70,000	70,000
Design	---	---	---	---
Fallout Shelter	---	---	---	---
			TOTAL	$500,000

PROJECT DESCRIPTION:

This project provides a system within the Space Environment Simulator for producing Earth Albedo and Infra-Red Radiation. The system will consist of high intensity lamp units mounted within the chamber and their associated controls and instrumentation. As envisioned, the lamp units would be distributed over an approximate 160°, 14' radius spherical cap in the lower section of the chamber. The coverage would represent the radiation pattern encountered by spacecraft at low orbital altitudes as they enter the Albedo and receive maximum Infra-Red Radiation during passage between the earth and the sun. Primary controls for the system would be located adjacent to the master control station for the Space Environment Simulator on the first floor of Building 10, with power supplies and auxiliary equipment installed in the basement. The system is to provide controlled intensity up to a maximum of 75 watts per square foot with close spectural match of the real environment.

PROJECT JUSTIFICATION:

Earth Albedo and Infra-Red simulation, as an adjunct to simulation of direct solar insolation is required during tests of spacecraft to establish both performance and the thermal balance characteristics of spacecraft. Simulation of this environment would improve evaluation and techniques particularly in the area of providing a realistic environment to sensors (experiments, guidance detectors and horizon scanners) and spacecraft surfaces of the stabilized observatories where orientation with respect to earth is fixed. So far as thermal balance is concerned the necessity for Albedo and Infra-Red simulation is strongly dependent on the case at hand. The thermal exposures of satellites are functions of their orbital period and plane and their relative orientation in that plane. With satellites in those orbits where they receive 100% solar exposure, the inputs from Albedo and Infra-Red can remain nearly constant during their life. If the Albedo and Infra-Red inputs are neglected during test, thermal gradients across opposite sides of such spacecraft can become sufficiently exaggerated to cause considerable difficulty in analyzing the effects of the real environment upon spacecraft reliability. In the case of the orbiting observatories,the alignment of optical systems and other sensors is a major consideration and proof of system function is strongly dependent upon a realistic thermal test environment.

To summarize: Simulation of Albedo and Earth emitted Infra-Red is required for the test and evaluation of near-earth orbiting spacecraft to:

1. Verify performance of earth oriented sensors and experiments.

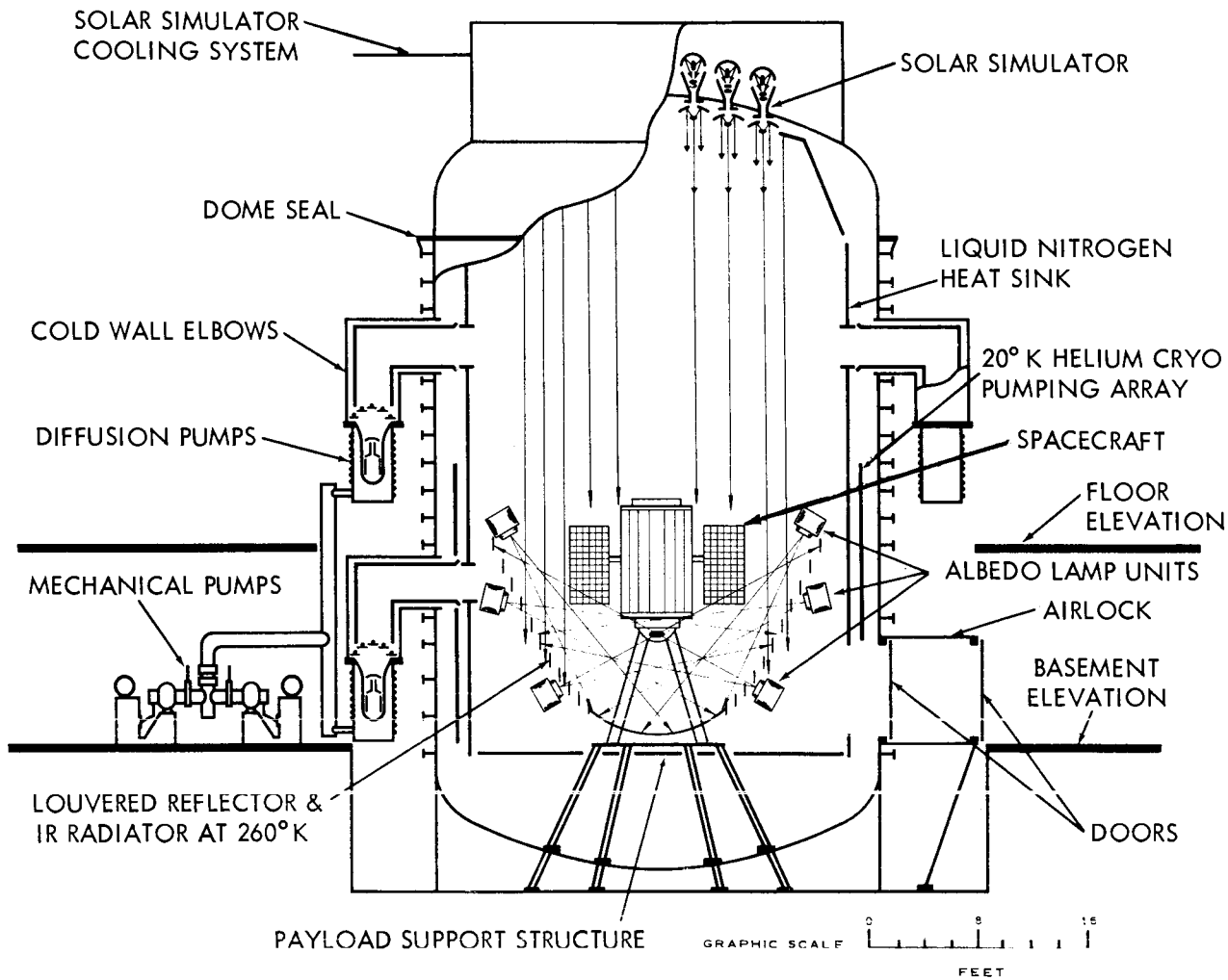
2. Verify the adequacy of the thermal design from the standpoint of providing a realistic radiation environment (simulated flux and distribution) to determine the proper functioning of electronics under simulated orbital conditions.

3. Verify proper temperature distribution to determine whether thermal distortion effects, which could be harmful to optical experiments, have been accounted for by the design.

ESTIMATED FUTURE YEAR FUNDING: None

GODDARD SPACE FLIGHT CENTER
FISCAL YEAR 1965 ESTIMATES

EARTH ALBEDO AND INFRA-RED SIMULATION SYSTEM FOR THE SPACE ENVIRONMENT SIMULATOR



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CONSTRUCTION OF FACILITIES

FISCAL YEAR 1965 ESTIMATES

ADDITION TO SPACECRAFT DEVELOPMENT ENGINEERING BUILDING NO. 233

PROGRAM OFFICE FOR THE INSTALLATION: Office of Space Science and Applications

PROGRAM OFFICE FOR THE PROJECT: Office of Space Science and Applications

AUTHORIZATION LINE ITEM: Jet Propulsion Laboratory

LOCATION OF PROJECT: Pasadena, Los Angeles County, California

COGNIZANT NASA INSTALLATION: Jet Propulsion Laboratory

TYPE OF CONSTRUCTION PROJECT: Extension

FUNDING:

FY 1963 and Prior Years	$595,000
FY 1964 Estimate	36,000
FY 1965 Estimate	564,000
Total Funding Thru FY 1965	$1,195,000

PROJECT COST ESTIMATE:

	Unit of Measure	Quantity	Unit Cost	Total Cost
Land Acquisition	---	---	---	---
Construction				$465,000
Laboratory building	Sq. Ft.	16,000	$27.00	432,000
Utilities	LS	---	33,000	33,000
Equipment				$80,000
Class I clean room	LS	---	50,000	50,000
Class IV clean room	LS	---	30,000	30,000
Design				$19,000
For construction	LS	---	19,000	19,000

	Unit of Measure	Quantity	Unit Cost	Total Cost
Fallout Shelter	---	---	---	---
		TOTAL		$564,000

PROJECT DESCRIPTION:

This project proposes the expansion of an existing facility, Spacecraft Development Engineering Building 233, in order to provide adequate clean laboratory space for the Engineering Mechanics Division. It will be an integrated facility combining shops, laboratories, stockrooms, and assembly areas. Of the gross floor area of approximately 35,000 sq. ft. (including the existing Spacecraft Development Engineering Building 233), approximately 14,200 sq. ft. will be devoted to NASA Type I clean room laboratories; approximately 2,700 sq. ft. to NASA Type IV clean rooms; and the balance to high bay assembly areas and conventional laboratory space. The shops, laboratories and assembly areas will provide space in which work will be performed by approximately 65 engineers, test engineers, and technicians.

The present Spacecraft Development Engineering Building 233 contains approximately 19,000 sq. ft., including 7,000 sq. ft. of high bay assembly area, an electronic cable and potting laboratory, a small machine shop, a mechanical lab, and a stockroom. This building will be expanded to the proposed 35,000 sq. ft. by the addition of two stories on the present west laboratory wing.

PROJECT JUSTIFICATION:

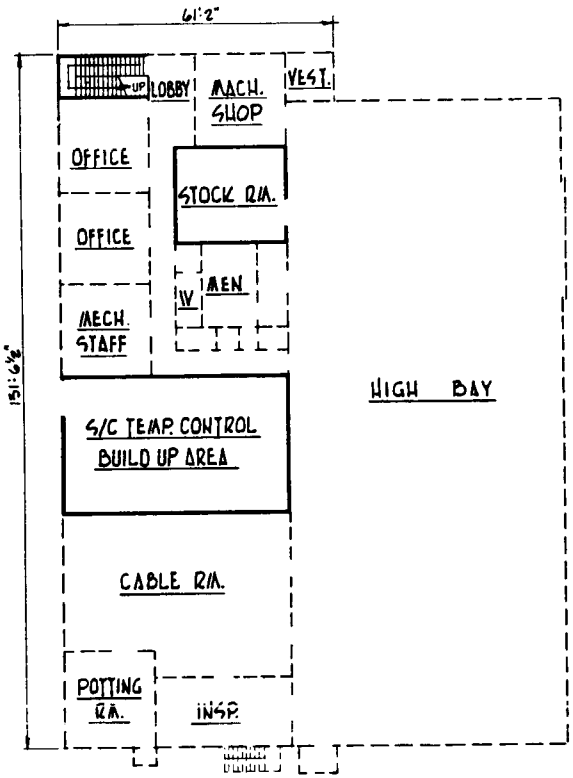
The Engineering Mechanics Division is responsible for the development of the configuration, structure, mechanisms, temperature control, cabling and electronic packaging for all JPL spacecraft projects. The delicacy and precision of components in current and future spacecraft make it mandatory that if the desired high reliability is to be obtained, work areas in which development and manufacturing occur must be much cleaner and better controlled than heretofore. The NASA has developed requirements which are delineated in NASA Procedure Document 200 Y, which specify much cleaner and better controlled work areas than are presently available for the accomplishment of many of the tasks for which the Engineering Mechanics Division is responsible. At the present time, the Division is housed in some 11 different buildings, including 33% of the activities at an off-Lab site and in 10 different trailers. The building and trailers including off-Lab space are widely scattered and cannot provide the environment delineated by NASA for achievement of desired high reliability.

ESTIMATED FUTURE YEAR FUNDING: None

JET PROPULSION LABORATORY

FISCAL YEAR 1965 ESTIMATES

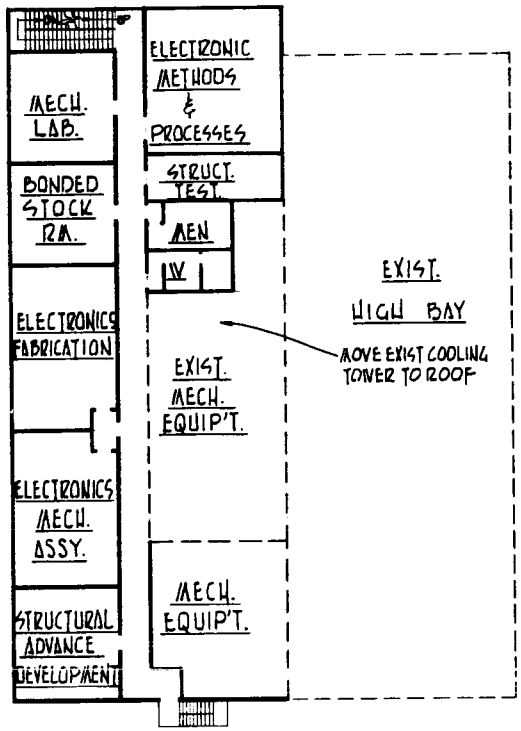
ADDITION TO SPACECRAFT DEVELOPMENT ENGINEERING BUILDING NO. 233



FIRST FLOOR PLAN

SCALE IN FEET

0 4 8 16 32

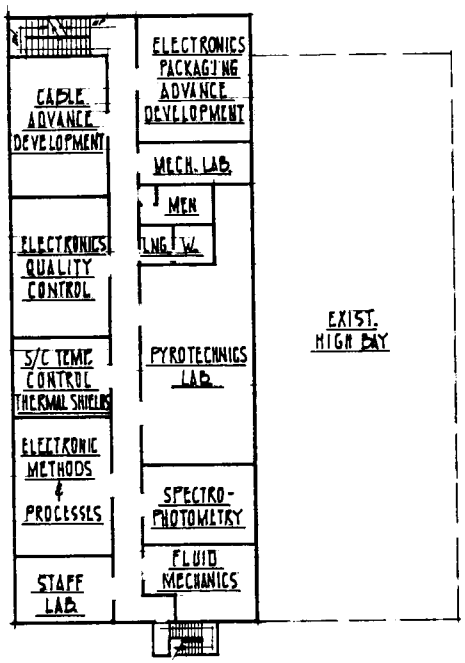


SECOND FLOOR PLAN

JET PROPULSION LABORATORY

FISCAL YEAR 1965 ESTIMATES

ADDITION TO SPACECRAFT DEVELOPMENT ENGINEERING BUILDING NO. 233



THIRD FLOOR PLAN

SCALE IN FEET

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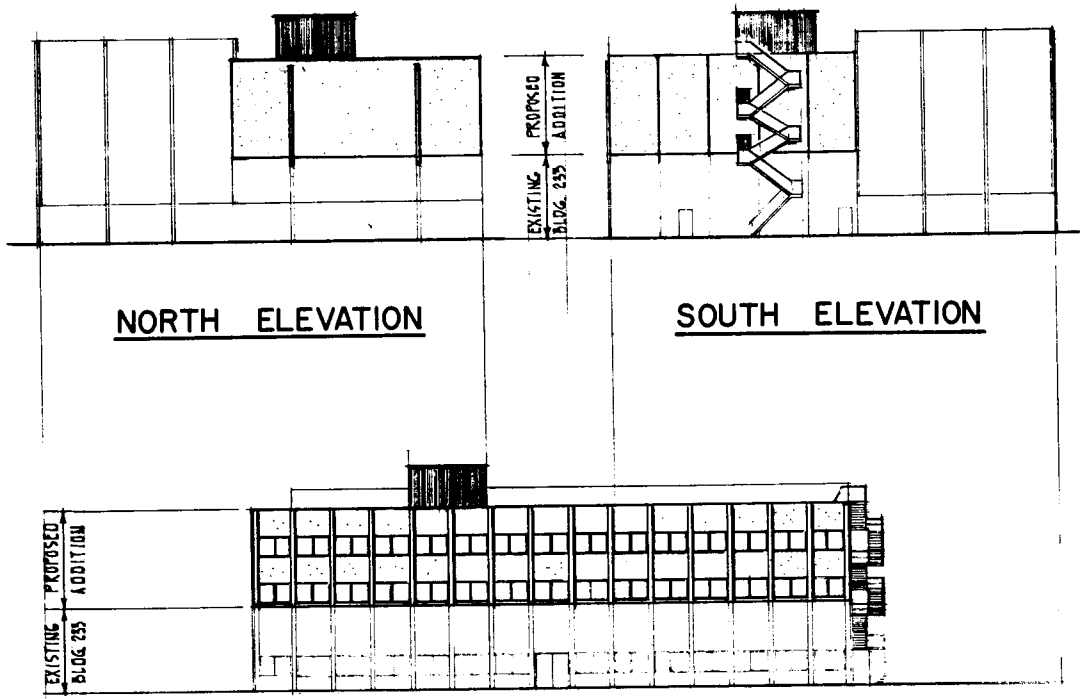

WEST ELEVATION

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1965 ESTIMATES

25-FOOT SIMULATOR MODIFICATION

PROGRAM OFFICE FOR THE INSTALLATION: Office of Space Science and Applications

PROGRAM OFFICE FOR THE PROJECT: Office of Space Science and Applications

AUTHORIZATION LINE ITEM: Jet Propulsion Laboratory

LOCATION OF PROJECT: Pasadena, Los Angeles County, California

COGNIZANT NASA INSTALLATION: Jet Propulsion Laboratory

TYPE OF CONSTRUCTION PROJECT: Alteration

FUNDING:

FY 1963 and Prior Years	$4,266,000
FY 1964 Estimate	150,000
FY 1965 Estimate	2,350,000
Total Funding Through FY 1965	$6,766,000

PROJECT COST ESTIMATE:

	Unit of Measure	Quantity	Unit Cost	Total Cost
Land Acquisition	---	---	---	---
Construction				$60,600
Laboratory building	Sq. Ft.	625	$55.52	34,700
Site preparation	LS	---	3,300	3,300
Roads and parking	LS	---	500	500
Utilities	LS	---	22,100	22,100
Equipment				$2,251,400
Lamp area temperature control	LS	---	20,000	20,000
Tank modifications	LS	---	350,000	350,000
Cryogenic system modifications	LS	---	310,000	310,000
Optical system modifications	LS	---	1,571,400	1,571,400

	Unit of Measure	Quantity	Unit Cost	Total Cost
Design				$38,000
For Construction	LS	---	$8,000	8,000
For Equipment	LS	---	30,000	30,000
Fallout Shelter	---	---	---	---
		TOTAL		$2,350,000

PROJECT DESCRIPTION:

This project proposes major modifications to the JPL 25-foot simulator facility in order to obtain a larger and higher performance solar simulation capability required for testing full-scale scientific spacecraft of the Centaur boosted class such as Mariner-B and Surveyor. The 25-foot diameter by 25-foot high clear test volume and internal cold sink walls will remain the same size when the larger solar beam is produced. The new solar simulation system will provide a vertically downward beam 15 feet in diameter having an intensity of 135 watts/square foot (earth orbit intensity) with $\pm$ 5% uniformity, and $\pm 2^{\circ}$ collimation. A smaller diameter 10 foot beam with 270 watts/square foot (Venus orbit intensity) will also be available. In comparison, the present system is limited to a 6 foot diameter, 135 watts/square foot beam, with $\pm$ 5% uniformity and $\pm 5^{\circ}$ collimation.

The new solar simulation system will be composed of a multi-lamp array in which the energy from each lamp will be directed upward through a transfer lens in the wall of the vacuum vessel to a large primary collimating mirror in the top of the simulator. The uniform beam of light leaving the primary collimator is oriented vertically downward to the test area. Each lamp illuminates the entire test area.

The installation of the advanced solar simulation system will require the following principal tasks:

a. Removal of the existing solar simulation equipment, including the 28 foot high solar lamp and mirror enclosure.

b. Construction of a basement to the north of the chamber to house the new lamp array.

c. Extension of the vacuum vessel upward approximately 28 feet to accommodate the optical path and off-axis collimating reflector. The overall facility height will be essentially unchanged.

d. Installation of a vacuum tank penetration for the transfer lens array, relocation of several diffusion pumps, and modification and extension of the liquid nitrogen cooled cold walls.

e. Installation of advanced optical system components including lamp array, power supplies, lens system, and primary collimator.

This work, although relatively extensive, is at the same time straight forward. No difficulty is foreseen in accomplishing it with a minimum of facility down-time.

PROJECT JUSTIFICATION:

The solar simulation performance levels of the proposed system are compared below with the capability of the present system.

Performance Parameter	Present Capability	Proposed System	
		Earth to Mars Orbit	Earth to Venus Orbit
Beam size, hexagonal measured across flats, (diameter) ft.	6	15	8 to 10
Practical operating intensity, watts/sq. ft.	135 (Earth orbit)	135 to 50	135 to 270
Uniformity, percent	±5	±5	±8
Collimation, degrees	±5	±2	±2
Spectral match with sun	Fair	Good	Good

The present solar simulation system provides a useful and important test capability for spacecraft of the Atlas-Agena class such as Ranger, Mariner-R, and Mariner-C. However, the testing requirements for future spacecraft of the Centaur class, such as Mariner-B, and Surveyor, require a larger solar simulation beam in the JPL 25-Foot Space Simulator than can be produced with the present system. Furthermore, the improvements in uniformity, collimation, and spectrum which will be obtained with the new system are highly significant and are regarded as essential for accurate thermal-balance testing of advanced classes of scientific spacecraft.

The maximum performance attainable with the present system is estimated to be a six-foot 5% uniform beam or a seven-foot 10% uniform beam. A comprehensive analysis of the existing solar-simulator clearly indicates that it is not possible to greatly improve its capability because of basic optical geometry restraints. Advances in the state-of-the-art since the original

design enables fitting the facility with a larger solar simulation unit which will be commensurate with the overall chamber size and testing potential.

ESTIMATED FUTURE YEAR FUNDING: None

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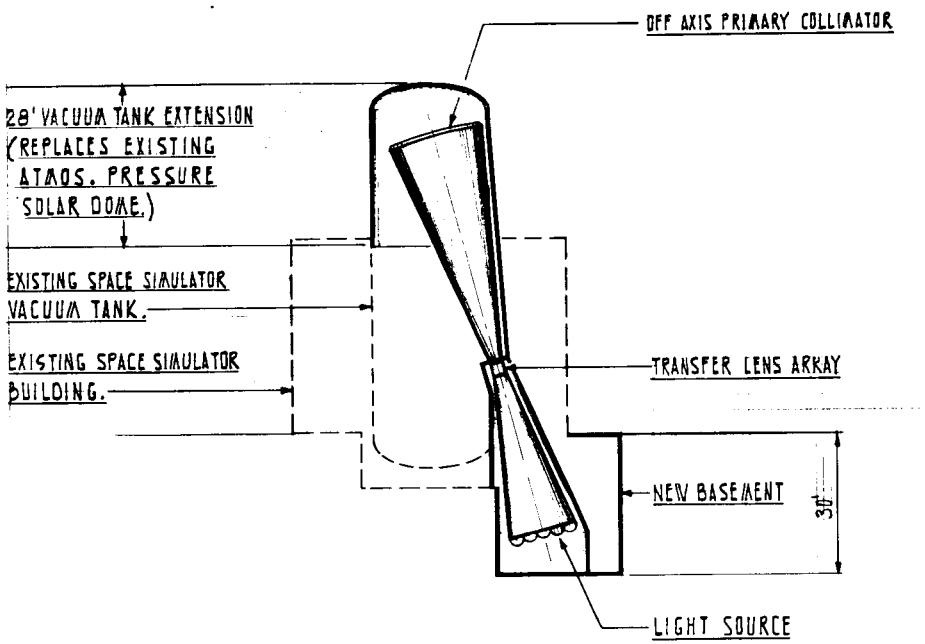
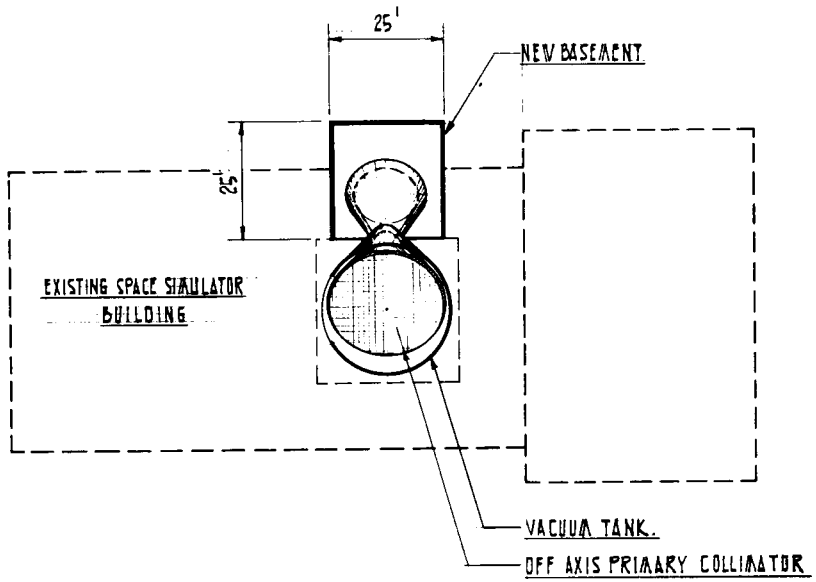
JET PROPULSION LABORATORY

FISCAL YEAR 1965 ESTIMATES

25 FOOT SIMULATOR MODIFICATION



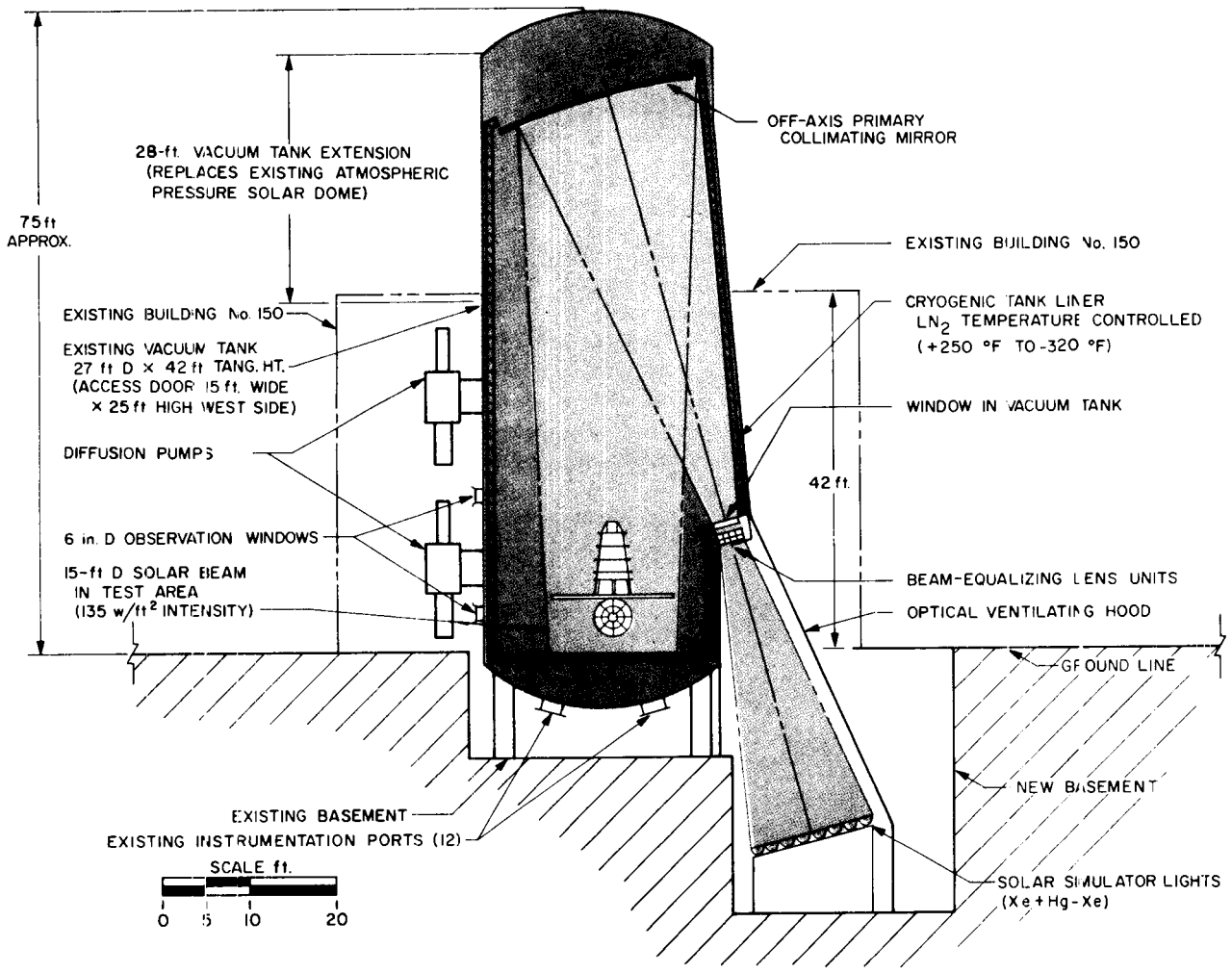
SECTION



FLOOR PLAN

SCALE IN FEET

0 4 8 16 32



PROPOSED

JPL 25-ft. SPACE SIMULATOR MODIFICATION

CROSS SECTION (LOOKING WEST)

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1965 ESTIMATES

UTILITIES INSTALLATIONS

PROGRAM OFFICE FOR THE INSTALLATION: Office of Space Science and Applications

PROGRAM OFFICE FOR THE PROJECT: Office of Space Science and Applications

AUTHORIZATION LINE ITEM: Jet Propulsion Laboratory

LOCATION OF PROJECT: Pasadena, Los Angeles County, California

COGNIZANT NASA INSTALLATION: Jet Propulsion Laboratory

TYPE OF CONSTRUCTION PROJECT: Extension

FUNDING:

FY 1963 and Prior Years	$2,452,000
FY 1964 Estimate	420,000
FY 1965 Estimate	400,000
Total Funding Thru FY 1965	$3,272,000

PROJECT COST ESTIMATE:

	Unit of Measure	Quantity	Unit Cost	Total Cost
Land Acquisition	---	---	---	---
Construction				$340,000
Site preparation	LS	---	$20,000	20,000
Roads and Parking	LS	---	10,000	10,000
Utilities	LS	---	310,000	310,000
Equipment				$25,000
Electrical switchgear	LS	---	25,000	25,000

	Unit of Measure	Quantity	Unit Cost	Total Cost
Design				$35,000
For construction	LS	---	$35,000	35,000
Fallout Shelter	---	---	---	---
		TOTAL		$400,000

PROJECT DESCRIPTION:

This project proposes the extension of utilities and the up-dating of obsolete utilities on the laboratory. The scope of work is shown on the JPL site plan on the following page. The following is a specific description of the proposed items:

1.5 million gallon storage tank: Provide a 1.5 million gallon underground water storage tank on the west end of the laboratory with a supply line to the existing tank on the east end of the laboratory. Provide a tie line from the new tank to the existing distribution system. Some of the old water lines will be replaced with larger ones to provide a more adequate water supply for fire-fighting.

Extension of utilities: This project provides for the extension of utilities to some of the new buildings in this program.

Landscaping and erosion control: Landscaping is needed in areas near the new buildings and roads in accordance with the Master Site Plan. Erosion control is required on a number of bare, steep slopes. This work will include terracing and planting to avoid undue erosion.

Electrical distribution: Addition of a tiebreaker to the main JPL substation. This will require foundations and paving in connection with the installation of a main switch.

PROJECT JUSTIFICATION:

The justification for the individual items in this project is as follows:

1.5 million gallon storage tank: The present water storage facilities do not have the capacity to handle laboratory requirements and fire-fighting capability on the mesa. Under the fiscal year 1963 utilities program, the architect-engineer made a study of the present water distribution system and stated that the new reservoir and larger water distribution lines are required.

Extension of utilities: To obtain a complete operable facility it is necessary to extend utilities to some of the new buildings under this program. Utilities are installed under roads and the service is extended to the edge of the road to eliminate the necessity of tearing up the road to connect to the supply lines.

Landscaping and erosion control: The areas around new buildings and roads are at finished grade; however, the areas are not protected from soil erosion and will necessitate landscaping.

Electrical distribution: The expansion of the main substation is required to broaden the capabilities of the 16.5 KV distribution due to the increase in demand for electrical power.

ESTIMATED FUTURE YEAR FUNDING: $1,000,000

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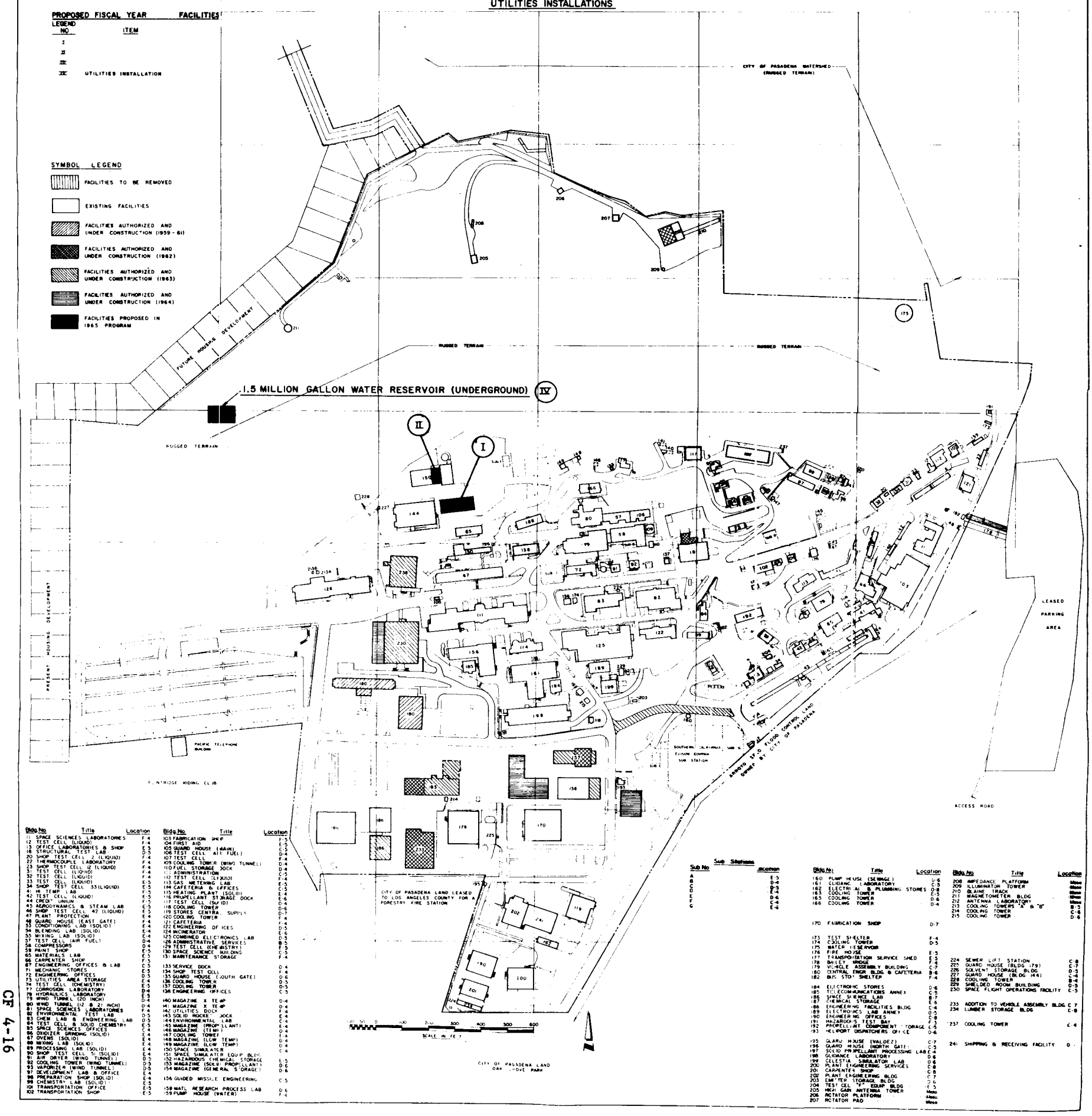
JET PROPULSION LABORATORY
FISCAL YEAR 1965 ESTIMATES
LOCATION PLAN
UTILITIES INSTALLATIONS



Bldg No	Title	Location
11	SPACE SCIENCES LABORATORIES	F-4
12	TEST CELL (LIQUID)	F-4
13	OFFICE LABORATORIES & SHOP	E-5
18	STRUCTURAL TEST LAB	D-5
20	SHOP TEST CELL 2 (LIQUID)	F-4
22	THERMOCOUPLE LABORATORY	F-4
23	SHOP TEST CELL 12 (LIQUID)	F-4
31	TEST CELL (LIQUID)	F-4
32	TEST CELL (LIQUID)	F-4
33	TEST CELL (LIQUID)	E-5
34	SHOP TEST CELL 33 (LIQUID)	E-5
41	HI TEMP LAB	F-5
42	TEST CELL (LIQUID)	E-5
44	CREDO* UNION	F-5
45	AERODYNAMICS & STEAM LAB	E-5
46	SHOP TEST CELL 42 (LIQUID)	E-5
47	PLANT PROTECTION	E-4
48	GUARD HOUSE (EAST GATE)	F-4
53	CONDITIONING LAB (SOLID)	E-4
54	BLENDING LAB (SOLID)	E-4
55	MIXING LAB (SOLID)	E-4
57	TEST CELL (AIR FUEL)	D-4
58	COMPRESSORS	D-4
59	PAINT SHOP	E-5
65	MATERIALS LAB	E-5
66	CARPENTER SHOP	F-5
67	ENGINEERING OFFICES & LAB	C-5
71	MECHANIC STORES	E-5
72	ENGINEERING OFFICES	D-5
73	UTILITIES AREA STORAGE	E-4
74	TEST CELL (CHEMISTRY)	E-5
77	CORROSION LABORATORY	D-4
78	HYDRAULICS LABORATORY	E-5
79	WIND TUNNEL (20 INCH)	D-4
80	WIND TUNNEL (12 & 21 INCH)	D-4
81	SPACE SCIENCES LABORATORIES	F-4
82	ENVIRONMENTAL TEST LAB	D-5
83	CHEM LAB & ENGINEERING LAB	D-5
84	TEST CELL & SOLID CHEMISTRY	E-5
85	SPACE SCIENCES OFFICES	C-4
86	OXIDIZER GRINDING (SOLID)	E-4
87	OVENS (SOLID)	E-4
88	MIXING LAB (SOLID)	E-4
89	PROCESSING LAB (SOLID)	E-4
90	SHOP TEST CELL 51 (SOLID)	E-4
91	AIR DRYER (WIND TUNNEL)	D-5
92	COOLING TOWER (WIND TUNNEL)	D-5
93	VAPORIZER (WIND TUNNEL)	D-5
97	DEVELOPMENT LAB & OFFICE	E-4
98	PREPARATION SHOP (SOLID)	E-4
99	CHEMISTRY LAB (SOLID)	E-5
101	TRANSPORTATION OFFICE	E-5
102	TRANSPORTATION SHOP	E-5

Bldg No	Title	Location
103	FABRICATION SHOP	E-5
104	FIRST AID	E-5
105	GUARD HOUSE (MAIN)	E-5
106	TEST CELL (AIR FUEL)	D-4
107	TEST CELL	F-4
109	COOLING TOWER (WIND TUNNEL)	D-4
110	FUEL STORAGE DOCK	D-4
111	ADMINISTRATION	C-5
112	TEST CELL (LIQUID)	F-4
113	GAS METERING LAB	E-5
114	CAFETERIA & OFFICES	C-5
115	HEATING PLANT (SOLID)	E-4
116	PROPELLANT STORAGE DOCK	E-6
117	TEST CELL (SOLID)	D-4
118	COOLING TOWER	D-6
119	STORES CENTRAL SUPPLY	D-7
120	COOLING TOWER	F-4
121	CAFETERIA	F-4
122	ENGINEERING OFFICES	D-5
124	INCINERATOR	E-6
125	COMBINED ELECTRONICS LAB	D-5
126	ADMINISTRATIVE SERVICES	B-5
129	TEST CELL (CHEMISTRY)	E-5
130	SPACE SCIENCE BUILDING	C-5
131	MAINTENANCE STORAGE	F-4
133	SERVICE DOCK	D-4
134	SHOP TEST CELL	F-4
135	GUARD HOUSE (SOUTH GATE)	D-6
136	COOLING TOWER	D-5
137	COOLING TOWER	D-5
138	ENGINEERING OFFICES	C-5
140	MAGAZINE X TEMP	D-4
141	MAGAZINE X TEMP	D-4
142	UTILITIES DOCK	F-4
143	SOLID ROCKET DOCK	E-4
144	ENVIRONMENTAL LAB	C-4
145	MAGAZINE (PROPELLANT)	E-4
146	MAGAZINE (TEMP)	D-4
147	COOLING TOWER	F-4
148	MAGAZINE (LOW TEMP)	D-4
149	MAGAZINE (LOW TEMP)	D-4
150	SPACE SIMULATOR	C-4
151	SPACE SIMULATOR EQUIP BLDG	
152	HAZARDOUS (CHEMICAL STORAGE	E-5
153	MAGAZINE (SOLID PROPELLANT)	D-6
154	MAGAZINE (GENERAL STORAGE)	D-6
156	GUIDED MISSILE ENGINEERING	C-5
158	MATL RESEARCH PROCESS LAB	D-6
159	PUMP HOUSE (WATER)	F-4

Sub No	Sub Stations	Location
A		E-5
B		D-4
C		D-5
D		E-4
E		D-6
F		C-4
G		E-6

Bldg No	Title	Location
160	PUMP HOUSE (SEWAGE)	D-6
161	GUIDANCE LABORATORY	C-5
162	ELECTRICAL & PLUMBING STORES	D-6
163	COOLING TOWER	E-5
165	COOLING TOWER	D-6
166	COOLING TOWER	D-4
170	FABRICATION SHOP	D-7
173	TEST SHELTER	F-4
174	COOLING TOWER	D-5
175	WATER RESERVOIR	
176	FIRE HOUSE	E-5
177	TRANSPORTATION SERVICE SHED	E-5
178	BAILEY BRIDGE	F-4
179	VEHICLE ASSEMBLY BUILDING	C-7
180	CONTRAL ENGR BLDG & CAFETERIA	B-6
182	BUS STOP SHELTER	F-4
184	ELECTRONIC STORES	D-6
185	TELECOMMUNICATIONS ANNEX	C-5
186	SPACE SCIENCE LAB	B-7
187	CHEMICAL STORAGE	E-6
188	ENGINEERING FACILITIES BLDG	C-4
189	ELECTRONICS LAB ANNEX	D-5
190	ENGINEERING OFFICES	C-8
191	HAZARDOUS TEST BAY	F-3
192	PROPELLANT COMPONENT STORAGE	E-5
193	HELIPORT DISPATCHERS OFFICE	D-6
195	GUARD HOUSE (VALDEZ)	C-7
196	GUARD HOUSE (NORTH GATE)	C-5
197	SOLID PROPELLANT PROCESSING LAB	E-4
198	GUIDANCE LABORATORY	D-6
199	CELESTIA SIMULATOR LAB	D-6
200	PLANT ENGINEERING SERVICES	C-8
201	CARPENTER SHOP	C-8
202	PLANT ENGINEERING BLDG	C-7
203	EMITTER STORAGE BLDG	D-6
204	TEST CELL "F" EQUIP BLDG	F-5
205	HIGH GAIN ANTENNA TOWER	Misc
206	ROTATOR PLATFORM	Misc
207	ROTATOR PAD	Misc

Bldg No	Title	Location
208	IMPEDANCE PLATFORM	Misc
209	ILLUMINATOR TOWER	Misc
210	BLAINE TRACK	Misc
211	MAGNETOMETER BLDG	Misc
212	ANTENNA LABORATORY	Misc
213	COOLING TOWERS "A" & "B"	B-5
214	COOLING TOWER	C-4
215	COOLING TOWER	D-6
224	SEWER LIFT STATION	C-8
225	GUARD HOUSE (BLDG 179)	C-7
226	SOLVENT STORAGE BLDG	D-5
227	GUARD HOUSE (BLDG 144)	C-4
228	COOLING TOWER	B-4
229	SHIELDED ROOM BUILDING	D-5
230	SPACE FLIGHT OPERATIONS FACILITY	E-5
233	ADDITION TO VEHICLE ASSEMBLY BLDG	C-7
234	LUMBER STORAGE BLDG	C-8
237	COOLING TOWER	E-4
241	SHIPPING & RECEIVING FACILITY	D-

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1965 ESTIMATES

ADDITION TO UNMANNED SPACECRAFT EXPLOSIVE SAFE ASSEMBLY COMPLEX
(SOLID PROPELLANT LABORATORY)

PROGRAM OFFICE FOR THE INSTALLATION: Office of Manned Space Flight

PROGRAM OFFICE FOR THE PROJECT: Office of Space Science & Applications

AUTHORIZATION LINE ITEM: John F. Kennedy Space Center, NASA

LOCATION OF PROJECT: Cape Kennedy, Brevard County, Florida

COGNIZANT NASA INSTALLATION: John F. Kennedy Space Center, NASA

TYPE OF CONSTRUCTION PROJECT: New

FUNDING:

FY 1963 and Prior Years	$1,181,000
FY 1964 Estimate	30,000
FY 1965 Estimate	570,000
Total Funding Through FY 1965	$1,781,000

PROJECT COST ESTIMATE:

	Unit of Measure	Quantity	Unit Cost	Total Cost
Land Acquisition	---	---	---	---
Construction				$500,000
Propellant laboratory	Sq. Ft.	3,000	$105.00	315,000
Site preparation	LS	---	50,000	50,000
Roads and Parking	LS	---	35,000	35,000
Utilities	LS	---	100,000	100,000
Equipment				$70,000
Crane	LS	---	70,000	70,000
Design	---	---	---	---

	Unit of Measure	Quantity	Unit Cost	Total Cost
Fallout Shelter	---	---	---	---
		TOTAL		$570,000

PROJECT DESCRIPTION:

This project provides for the addition of an approximately 3,000 square-foot gross area solid propellant laboratory to the existing Explosive Safe Assembly Complex consisting of a liquid propellant laboratory, assembly facility and instrumentation laboratory. The method of construction will be reinforced concrete and revetted as required to provide blast protection to the other buildings in the complex. Frangible type roof and walls will be used where possible to improve the safety conditions existing in the complex. The building will be dust-free, air conditioned, and designed and constructed to insure minimum contamination of the spacecraft while in the laboratory.

PROJECT JUSTIFICATION:

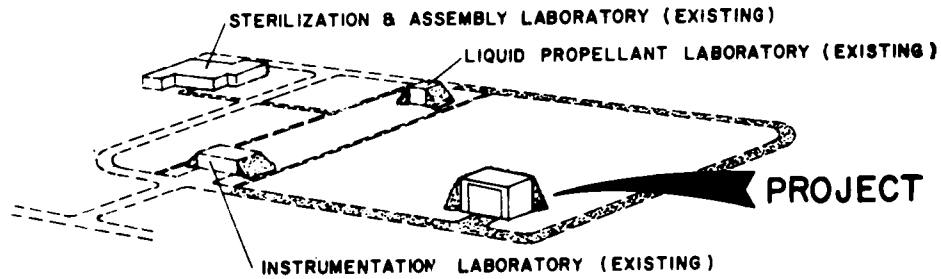
This facility is required for assembly, checkout, and static and dynamic balancing or optical alignment of solid propellant motors used on unmanned spacecraft such as Surveyor, Mariner, and Lunar Orbiter. The building presently being used as a solid propellant laboratory was initially constructed in 1955 as an instrumentation laboratory and is barely adequate for use in the preparation of the current Ranger spacecraft. The facility is not adequate for follow-on spacecraft as it contains essentially no provision for clean room environment, is too small from the standpoint of both floor area and hook height, is located about 2 miles from the other buildings in the explosive safe complex and is also located close to several military weapon system launch complexes requiring evacuation of this facility during periods of hazardous operations on these launch complexes.

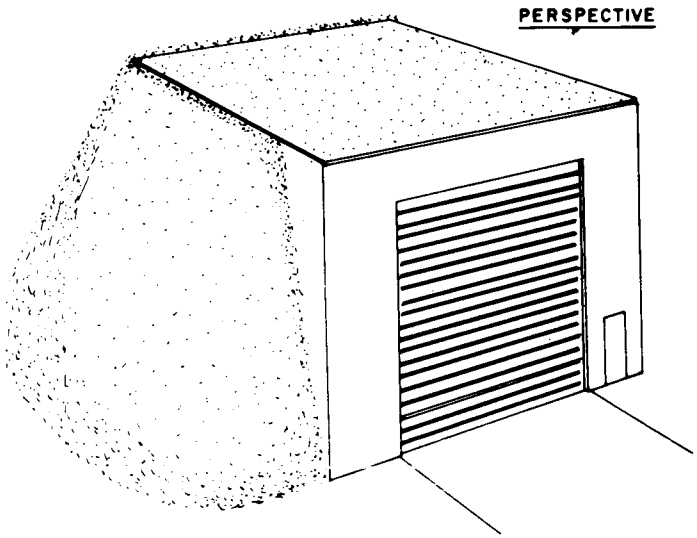
ESTIMATED FUTURE YEAR FUNDING: $2,000,000

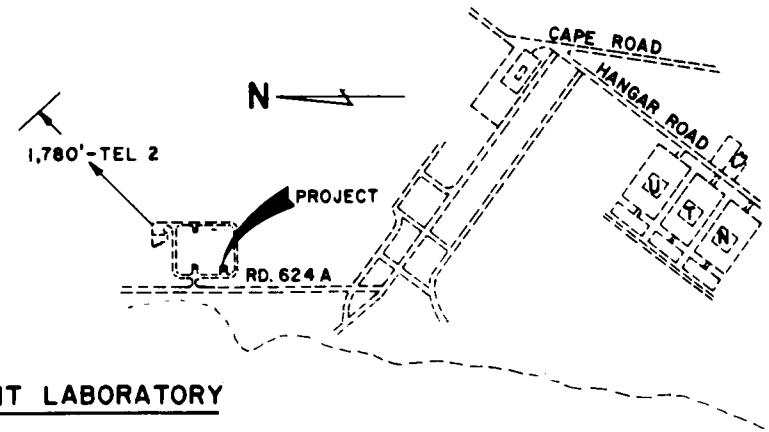
JOHN F. KENNEDY SPACE CENTER, NASA

FISCAL YEAR 1965 ESTIMATES

ADDITION TO UNMANNED SPACECRAFT EXPLOSIVE SAFE ASSEMBLY COMPLEX







SOLID PROPELLANT LABORATORY

SITE PLAN

0 4 6 8 10

GRAPHIC SCALE X 100

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CONSTRUCTION OF FACILITIES

FISCAL YEAR 1965 ESTIMATES

MODIFICATIONS TO CENTAUR LAUNCH COMPLEX NO. 36

PROGRAM OFFICE FOR THE INSTALLATION: Office of Manned Space Flight

PROGRAM OFFICE FOR THE PROJECT: Office of Space Science & Applications

AUTHORIZATION LINE ITEM: John F. Kennedy Space Center, NASA

LOCATION OF PROJECT: Cape Kennedy, Brevard County, Florida

COGNIZANT NASA INSTALLATION: John F. Kennedy Space Center, NASA

TYPE OF CONSTRUCTION PROJECT: Alteration

FUNDING:

FY 1963 and Prior Years	$25,009,000
FY 1964 Estimate	49,000
FY 1965 Estimate	451,000
Total Funding Thru FY 1965	$25,509,000

PROJECT COST ESTIMATES:

	Unit of Measure	Quantity	Unit Cost	Total Cost
Land Acquisition	---	---	---	---
Construction				$125,000
TV camera platforms	LS	---	$6,000	6,000
Laboratory and engineering office in the launch and service building	Sq. Ft.	1,000	25.00	25,000
Modify electrical facility power for LO_2 transfer system	LS	---	7,000	7,000
Installation of pad, pedestals, and foundation for flox capability	LS	---	13,400	13,400
Visitor's observation room in launch control center	Sq. Ft.	300	12.00	3,600

	Unit of Measure	Quantity	Unit Cost	Total Cost
Launch control modification center	LS	---	$20,000	$20,000
Install sliding doors on service structure	LS	---	50,000	50,000
Equipment				$326,000
Replacement of high pressure gas lines	LS	---	92,000	92,000
Install new line and modify LO_2 system for flox capability	LS	---	60,000	60,000
Modernize and rehabilitate LO_2 system	LS	---	172,000	172,000
Launch control center equipment	LS	---	2,000	2,000
Design	---	---	---	---
Fallout Shelter	---	---	---	---
		TOTAL		$451,000

PROJECT DESCRIPTION:

This project provides for the following necessary modifications and additions to Centaur Launch Complex 36 to support a more rapid launch schedule which results as the vehicle progresses from R&D to operational status:

Additional TV Camera Platforms: This task includes fabrication and execution of two TV camera platforms with the installation of the necessary power control, and data transmission cables.

Modification to LC-36B Launch Service Building: Areas totaling 1000 square feet underneath the ramp and the launch pad in the Launch Service Building will be properly sound-proof partitioned with lighting and air conditioning to provide additional office and laboratory space.

Launch Control Center Modifications: This task consists of building an adequate 15'x20' observation room in the first floor of the blockhouse for required visitors, inspectors, and observers. Adequate air conditioning and communication equipment, furniture, etc., will be provided. It also consists of providing a flush type toilet with outside septic tank to the LCC, tiling the base-

ment floor, and adding an additional coat of tinted asbestos limpet acoustic material to the ceiling of the first and second floor.

Additions of Sliding Doors on LC-36A Service Tower: This task consists of installing seven sets of aluminum sliding doors on the south side of the service tower starting at TS-109 and progressing downward.

Propellant Services & High Pressure Gas: This task consists of replacing the majority of high pressure gas lines from the GN_2 tanks to the cryogenic propellant (LO_2, LH_2, & LN_2) storage tanks and to the vehicle disconnects. It also provides addition of flox capability which requires additional pad area, pedestals, storage tank, propellant and water piping, electrical instrumentation and power, to provide capability of tanking both fluorine and oxygen into the vehicle as the fuel oxidizing agent. Modifications to the Liquid Oxygen System on LC-36A consists of replacing the 10,000 and 28,000 gallon LO_2 storage tank with one 38,000 gallon tank and the installation of a new pressurized pumping system with controls, valves, and electric power in place of the present outdated mechanical pumping system.

PROJECT JUSTIFICATION:

As the Centaur vehicle is flight tested during the R&D development, the older facilities become obsolete due to wear, corrosion, new developments, etc. In order to launch the vehicles with the greatest reliability, Complex 36A must be updated to the Complex 36B configuration, and modifications added to common use areas so they more adequately service both launch pads The modification and additions here listed will help accomplish the overall launch of the Centaur vehicle and are needed for the following reasons:

Additional TV Camera Platforms: Changes in configurations of both launch vehicle and launch stand as well as addition of payloads have resulted in increased requirements for closed-loop TV coverage of critical areas during pre-launch and launch operations.

Modifications to LC-36B Launch Service Building: Additional engineering office and laboratory space is required for personnel assigned to work on Complex 36B. At the present time sufficient space does not exist in the 36A or 36B Launch Service Buildings. Those areas which can be occupied must be prepared to provide this extra space.

Launch Control Center Modifications: Design personnel, program managers, visitors, observers, etc., find it necessary to watch a launch operation so they can more adequately understand the problems involved in vehicle launches. This room is constructed on the first floor of the blockhouse in the least used space and will be used to control movement of the required observers so

they will not interfere with operations. (1) With the increase of personnel in the blockhouse during critical tests, the present portable sanitation system is no longer adequate and it must be replaced with a flush type toilet. (2) The first floor of the blockhouse is bare concrete, the surface of which is difficult to keep clean. Since the addition of LC-36B control equipment to the Launch Control Center, a great deal of electronic equipment has been moved to the first floor. The addition of floor tile will greatly improve the cleanliness of this area reducing the risk of shorting out equipment by dust hazard. (3) With the addition of more equipment for LC-36B and an increase in operational personnel the noise level in the blockhouse will be greatly increased. The additional acoustical material will help reduce this excessive noise level.

Addition of Sliding Doors on LC-36A Service Tower. Replacement of the present weather curtains, with sliding doors on LC-36A service tower will follow the present design of LC-36B service tower and provide greater protection and better environmental control of the Atlas Centaur booster and its payload.

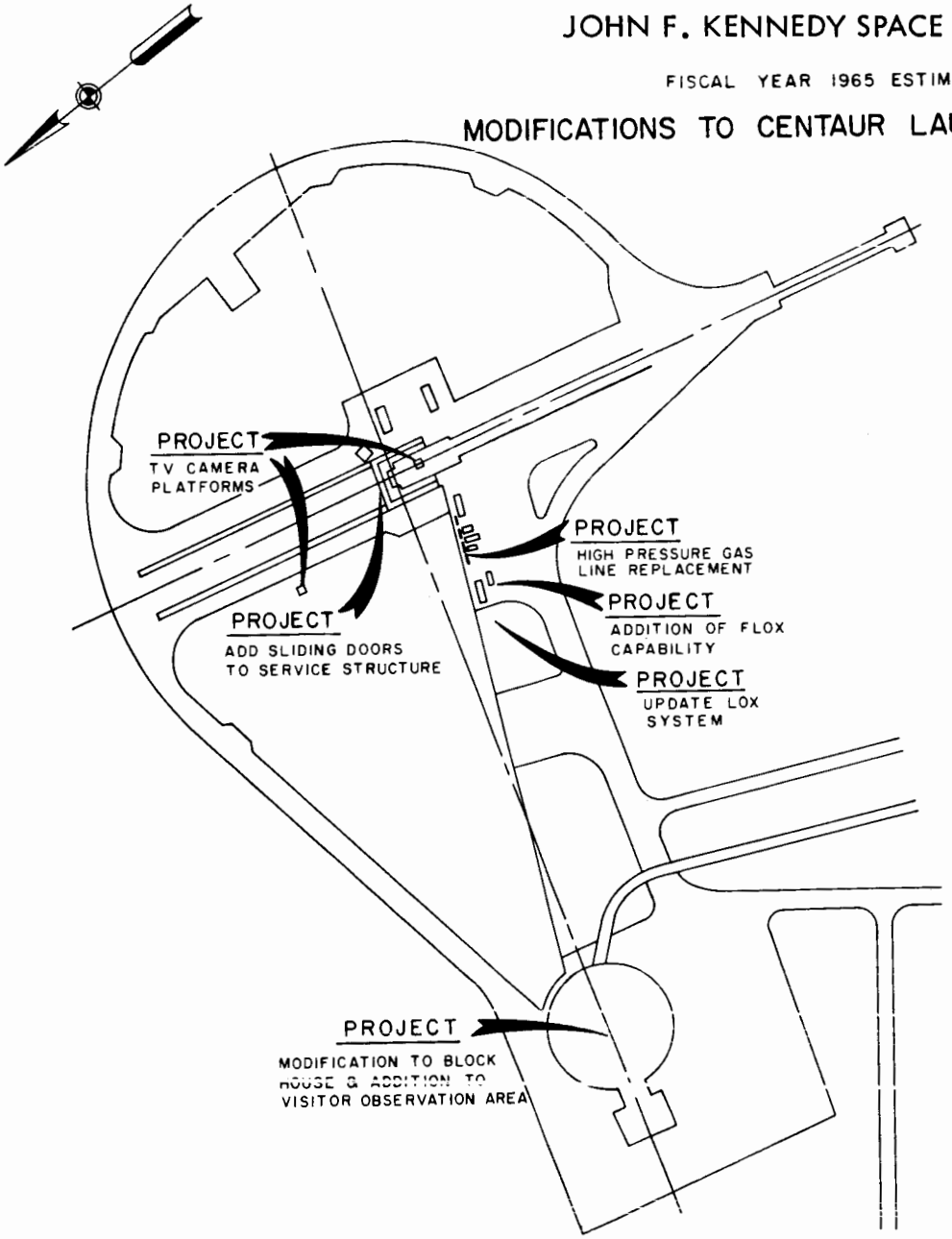
Propellant Services and High Pressure Gas. Stress corrosion of these high pressure lines has resulted in continual replacement of small sections of GN_2 tubing with corrosion resistent tubing. This task will replace all the remaining old tubing at one time, resulting in lower overall costs, providing greater safety, and more reliability to the high pressure gaseous nitrogen system. The addition of flourine with the liquid oxygen will result in increased I.S.P. and thrust level of the Atlas Centaur booster and consequently put heavier payloads in orbit. Many operational and technical problems have been encountered in precise tanking operations on LC-36A because of the older pump driven liquid oxygen propellant system. There is also a need to tank the Centaur upper stage with LO_2. The installation of a pressurized system designed for LC-36B and used on Atlas operational sites will result in greater reliability and provide for simultaneous topping of both stages decreasing propellant tanking time during launch operations.

ESTIMATED FUTURE YEAR FUNDING: $1,000,000

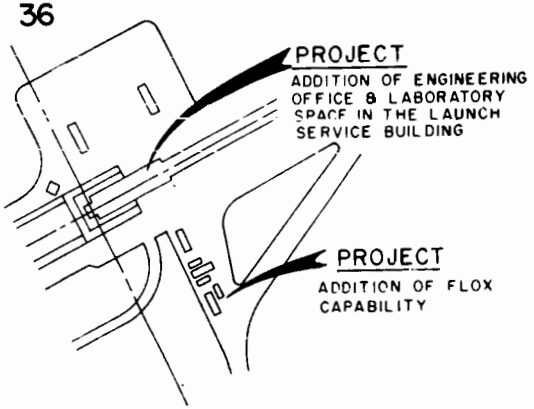
JOHN F. KENNEDY SPACE CENTER, NASA

FISCAL YEAR 1965 ESTIMATES

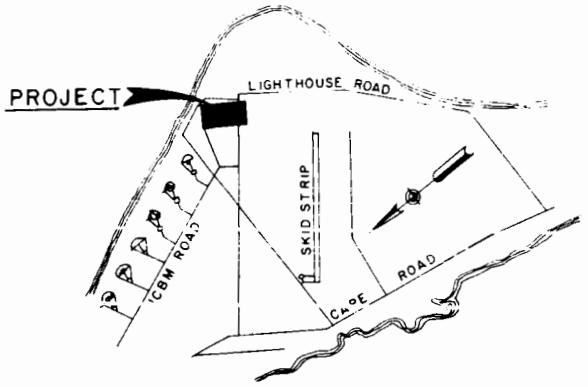
MODIFICATIONS TO CENTAUR LAUNCH COMPLEX 36



COMPLEX 36A



COMPLEX 36B



VICINITY MAP

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1965 ESTIMATES

MODIFICATIONS TO LAUNCH COMPLEX NO. 17

PROGRAM OFFICE FOR THE INSTALLATION: Office of Manned Space Flight

PROGRAM OFFICE FOR THE PROJECT: Office of Space Science & Applications

AUTHORIZATION LINE ITEM: John F. Kennedy Space Center, NASA

LOCATION OF PROJECT: Cape Kennedy, Brevard County, Florida

COGNIZANT NASA INSTALLATION: John F. Kennedy Space Center, NASA

TYPE OF CONSTRUCTION PROJECT: Alteration

FUNDING:

FY 1963 and Prior Years	---
FY 1964 Estimate	$35,000
FY 1965 Estimate	465,000
Total Funding Through FY 1965	$500,000

PROJECT COST ESTIMATE:

	Unit of Measure	Quantity	Unit Cost	Total Cost
Land Acquisition	---	---	---	---
Construction				$245,000
Elevator	LS	---	$145,000	145,000
Electrical modifications	LS	---	70,000	70,000
Site preparation	LS	---	5,000	5,000
Support building	Sq. Ft.	1,920	13.00	25,000
Equipment				$220,000
Masts	LS	---	220,000	220,000
Design	---	---	---	---
Fallout Shelter	---	---	---	---
		TOTAL		$465,000

PROJECT DESCRIPTION:

This project provides for the following modifications to Launch Complexes 17A and B: The automatic service and operational personnel elevators for both pads 17A and B that operate between ground level and the eight level of the gantrys will be increased in size from 4'5"x5'6" to 6'0"x6'0" and in capacity from 2000 pounds to 3500 pounds. The operating speed will be increased from 50'/min. to 75-100'/min. Modifications to the elevator shaft and associated equipment also will be provided; two structural steel fixed umbilical masts, one each at Pads 17A and 17B will be constructed. The masts will be 110 feet tall with 8'x8' base, of constant size through mid-point, tapering to 4'x4' at the top. Four umbilical reach arms will be provided at various levels and will be automatically retractable by spring loading and counter-balance methods. Each umbilical arm station will be provided with an emergency ladder and service platform and a personnel and equipment elevator will be installed to serve each station. The masts will be equipped with supports for flight vehicle fuel and oxidizer lines, high pressure gas lines, electrical control cables, and air conditioning ducts to the stages of the Thor Delta booster and to the spacecraft; the gantry drive power will be increased by replacing the existing 31 H.P. motor generator (MG) set supplying electric power to the drive motors with a 60 H.P. MG set (speed variator) on each of the gantrys at Complex 17. Four additional tractor drive motors will be provided to each gantry. Each electric drive motor will be a minimum of 10 H.P., direct current operated with gear reduction drive; a single story 32'x60' operational support building will be constructed of concrete block with slab floor and built-up roof. The building will include shops, office and utility space and will be equipped with locker, shower and toilet accommodations. The building will be air conditioned and heated and the shops portion will be equipped with a 1.5 ton monorail hoist; movable steel platforms will be installed at levels 8X, 8B, and 9A of service tower 17A. The platforms will be approximately 15'x14'; the existing 44-ton air conditioning system located at the base of each launcher will be replaced with a 100-ton system.

PROJECT JUSTIFICATION:

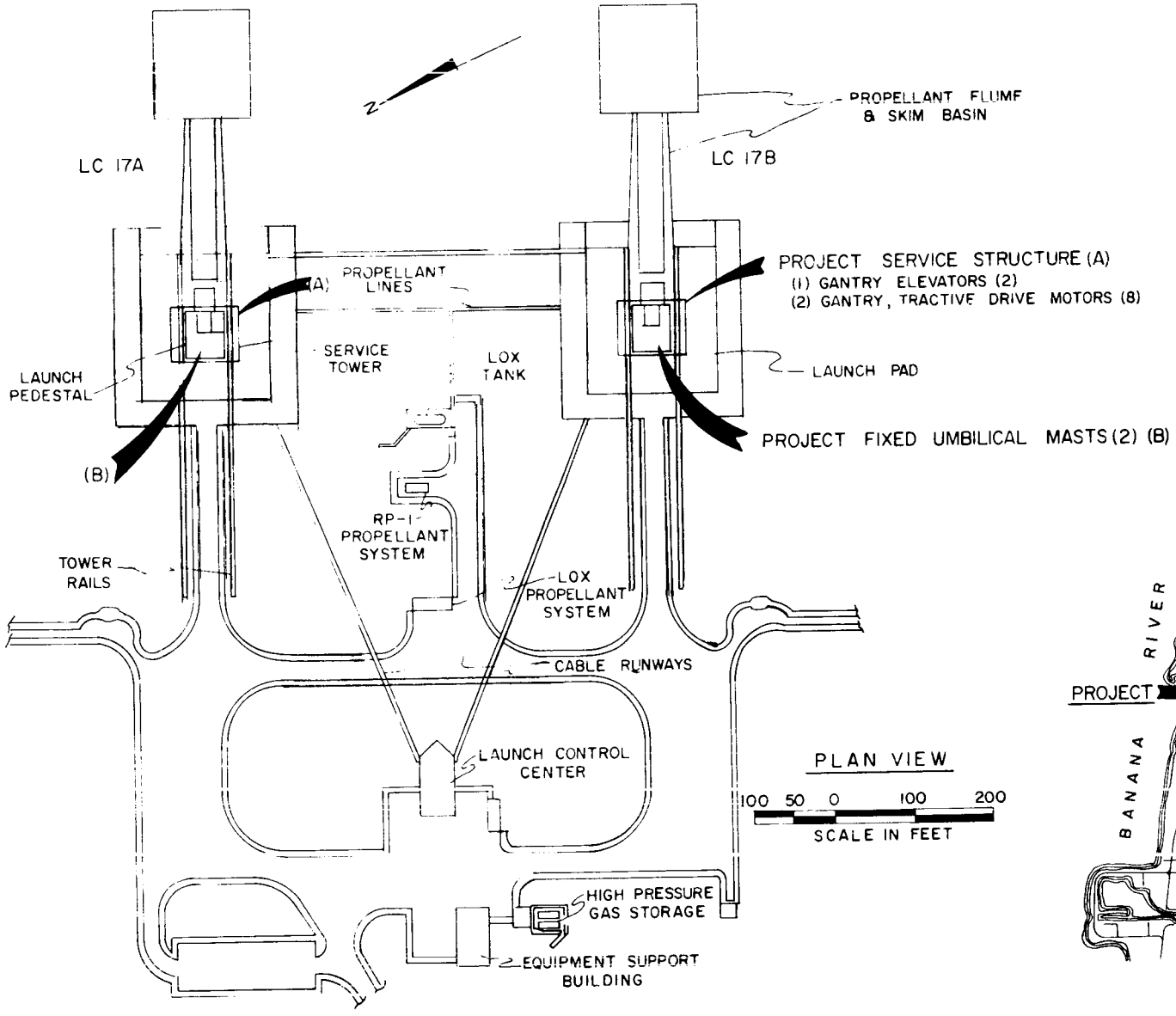
Proposed increase in launching schedule of unmanned spacecraft utilizing the Thor Delta booster and the increased intricacy of the spacecraft necessitate the projected modifications. Complexes 17A and 17B have been in operation for over five years. The present equipment is old and outdated and in some cases presents a safety hazard. Long exposure to the elements has deteriorated most of the equipment beyond economical repair, therefore replacement will be necessary.

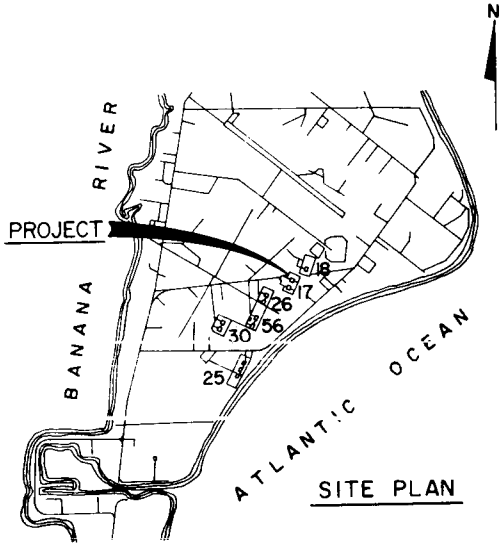
ESTIMATED FUTURE YEAR FUNDING: None

JOHN F. KENNEDY SPACE CENTER, NASA

FISCAL YEAR 1965 ESTIMATES

MODIFICATIONS TO LAUNCH COMPLEX NO. 17





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CONSTRUCTION OF FACILITIES

FISCAL YEAR 1965 ESTIMATES

SPIN BALANCE FACILITIES FOR UNMANNED SPACECRAFT

PROGRAM OFFICE FOR THE INSTALLATION: Office of Manned Space Flight

PROGRAM OFFICE FOR THE PROJECT: Office of Space Science and Applications

AUTHORIZATION LINE ITEM: John F. Kennedy Space Center, NASA

LOCATION OF PROJECT: Cape Kennedy, Brevard County, Florida

COGNIZANT NASA INSTALLATION: John F. Kennedy Space Center, NASA

TYPE OF CONSTRUCTION PROJECT: New

FUNDING:

FY 1963 and Prior Years	---
FY 1964 Estimate	$12,000
FY 1965 Estimate	255,000
Total Funding Through FY 1965	$267,000

PROJECT COST ESTIMATE:

	Unit of Measure	Quantity	Unit Cost	Total Cost
Land Acquisition	---	---	---	---
Construction				$179,400
Spin test building	Sq. Ft.	1,500	$100.00	150,000
Control building	Sq. Ft.	600	45.00	27,000
Site preparation	LS	---	2,400	2,400
Equipment				$75,600
Crane	LS	---	75,600	75,600
Design	---	---	---	---

	Unit of Measure	Quantity	Unit Cost	Total Cost
Fallout Shelter	---	---	---	---
		TOTAL		$255,000

PROJECT DESCRIPTION:

This project provides two buildings (spin test building and control building) for support of unmanned spacecraft spin balance tests. Construction will consist of reinforced concrete frame with masonry curtain walls. The spin test building will be approximately 2,300 square feet in area and will be equipped with a five-ton crane with a hook height of 35 feet. Advanced handling and balance operation will take place in this building. The second building will be approximately 1,000 square feet in area and will house the control equipment for the balancing fixtures, work shops, offices and storage areas. A protective wall will be constructed between the two buildings as a safety measure. Utilities will include power, communications, water, sewerage, roads, and parking.

PROJECT JUSTIFICATION:

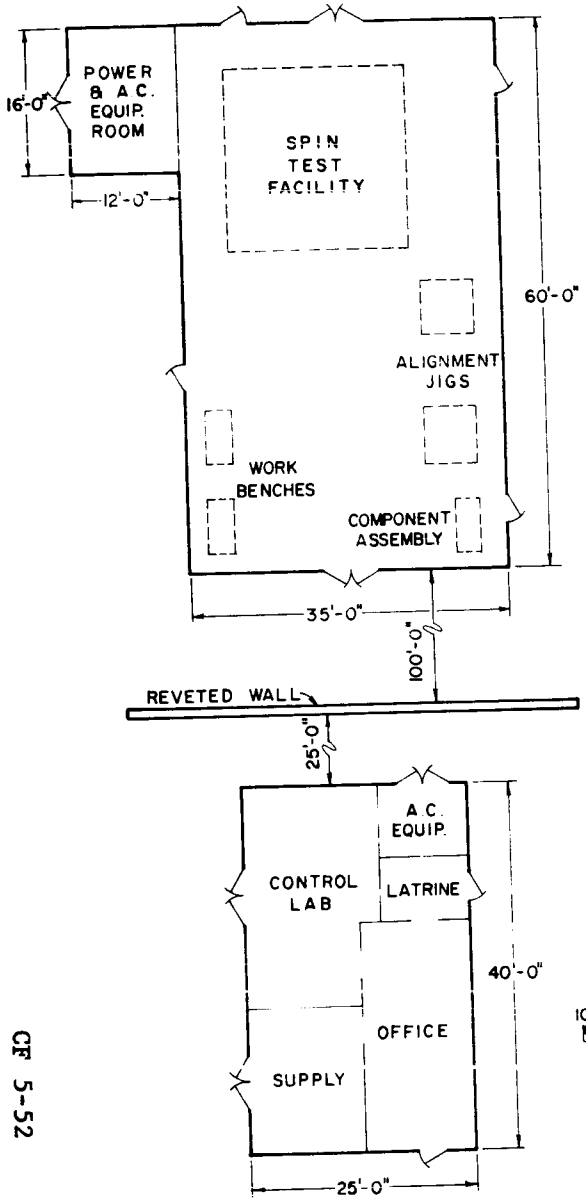
The existing Spin Test Facility is within the danger area of the Centaur launch complex 36. Increased Centaur prelaunch preparation activities such as fueling tests, combined systems tests and simulated launches limit the allowable working hours in the spin-test facility. The new facility will be used for programs such as FIRE, Orbiting Astronomical Observatory, and Orbiting Geophysical Observatory. FIRE and advanced spacecraft are to be flown on Atlas/Agena, which will require more working area and building height than are presently available in the existing facility. Limited work space in the existing facility increases the possibility of schedule slippages due to the inability to complete spacecraft and upper stage alignment and balancing operations on schedule. Probable degradation of spacecraft performance may result because of delays caused by Centaur Launch Vehicle activities on Launch Complex #36 which require the clearing of people from the existing spin balance building for extended periods.

ESTIMATED FUTURE YEAR FUNDING: None

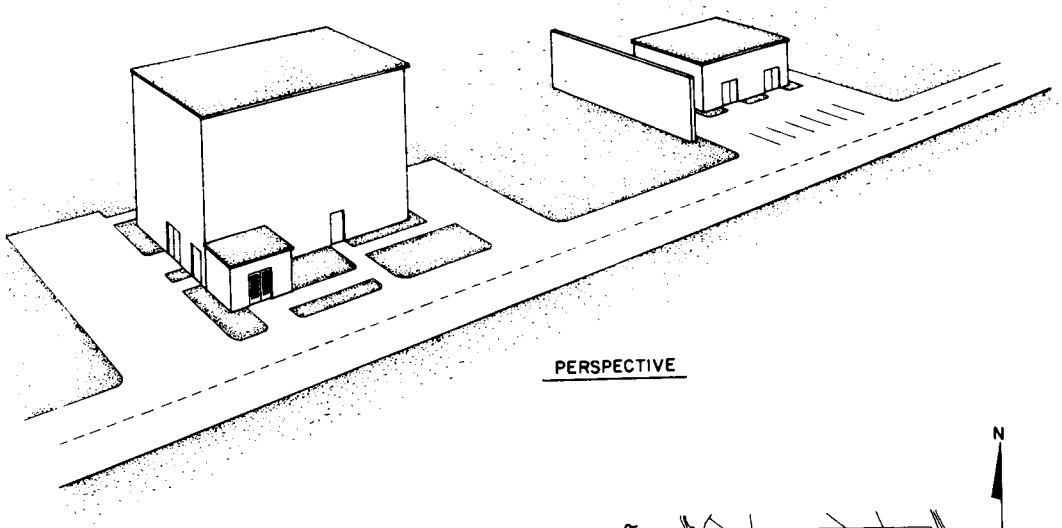
JOHN F. KENNEDY SPACE CENTER, NASA

FISCAL YEAR 1965 ESTIMATES

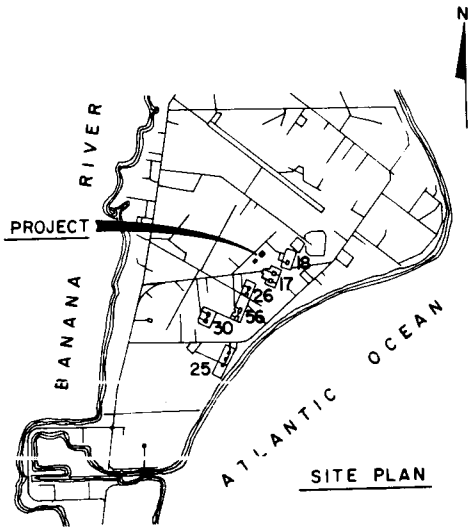
SPIN BALANCE FACILITIES FOR UNMANNED SPACECRAFT



PLAN



PERSPECTIVE



SITE PLAN

CONSTRUCTION OF FACILITIES

FISCAL YEAR 1965 ESTIMATES

LAUNCH AREA MODIFICATION

PROGRAM OFFICE FOR THE INSTALLATION: Office of Space Science and Applications

PROGRAM OFFICE FOR THE PROJECT: Office of Space Science and Applications

AUTHORIZATION LINE ITEM: Wallops Station

LOCATION OF PROJECT: Wallops Island, Accomack County, Virginia

COGNIZANT NASA INSTALLATION: Wallops Station

TYPE OF CONSTRUCTION PROJECT: Alteration

FUNDING:

FY 1963 and Prior Years	---
FY 1964 Estimate	---
FY 1965 Estimate	$684,000
Total Funding Through FY 1965	$684,000

PROJECT COST ESTIMATE:

	Unit of Measure	Quantity	Unit Cost	Total Cost
Land Acquisition	---	---	---	---
Construction				$260,000
Area two environmental enclosure	LS	---	$85,000	85,000
Area two power sub-station	LS	---	15,000	15,000
Area two utility building	Sq. Ft.	800	$12.50	10,000
Area two replacement of I-beam launcher foundation and installation of new launcher	LS	---	33,000	33,000
Area four environmental enclosure for tubular launcher	LS	---	85,000	85,000

	Unit of Measure	Quantity	Unit Cost	Total Cost
Area four utility building	Sq. Ft.	1,200	$12.50	$15,000
Grading	LS	---	2,000	2,000
Excavation of deteriorated concrete - Area Two	LS	---	15,000	15,000
Equipment				$369,000
Checkout and firing circuits	LS	---	85,000	85,000
Cabling and trays	LS	---	120,000	120,000
Launcher	LS	---	100,000	100,000
Heat and air conditioning	LS	---	64,000	64,000
Design	---	---	---	$55,000
Design	---	---	---	55,000
Fallout Shelter		---	---	---
		TOTAL		$684,000

PROJECT DESCRIPTION:

This project will modify equipment and structures in Launch Areas 1, 2, and 4. The project consists of replacing an obsolete I-beam launcher in Area 2 with a new remotely controlled and indicated universal launcher, including environmental shelter, utility enclosure, and power sub-station. The launcher foundation and surrounding concrete will be replaced. This new launcher will be designed and constructed to handle multi-stage vehicles using up to the Honest John booster (85,000-pound thrust, 2,000-pound propellant) as the first-stage booster, and up to a total vehicle weight of 10,000 pounds. The launcher controls and indicators will be located remotely in the blockhouse. This will enable rapid pointing of the vehicle in order to correct for changes in wind conditions. An environmental shelter and utility enclosure will be provided for the existing tubular launcher in Area 4. This environmental shelter will be temperature and humidity controlled which will enable keeping the vehicle propellants within their manufacturers' tolerances, and the scientific payloads within design limits.

Some modifications to the vehicle and payload checkout circuits, firing circuits, cabling and duct work, will be made in Launch Areas 1, 2, and 4. RAM type universal vehicle and payload checkout consoles and the necessary cabling will be provided in the blockhouses at these launch locations. This type of console has been used at other launch areas at this Station and will provide flexible means of tailoring to the varied experiments and vehicles being launched from those areas.

PROJECT JUSTIFICATION:

These launch area modifications are necessary in order to update the facilities to accommodate the requirements of increasingly more complex and sophisticated payloads, vehicles, launch conditions, and increasing launch schedule. Launch Areas 1, 2, and 4 are universal, general-purpose facilities that provide launching support to Office of Space Sciences and Office of Advanced Research and Technology scientific research programs. These general-purpose facilities have the capability of launching multi-stage, unguided, aerodynamically stabilized vehicles from the Nike series up to the 50 - 70 feet long vehicles utilized in the Sounding Rocket Programs and the Small Vehicle Research Programs. Representative experiments launched from these areas are radio attenuation measurements, sodium vapor, meteorological sounders, ionospheric studies, atmospheric structures and development experiments for ECHO or SNAP payloads. The launching rate for these areas has reached approximately 200 vehicles each year, excluding numerous meteorological synoptic measurements. The firing rate, payload and vehicle launch sophistication, and environmental requirements make it essential that these facilities be updated.

Replacement of the I-beam launcher in Area 2 is necessary since this is a manually controlled obsolete launcher which can only be approximately pointed and has a very slow adjustment rate. Therefore, only those vehicles which are insensitive to winds or are pre-set at a very low elevation angle can be launched from this pad. In order to launch sounding rockets at elevation angles to 83 degrees, and be able to correct for wind changes, especially during sunrise or sunset periods, a new launcher similar to that which is now located in Area 4 is required. This will also help accommodate the increasing launch schedule.

Since the facilities of this Station are tailored to provide services for many varied types of rocket experiments, universal checkout consoles and associated cabling will enable rapid switching from one experiment to the next. This concept has been used at other launch locations on Wallops and has provided very successful services.

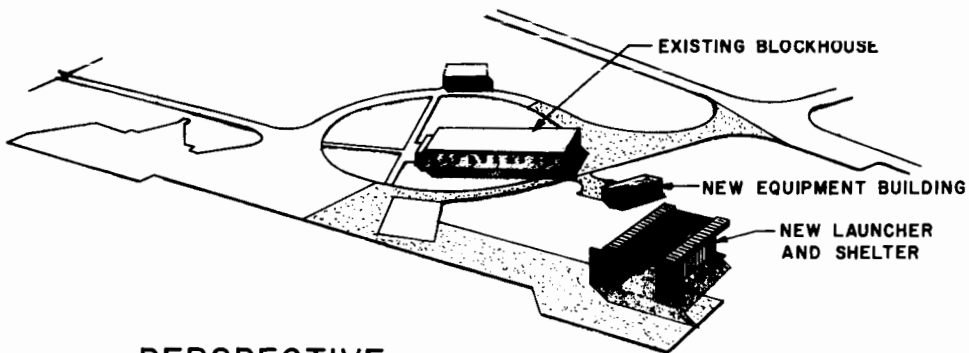
The environmental shelters are necessary to provide temperature and humidity control for the vehicles and payloads during their build-up and awaiting launch window conditions. Presently, it is often necessary to remove the payload and rocket stages whenever there is a cancellation. These removals and repeated build-ups require many valuable man-hours and range time, and reduce the overall reliability of the experiment. This need is increasing since recent high-energy propellants have stringent temperature limits; additionally, the payloads are increasingly more complex and often require environmental control.

ESTIMATED FUTURE YEAR FUNDING: $5,500,000

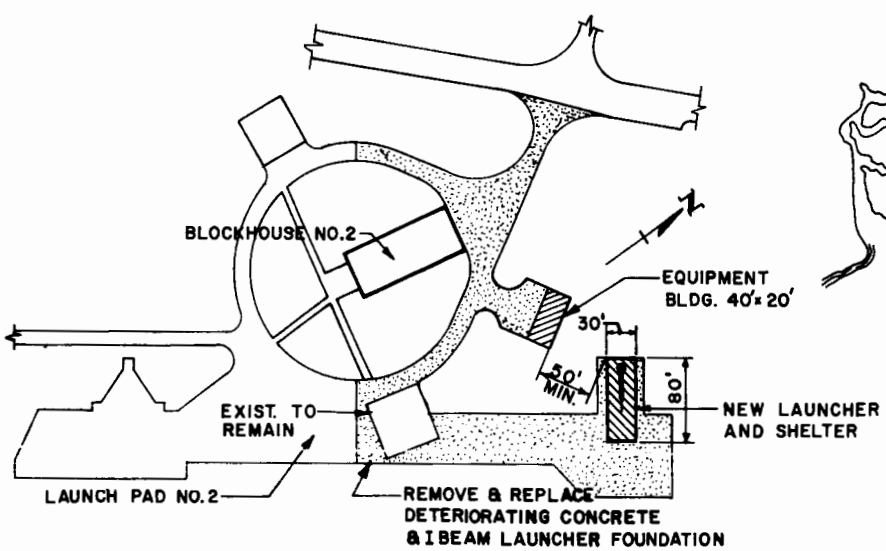
WALLOPS STATION

FISCAL YEAR 1965 ESTIMATES

LAUNCH AREA MODIFICATION

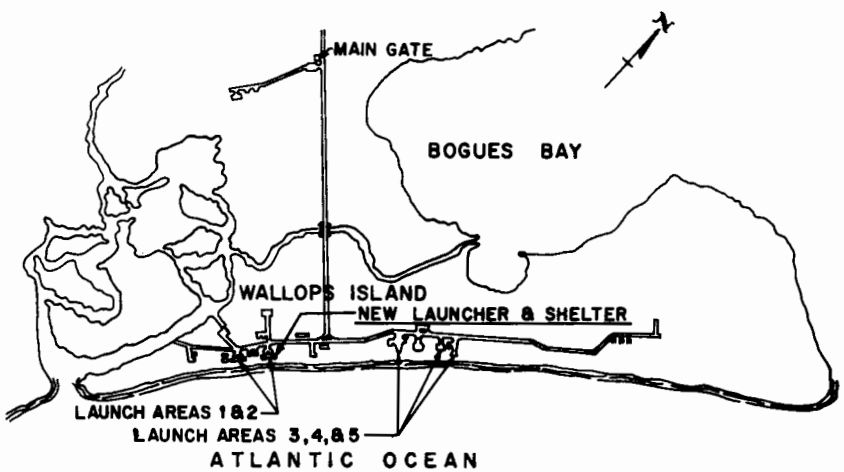


PERSPECTIVE



PLAN

SCALE 0' 50' 100' 200'



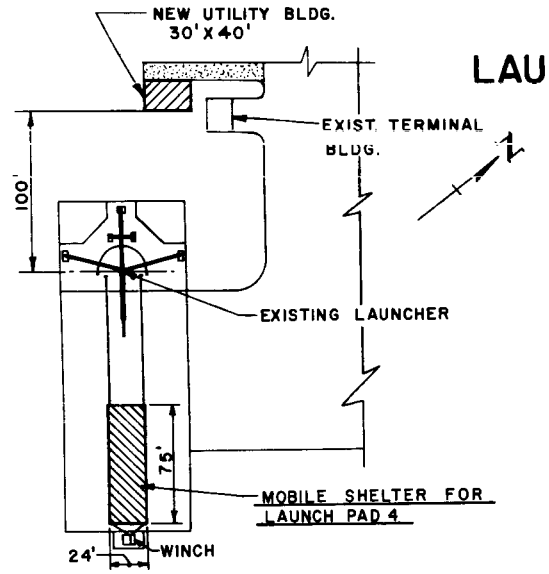
LOCATION PLAN

SCALE 0 1/2 1MI.

WALLOPS STATION

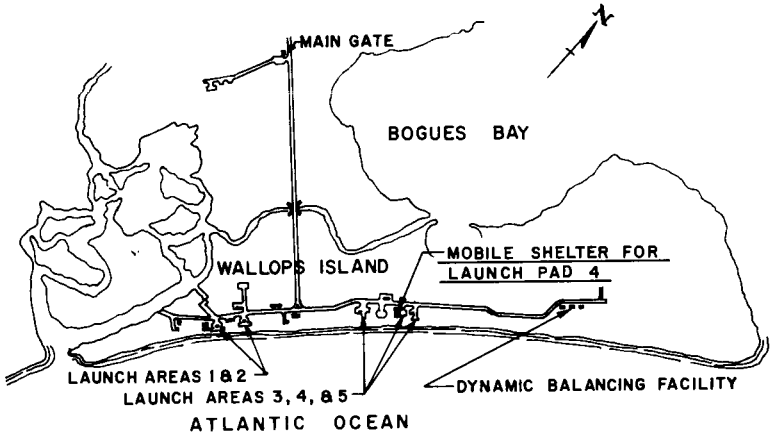
FISCAL YEAR 1965 ESTIMATES

LAUNCH AREA MODIFICATION



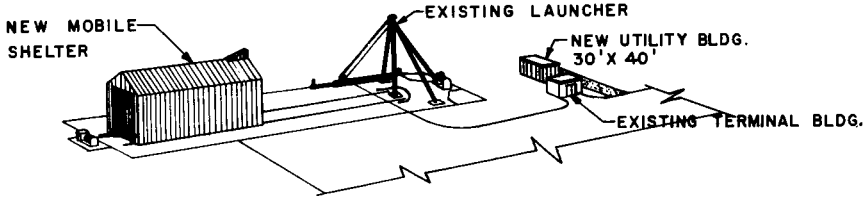
PLAN

SCALE 0 20' 50' 75' 100'



LOCATION PLAN

SCALE 0 1/2 1MI.



PERSPECTIVE

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CONSTRUCTION OF FACILITIES

FISCAL YEAR 1965 ESTIMATES

SUPPORT FACILITIES

PROGRAM OFFICE FOR THE INSTALLATION: Office of Space Science and Applications

PROGRAM OFFICE FOR THE PROJECT: Office of Space Science & Applications

AUTHORIZATION LINE ITEM: Wallops Station

LOCATION OF PROJECT: Wallops Island, Accomack County, Virginia

COGNIZANT NASA INSTALLATION: Wallops Station

TYPE OF CONSTRUCTION PROJECT: New

FUNDING:

FY 1963 and Prior Years	---
FY 1964 Estimate	50,000
FY 1965 Estimate	$1,120,000
Total Funding Through FY 1965	$1,170,000

PROJECT COST ESTIMATE:

	Unit of Measure	Quantity	Unit Cost	Total Cost
Land Acquisition	---	---	---	---
Construction				$1,070,000
Bypass road	miles	2.5	$290,000	732,000
Sewerage system (10 MGD capacity)	LS	---	385,000	385,000
Site preparation (clearing and grubbing)	LS	---	3,000	3,000
Equipment	---	---	---	---
Design	---	---	---	---

	Unit of Measure	Quantity	Unit Cost	Total Cost
Fallout Shelter	---	---	---	---
		TOTAL		$1,120,000

PROJECT DESCRIPTION:

This project will provide a launch area bypass road and sewerage system. The bypass road will begin at the end of the existing dike south of the causeway and extend in a northerly direction approximately 400 feet west of and roughly parallel to the existing road, terminating one and one-fourth (1¼) miles north of the causeway. The total length will be approximately 2.5 miles. The bypass road will be 22 feet wide and constructed by placing a double bituminous surface treatment upon a clay-sand dike. This dike will be 40 feet wide across the crown, with the crown 12 feet above mean low water. The shoulders and slopes will be protected from erosion by seeding and shrub planting. Where necessary, the base for the dike will be excavated down to the sand stratum and filled with clay and sand. The bypass road with its dike base will complete the present dike system, resulting in high water protection around the entire periphery of all launch areas. Pumping stations will be provided to remove excess water within the dike system caused by heavy rains or severe storm tides.

A sewage collection and treatment system, consisting of two main parts, will be provided for Wallops Island, servicing the facilities south of the causeway and to Launch Area No. 5 on the north, respectively. Each of the parts will consist of an aerobic sewage treatment plant with comminutor, chlorinators, pump stations, and all trunk line and main sewer pipe necessary to service the respective areas.

PROJECT JUSTIFICATION:

The bypass road is required to permit controlled access to facilities between road blocks established on the main road during countdown and launch operations while allowing unrestricted access to other work areas. By design and siting, the road will serve as a dike to protect Island facilities from water damage resulting from high tides and wave action accompanying hurricanes and coastal storms such as occurred in March 1962. At present, closing off the main road prevents traffic flow in either direction through the active launch area or areas and acts to isolate one end of the Island from the other. This hampers and delays the performance of work not directly concerned with the impending launch, as well as restricting launch operations.

The existing multi-septic tank sewage system on Wallops Island is inadequate to meet present requirements. The work force on the Island has increased from 150 in 1960 to 425 in 1963 and is expected to reach 530 by 1965. Heavy rains raise the ground water table on the Island to the level of the drain fields and when this occurs, the effluent is transported by the

ground water above ground level in many areas. This condition constitutes a severe health hazard which has been discussed at length with the local representatives of the Virginia State Board of Health. They concur emphatically with Wallops Station personnel on the immediate need of replacing the present inadequate sewage system with a collection and treatment system capable of properly serving the population increase and eliminating this health hazard.

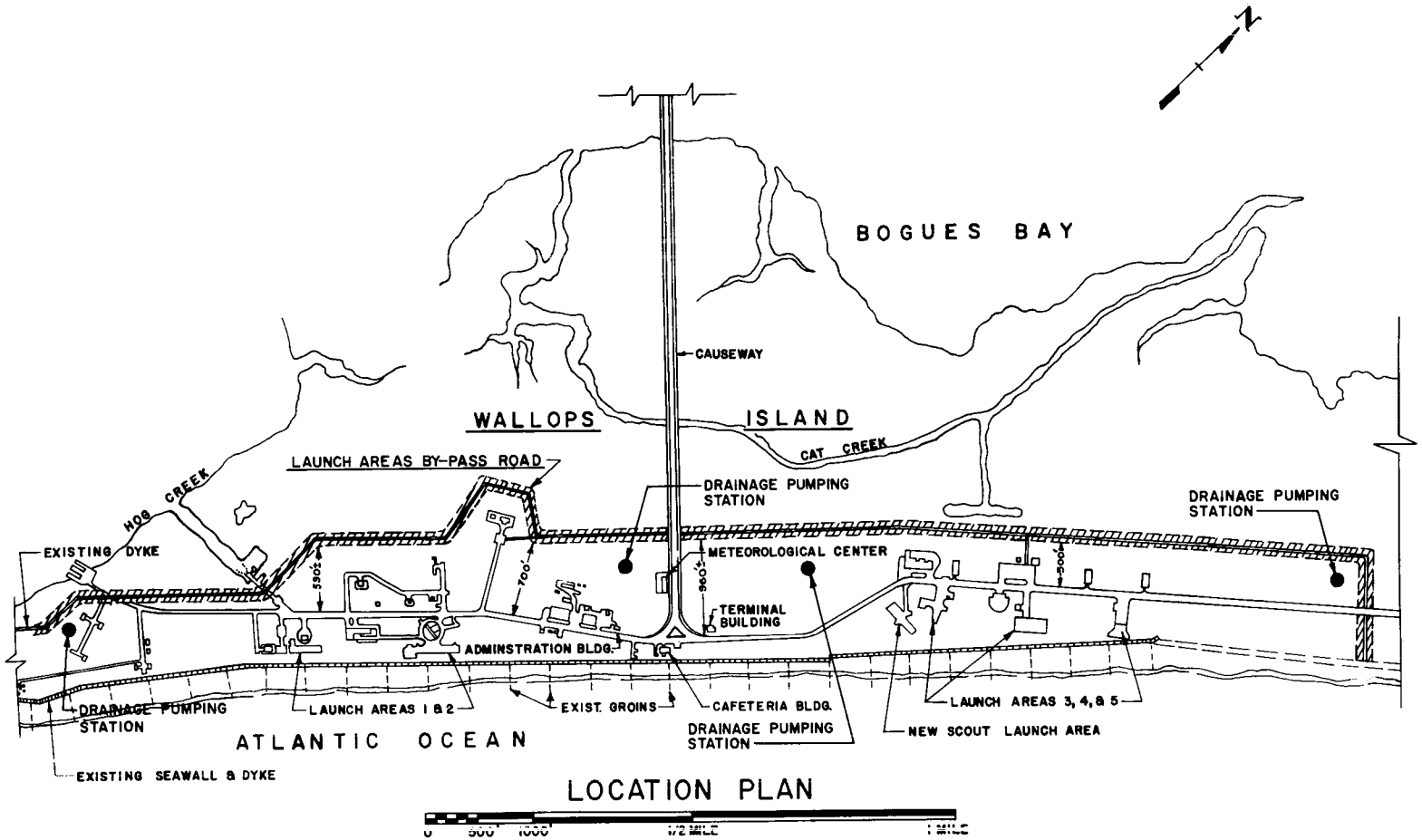
ESTIMATED FUTURE YEAR FUNDING: $1,000,000

WALLOPS STATION

FISCAL YEAR 1965 ESTIMATES

SUPPORT FACILITIES

BY-PASS ROAD AND DYKE



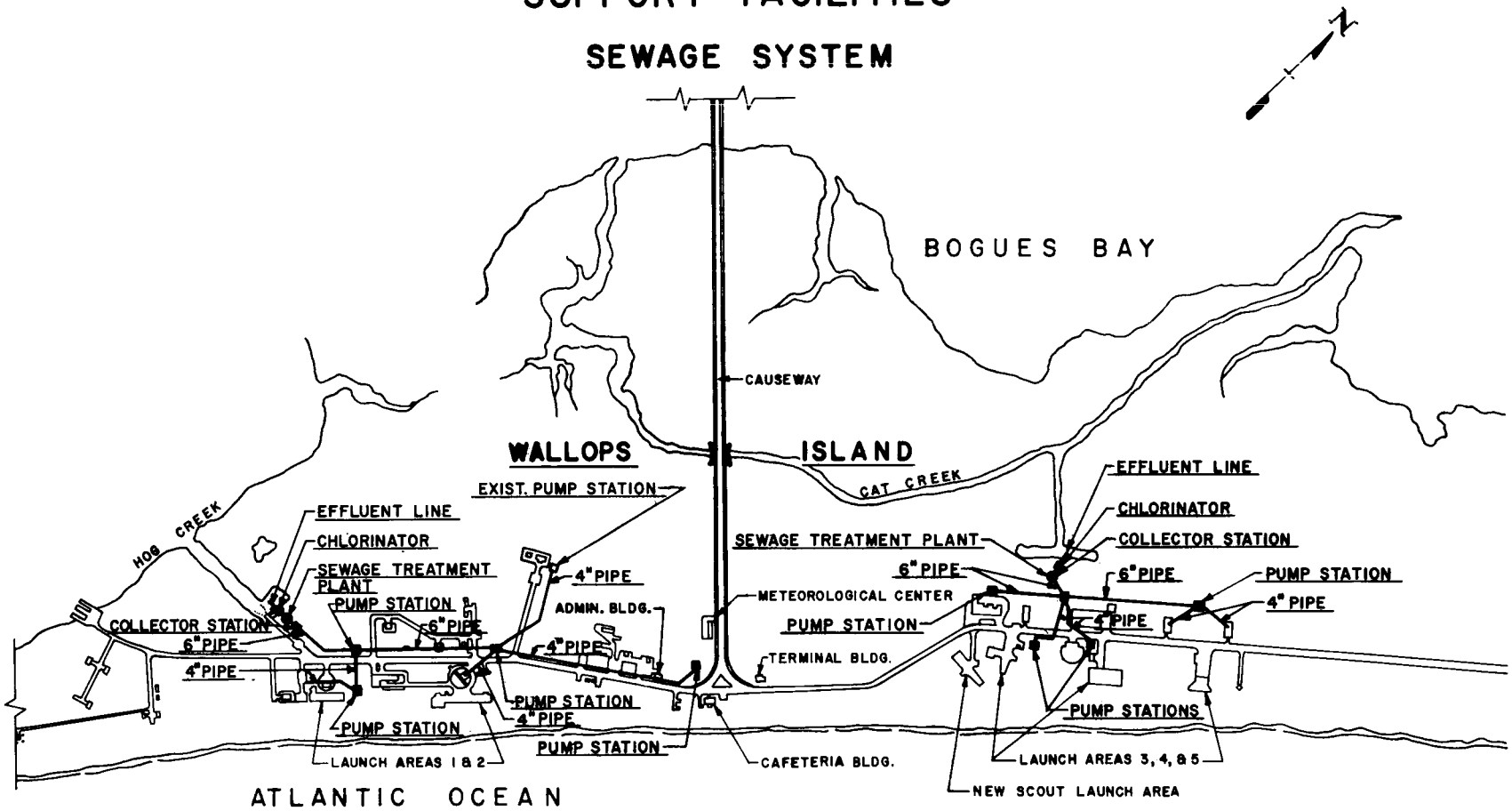
LOCATION PLAN

WALLOPS STATION

FISCAL YEAR 1965 ESTIMATES

SUPPORT FACILITIES

SEWAGE SYSTEM



LOCATION PLAN

0' 500' 1000' 1/2 MILE 1 MILE

U. S. GOVERNMENT PRINTING OFFICE : 1964 O - 718-880