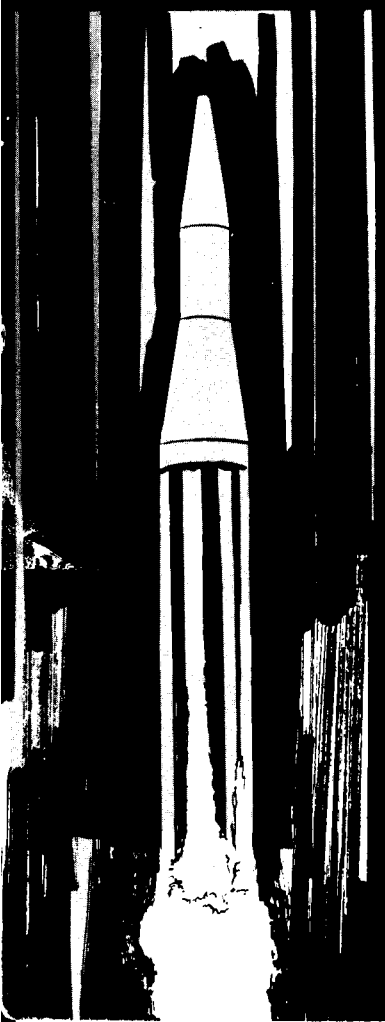
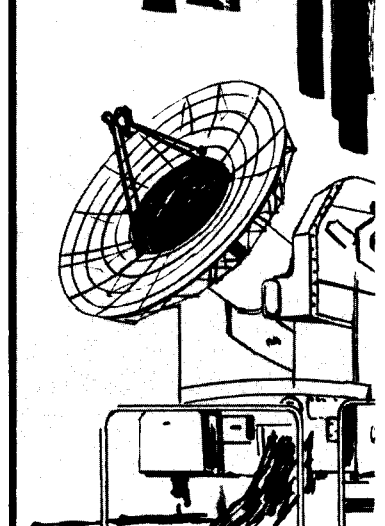
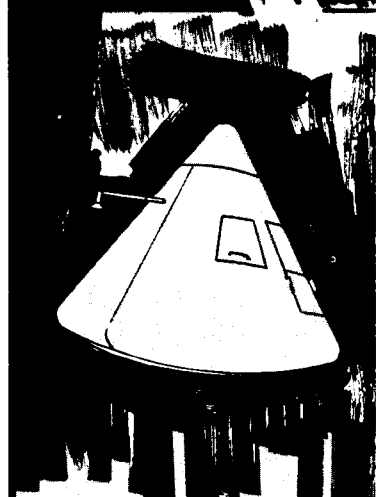


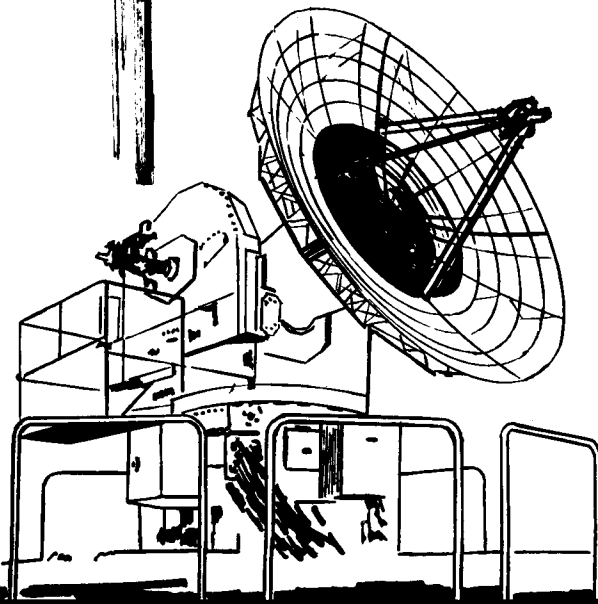
**REPORT  
TO THE CONGRESS  
FROM THE PRESIDENT  
OF THE  
UNITED STATES**

**UNITED STATES  
AERONAUTICS AND  
SPACE ACTIVITIES  
1962**



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**REPORT  
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**UNITED STATES AERONAUTICS AND  
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1962**

THE WHITE HOUSE  
Washington

January 28, 1963

TO THE CONGRESS OF THE UNITED STATES:

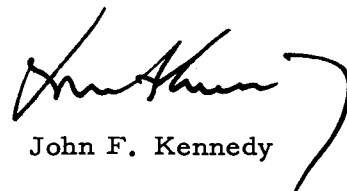
In accordance with Section 206 (b) of the National Aeronautics and Space Act of 1958, as amended, I transmit herewith a report for the calendar year 1962, on this nation's aeronautics and space activities.

The year 1962 was a period of acceleration, accomplishment, and relative progress for the United States in its space leadership drive. In both numbers and complexity of space projects, the past year was the most successful in our brief but active space history.

The benefits of our peaceful space program, in both its civilian and military aspects, are becoming increasingly evident. Not only have the horizons of scientific knowledge been lifted, but the resulting international cooperation and world-wide dissemination of knowledge and understanding have strengthened the world image of this country as a force for peace and freedom. The economic benefits of our national space program are also revealing themselves at an increasing rate.

These growing space successes have required the support of increasing budgets. Thus, the recommended budget which I submitted to the Congress earlier this month contains requests for funds for the fiscal year 1964 space program in the total amount of \$7.6 billion. This is an increase of \$2.1 billion over FY 1963, \$4.3 billion over FY 1962, and \$5.8 billion over FY 1961.

In summary form, the accompanying report depicts the contributions of the various departments and agencies of the Government to the national space program during 1962.



John F. Kennedy

**TABLE OF CONTENTS**

		Page
Chapter I	U. S. Aeronautics and Space Activities -- 1962 -- Summary. . . . .	1
Chapter II	National Aeronautics and Space Council. .	7
Chapter III	National Aeronautics and Space Administration. . . . .	9
Chapter IV	Department of Defense . . . . .	33
Chapter V	Atomic Energy Commission . . . . .	49
Chapter VI	Department of State. . . . .	55
Chapter VII	National Science Foundation . . . . .	59
Chapter VIII	Department of Commerce. . . . .	63
Chapter IX	Space Science Board. . . . .	77
Chapter X	Smithsonian Astrophysical Observatory	83
Chapter XI	Federal Aviation Agency. . . . .	87
Chapter XII	Federal Communications Commission. .	95
Chapter XIII	United States Information Agency. . . .	101
Appendix A - 1	U. S. Launching Record 1957-62 . . .	107
Appendix A - 2	Successful U. S. Launches - 1962. . .	108
Appendix B	U. S. Space Launch Vehicles. . . . .	123
Appendix C	Historical Background and Communications Satellite Act of 1962	125
Appendix D - 1	Historical Summary and FY 1964 Budget Recommendations. . . . .	137
Appendix D - 2	Space Activities Budget. . . . .	139

# Chapter I

## U.S. Aeronautics and Space Activities 1962

### SUMMARY

In 1962 the United States achieved a sure footing on the frontier of space. Both the number and the complexity of accomplishments in the national space program revealed to the world the progress that can flow from an energetic application of resources.

While successes in space achievement were characteristic, this past year also contained some delays and disappointments. Lessons learned from the failures as well as the successes should contribute to a record of even greater net advance in 1963.

Foremost among the broad list of accomplishments was the placing of three U.S. astronauts into earth orbits, the Venus probe, intercontinental communication by active satellite, acquisition of data from defense launches, and progress in rocket planning and development.

On three occasions, people throughout the world watched as the United States, in an entirely "open" fashion, successfully launched an astronaut into orbit and returned him safely to earth. By means of a highly sophisticated probe launched toward Venus, the United States obtained man's first close-up electronic look at another planet. Television shows, telephone and telegraph messages were exchanged via satellite between this country and Europe and the weather satellite system provided continuous operational data to aid weather forecasters and those who depend on weather forecasts, all over the world. Satellites to aid the navigation of ships at sea were improved and the first prototype operational navigation satellite completed, and a satellite to provide very precise mapping of the earth's surface was launched. 1962 was a year which saw this country launch many scientific satellites to study the most distant reaches of the earth's atmosphere as well as the fields and particles of interplanetary space.

Important advances toward development of the system that will place U.S. astronauts on the moon were made, including the decision to send the three-man lunar spacecraft into orbit around the moon and then to send a segment of the craft, manned by two of the astronauts, to the moon's surface. Due to the magnitude of this effort and its high priority rating, a significant portion of space funds and resources was devoted to the manned lunar-landing project. However, it was clear from the broadly based national program that the lunar effort was but one of a number of space objectives and that space leadership calls for space competences in many areas including exploration beyond the moon with more advanced technology.

Cooperative space programs were carried out with an increasing number of countries. Satellite payloads were developed by the United Kingdom and Canada and launched into orbit in cooperation with the United States.

In keeping with the U.S. objectives that space should be kept for peaceful use by all nations, continuing efforts were made to maintain the freedom of space. The previously announced policy that military space projects which help keep the peace are as peaceful in character as any other space projects was strengthened through public

explanations which fostered broader public understanding of its import. The United States also reiterated its policy of peaceful intentions, i. e., not to develop or place in orbit any weapons of mass destruction, and at the same time urged that such policy be universally accepted.

An encouraging start was made in the area of international cooperation between the two major space powers: the United States and the Soviet Union. A bilateral agreement was carefully developed and was reported to the United Nations: the two powers agreeing to coordinate their capabilities toward the establishment of a global weather satellite system, in mapping of the earth's magnetic field, and in experiments with communication satellites.

Aeronautical developments included progress in detailed analysis of the potentialities of a supersonic transport, and in development of various types of vertical, and short take-off and landing aircraft. A contract was also let for a new high performance fighter aircraft for use by more than one of the armed services.

As with any program which pushes into the areas of unknown scientific knowledge or new engineering development, the U.S. national space program experienced its share of failures. Also, certain of the projects, though providing some information and achieving significant accomplishments, could not be considered complete successes. The early attempts to land scientific instruments on the moon failed to send back scientific information. The effort to develop a powerful second-stage rocket vehicle using liquid hydrogen experienced difficulties. These and other setbacks are being analyzed in an effort to provide answers which will help to insure future successes.

There were many "firsts" for the U.S. National Space Program in 1962, and the broad range of successes indicates the magnitude of the U.S. effort to reach out into space for knowledge, and for new tools useful to mankind. Of particular note were the following accomplishments:

... A U.S. astronaut was orbited around the earth three times in our initial manned orbital effort with project MERCURY. This was followed by another three-orbit flight, and then by a six-orbit flight.

... Substantial advances were made toward developing more powerful launch vehicles required for two-man orbits, rendezvous and docking, and the lunar mission. TITAN II was tested and the first stage of the SATURN C-1 vehicle, which generated 1.3 million pounds of thrust, was twice launched on test missions.

... Plans were initiated to provide a new large launch complex for the SATURN C-5 booster system at Cape Canaveral. Provision was made at the Michoud Plant at New Orleans, Louisiana, for the manufacture and assembly of SATURN launch vehicles, and land was acquired for test sites nearby at the Mississippi Test Facility for testing large stages.

... MARINER II flew within 21,594 miles of Venus, providing much new information about that planet.

... TELSTAR demonstrated the transmission of television and other wide-band information over intercontinental distances.

... Commercial use of space communications systems came closer to reality with the passage of the Communications Satellite Act of 1962. In accord with this statute, incorporators were selected to form a privately owned and publicly regulated satellite communications corporation.

... Development of satellite inspector capabilities continued through 1962. Program assessment resulted in the termination of a prototype coorbital demonstration system and an inspector system definition study was initiated.

... Decision was made to use the Lunar Orbital Rendezvous (LOR) technique to place U.S. astronauts on the moon during this decade. Design and development of the APOLLO lunar spacecraft, together with its guidance and navigation systems, progressed steadily, and a contract for the design, development and production of the Lunar Excursion Module (LEM) was awarded.

... Additional astronauts were selected for the expanding manned space projects.

... Construction of NASA's Manned Spacecraft Center near Houston, Texas, was begun. The Center will serve as an astronaut training base, a spacecraft systems testing site, and a nerve center for rendezvous missions of GEMINI and for APOLLO missions.

... Using data from the TIROS weather satellites, meteorologists gained increased knowledge of the origin, growth and dynamics of hurricanes, tornadoes, fronts, cyclones, jet streams, snow cover, ice conditions, and sea turbulence.

... The first foreign satellite payload, United Kingdom's ARIEL, was put into orbit in cooperation with the United States. The launching of Canada's ALOUETTE satellite followed. A joint agreement with Italy called for a cooperative program of scientific satellite launchings. Cooperative space programs were carried out with many other countries throughout the world.

... The TITAN III launch vehicle, standardized to perform a wide variety of space missions, was approved for development. This vehicle was selected to launch the X-20 (previously called DYNA-SOAR).

... Development of the X-20 glider system proceeded to a point where fabrication of the first gliders is expected to begin in 1963.

... Research did much to solve problems of critical heating during various phases of space flight. Studies were conducted on the re-entry heating rates and flight characteristics of various configurations at speeds up to 30,000 m.p.h.

... Previous plans were revised and new plans were developed for a medium-altitude military communications satellite system. The first satellite communications ship was completed and put to sea for tests.

... The Space Detection and Tracking System was improved by the addition of a high resolution radar sensor element in Alaska. Construction was started on a phased-array radar expected to possess greater capabilities than existing sensors.

... The TRANSIT satellite navigation system development was continued, pointing



toward operational deployment to provide worldwide, all-weather navigation to a degree of accuracy unattainable from present methods.

... The first Orbiting Solar Observatory (OSO) was placed into orbit, providing scientists new knowledge about the sun.

... Emphasis was placed on research and technology development of the ICBM Alarm system during 1962. Advances were made in infrared measurement and background discrimination techniques.

... Development continued on an Orbiting Astronomical Observatory (OAO) containing telescopes designed to map and record at least 50,000 stars and prepare the way for new astronomical knowledge.

... Large solid-fueled rockets with diameters up to 120 inches were placed under development, and an intensified effort to develop even larger solid rocket engines was initiated.

... Three additional nuclear power units (SNAP) were developed and made ready for use in the application satellites.

... A major stride toward development of nuclear rocket engines for operational missions was made with the first power operation of a reactor using liquid hydrogen. Other programs were directed towards development of a complete nuclear-electric power plant capable of meeting space power demands in the 300 to 1,000 electrical kilowatt range.

... An improved passive communications satellite (ECHO), 135 feet in diameter and weighing 500 pounds, was developed, and prepared for orbital launch.

... A geodetic satellite (ANNA) was launched and is providing tracking stations with location data to an accuracy of 100 feet relative to the center of the earth. The satellite is also defining the earth's gravity to an accuracy of five parts in one million. This knowledge is aiding more precise mapping, navigation and other scientific research.

... The X-15 research rocket-aircraft continued to go higher, and faster, to new records on the fringes of space.

... Both the Atlantic and Pacific launch ranges were expanded to meet the demands of the accelerated space program.

... The three-stage THOR-DELTA vehicle scored its fourteenth consecutive success with the launching of the RELAY communications satellite. THOR-AGENA and ATLAS-AGENA continued to be other important workhorses of the U.S. National Space Program.

... Progress was made in increasing payload capability of the all-solid four-stage SCOUT launch vehicle.

... Development of Vertical (VTOL) and Short-Take-Off-and-Landing (STOL) aircraft was intensified, using the tilt wing, tandem tilt propeller, and tandem rotating ducted fan principles, with promise for many military and commercial uses.

... EXPLORER satellites, as well as other vehicles, continued to explore and measure radiation, high energy particles, and micrometeoroids, and to provide information making manned space flights safer and unmanned satellites more reliable.

... A re-evaluation of the RANGER program was made because of initial failures. One of the payloads did reach the surface of the moon's far side and two others went into solar orbit.

... The RELAY communications satellite was launched. Although initial loss of electrical power prevented its performing its active communication missions, technical efforts were made in anticipation of obtaining successful transmissions.

... Disappointment was experienced in the initial attempt to test-fly the second-stage liquid hydrogen CENTAUR rocket vehicle, but reorganization of the program in conjunction with increased development efforts was effected to correct the difficulties.

... The second amateur radio satellite (OSCAR II) was placed into low earth orbit.

... The United States placed more than 50 satellite payloads in orbit during 1962.

The balance sheet of the U.S. space program during 1962 revealed an impressive net worth of new scientific knowledge, improved image of technological competence at home and abroad, successful space ventures, and increased devotion of energy and resources to space leadership.

## Chapter II

# National Aeronautics and Space Council

The Vice President, as Chairman of the National Aeronautics and Space Council, made a summary report to the President on the Council's accomplishments in 1962. The text of that report follows:

Nineteen Sixty Two was a year in which the United States showed clearly its ability to translate sound decisions into major space accomplishments. Significant progress was made in manned earth-orbiting flights; in communications, meteorology, geodesy, and navigation; in scientific investigation; in development of more powerful and more effective rocket engines; and in strengthened quality of governmental organization.

The United States generated a greater rate of space progress than did the USSR. However, Soviet accomplishments were also significant. At year's end, they were still ahead in size and total of weights placed into orbit, in the thrust of their operational rocket engines, and in the development of the art of rendezvousing in space. In addition, their progress in the life sciences and in electronic guidance was noteworthy.

The United States was successful in putting more than fifty satellite payloads into earth orbit; the USSR more than fifteen. In addition, both nations extended their space exploration toward the planets, such as Mars and Venus. Based upon available information, it can be concluded that the records of the two countries were closely similar in regard to the ratios of space successes to space failures.

The National Aeronautics and Space Council, acting essentially as a policy and management resource for the President, engaged in a wide range of activities in the aeronautics and space fields. During the year, the Council and its staff, acting upon the basic principle that this country is engaged in a national space program rather than a collection of separate and competing programs, stressed coordination as between government agencies and contributed its influence toward eliminating duplication. It also attempted to dissolve the confusion regarding the peaceful objectives of this country's space program by emphasizing that the non-aggression characteristics of our military space activities cause them to be just as peaceful as are the non-military space activities.

Due to the openness of our program, the world has become increasingly aware of U. S. space achievements and our international prestige has been increased due to the mounting number of our space successes, our positive efforts to cooperate with other nations, and our constructive sharing of information developed from space experiments. It seems particularly important that we strengthen and then maintain both the policy and the practice of making public all information regarding our space program, which will not adversely affect our national security.

In performing its responsibilities, the Council, directly and through its staff, engaged in a wide range of policy and coordinating activities.

Among these activities were:

- a. drafted statements of national space objectives and missions;
- b. prepared and recommended legislation to implement the communications satellite policy;
- c. assisted in drawing up the criteria and functions as regards the incorporators for the communications satellite corporation and also reviewed drafts of articles of incorporation and by-laws;
- d. encouraged, through inter-agency meetings, the coordination of NASA and Defense Department plans for communication satellites;
- e. encouraged and assisted in increasing the emphasis upon life sciences activities in NASA and in coordination between Defense and NASA in this field;
- f. participated in the development of plans and policies for increased cooperation between the U. S. and the U. S. S. R. in outer space;
- g. assisted in the preparation of a U. S. resolution, introduced to the United Nations, on the peaceful uses of outer space and participated in the development of U. S. positions on space for the 17th General Assembly;
- h. supervised the preparation and conducted the editing of the President's Annual Report to the Congress on U. S. astronautics and space activities for 1962;
- i. testified on space policies and space activities before Committees of the Congress;
- j. visited space installations, examined facilities, and discussed space developments and problems with managerial and technical specialists;
- k. requested a study of costs and market projections for supersonic transports;
- l. participated in the analysis and development of the Fiscal Year 1964 budgets for space;
- m. increased the public understanding of the national space program through speeches, articles, public appearances, and interviews;
- n. recommended top priority ratings for the APOLLO and CENTAUR projects; and
- o. engaged in numerous inter-agency, as well as government-industry, meetings and briefings on new developments in space technology.

The Space Council held formal meetings on such subjects as the comparison of U. S. and Soviet space programs, review of space budget plans and requests, impact of our space program on foreign relations, examination of the role of nuclear propulsion and nuclear power devices in the space program, assignment of priorities for major space programs, evaluation of defense plans for space activities, aspects of astronaut recruitment and training, examination of schedules and methods for the lunar project, and public information aspects of the national space program.

# Chapter III

## National Aeronautics and Space Administration

### INTRODUCTION

During 1962, the fifth year of the nation's space program, the National Aeronautics and Space Administration extended United States leadership in the scientific investigation of space; made substantial progress in manned space flight; and mobilized the resources required to attain the national goals of manned lunar exploration within this decade and ultimate and enduring pre-eminence in space.

As part of a broadly based space effort, emphasis was placed in 1962 on laying the basis for development and operation of the large launch vehicles required in advanced manned space flight programs. Lunar orbit rendezvous, utilizing the Advanced SATURN launch vehicle, was selected as the mode for placing the first American explorers on the Moon. All major components of the Advanced SATURN and the APOLLO spacecraft were placed under contract, and sites were selected and development initiated for the major engineering complexes on the ground which will be required to fabricate, test, and launch the huge rocket boosters required in advanced space exploration.

During the year NASA placed the first American astronaut in earth orbit, and in two subsequent manned orbital flights extended knowledge of the effects of prolonged weightlessness and other conditions encountered in space.

Scientific achievements in space included the successful launching of the ORBITING SOLAR OBSERVATORY, the most sophisticated satellite yet devised, and of MARINER II, a deep space probe which, in December, passed within 21,600 miles of the planet Venus, transmitting extensive information back to Earth before going into orbit around the sun.

Further progress was made in the application of space technology. Continued success of the TIROS meteorological satellite program permitted increased operational use of data by the U. S. Weather Bureau and led to partial funding of additional TIROS launches by that Agency. Two communications satellites, TELSTAR and RELAY, were launched, with TELSTAR providing the first demonstration of international television broadcasting.

NASA activities in aeronautical research were expanded during the year, in which all the original design goals of the X-15 research airplane were achieved. Continued emphasis was placed on advanced research and technology, not only to support existing programs in manned and unmanned flight, but as the basis for more advanced objectives in the future.

The year was the most productive to date in the development of international cooperation in space. Two international satellites and 21 sounding rockets were launched in cooperation with other nations. Cooperative agreements concluded with other political jurisdictions brought the total to 61 -- including an agreement between the United States and the U. S. S. R.

Constructive progress was made in the strengthening of the NASA management organization, and in the marshalling of industry, university, and government resources to achieve national space objectives.

### LAUNCH VEHICLES AND PROPULSION

In 1962, NASA made significant progress in developing launch vehicles, launch facilities, and rocket engines.

#### Large Launch Vehicle and Engine Development

Substantial advances were made toward developing more powerful launch vehicles required for the APOLLO project as well as for unmanned space projects. These vehicles include the SATURN, the SATURN B, and the Advanced SATURN. Pre-development studies of the NOVA-class vehicle were also undertaken.

The configuration of the SATURN consists of two stages: (1) The S-I booster stage, powered by eight H-1 engines (liquid oxygen-hydrocarbon fuel) developing 1.5 million pounds of thrust; and (2) the S-IV second stage, propelled by six RL-10 A-3 engines (liquid oxygen-liquid hydrogen fuel), generating 90,000 pounds of thrust. The SATURN is slated for use in earth orbital tests of two of the three modules of the APOLLO spacecraft.

The second and third unmanned developmental flights of the SATURN were successfully conducted in April and November. The flight configuration in both cases was composed of a live first stage and a dummy second stage.

In September, NASA approved the development of the SATURN B, an improved version of the SATURN, which will be used for earth orbital flights and rendezvous operations of the complete APOLLO spacecraft, including the Lunar Excursion Module. This launch vehicle will be composed of a first stage that is to be a modified version of the SATURN first stage, and a new second stage (S-IVB), propelled by one J-2 engine generating 200,000 pounds of thrust.

The next launch vehicle in line will be the Advanced SATURN, composed of three stages. The first stage -- S-IC -- will have five F-1 engines, each producing 1.5 million pounds of thrust. The second or S-II stage, composed of five J-2 engines, will yield one million pounds of thrust. The third stage is a slightly modified version of the S-IVB, which serves as the second stage of the SATURN B; it will have a single J-2 engine which will generate 200,000 pounds of thrust. At the beginning of the year, NASA selected the Advanced SATURN for development and in July announced its use for lunar-landing missions. Definitive contracts for each stage were signed during the year.

In August, NASA awarded two contracts for studies of NOVA-class launch vehicle configurations, facilities requirements, and developmental and operational plans. NOVA is planned as a rocket at least two to three times larger in payload capability than the Advanced SATURN. Expectations are for its use in the early 1970's for missions beyond the manned lunar landing.

#### Launch Vehicle Facilities

To meet requirements for more powerful launch vehicles, NASA undertook modifications of (1) the Marshall Space Flight Center's static test stand to accommodate the Advanced SATURN upper stages and (2) the Michoud Plant at New Orleans, La., to provide 1.8 million square feet of space for the manufacture and assembly of the

SATURN, SATURN B, and Advanced SATURN boosters.

During the year, NASA completed the acquisition of 13,550 acres for test sites at the Mississippi Test Facility, -- 40 miles from the Michoud Plant -- which will be the site of ground testing of large launch vehicle stages manufactured at Michoud. NASA began acquiring easements on about 128,000 acres of land needed as a buffer area to protect against the noise volumes associated with rocket testing. Construction began on the stands and related facilities required for the testing of the first two stages of the Advanced SATURN. Areas were set aside for the future construction of stands for testing NOVA vehicle stages.

### Launch Operations Center

Progress was made in acquiring additional land for the Launch Operations Center, Cape Canaveral, Fla. About 87,000 acres adjacent to existing facilities will provide sites for the most extensive space launch facilities in the world.

The future flight schedules for U.S. exploration of space will impose increasingly heavy demands on launch facilities at the Launch Operations Center. At the north end of the expanded reservation, three major launch complexes will constitute the spaceport for the launching of APOLLO vehicles. Of particular importance is Launch Complex 39. In July 1962, NASA established the basic design of this complex; it will embody an entirely new concept in launch facilities. Before the end of the year, architect-engineers had established detailed criteria for the complex. In Complex 39, the Advanced SATURN vehicle and the APOLLO spacecraft will be assembled and checked out inside a Vertical Assembly Building more than 500 feet tall. Thus, the delicate equipment will be protected from wind, weather, and salt spray during the several weeks preceding the launch.

Architect-engineering designs were completed for a mobile crawler-transporter which will carry the 350-foot-tall vehicle and spacecraft to the launch pads along a specially designed roadway. Similar designs were completed for the Vertical Assembly Building which will have high-bay areas for simultaneous work on four launch vehicles. Its foundations will be built to permit expansion to six bays. Three launch pads will be constructed initially.

### Light and Medium Launch Vehicles

NASA's launch vehicles for currently planned unmanned missions are CENTAUR, ATLAS-AGENA B, THOR-AGENA B, DELTA, and SCOUT.

Of these, only CENTAUR is still in the development stage. Difficulties have been encountered in developing liquid hydrogen technology for this launch vehicle. Even so, development is progressing, and CENTAUR will be the first United States launch vehicle to use liquid hydrogen as a fuel. This high-performance fuel will also be used later for the upper stages of the SATURN launch vehicle. CENTAUR is therefore also important as a vehicle incorporating the liquid hydrogen technology required for the manned lunar program.

A milestone in this liquid hydrogen technology was the completion in June of a "Preliminary Flight Readiness Test" hot firing series of the most recent Pratt and Whitney RL-10 engine configuration.

In May 1962, the first ATLAS-CENTAUR was launched from the Atlantic Missile Range. The CENTAUR stage broke up because of aerodynamic forces after less than one minute of flight, and the major flight objectives were not achieved; however, this was the first space vehicle fueled with liquid hydrogen launched by the United States.

In October 1962, NASA transferred the project management of the CENTAUR development program from the Marshall Space Flight Center to the Lewis Research Center. This transfer enables NASA to put more effort into the CENTAUR program without adversely affecting SATURN's development.

NASA planned extensive use of the Air Force-developed ATLAS-AGENA B and THOR-AGENA B. ATLAS-AGENA B vehicles successfully launched RANGER IV in April and MARINER II in August. In September a THOR-AGENA B was used as a launch vehicle for the first time: It successfully orbited the Canadian ALOUETTE (S-27) Topside SOUNDER satellite from the Pacific Missile Range. In December, project management of the NASA AGENA and its associated ATLAS and THOR boosters were transferred to Lewis Research Center.

The three-stage DELTA vehicle scored its fourteenth consecutive success with the launching of the communications satellite -- RELAY -- on December 13, 1962. Because of the success of this launch vehicle, NASA planned to procure additional quantities for launching TIROS weather satellites and experimental communications and scientific satellites.

NASA progressed in its efforts to increase the payload capability of the all-solid 4-stage SCOUT from 220 to 300 pounds in the 300 miles easterly orbit.

### MANNED SPACE FLIGHT

During 1962, decisive steps were taken in Project APOLLO toward reaching the Nation's goal of manned exploration of the moon, including manned lunar landing and return before the end of this decade. The year also witnessed three successful manned MERCURY flights and advances in the follow-on Project GEMINI.

The selection of the Lunar Orbital Rendezvous (LOR) as the technique for carrying out the Project APOLLO mission climaxed months of cooperative study efforts, which utilized the combined scientific and technical talent of industry and Government. Intensive follow-on studies confirmed the choice of the LOR technique as the most promising approach in terms of time, cost, and certainty of mission success.

#### Project MERCURY

The manned orbital flights of Project MERCURY in February, May, and October proved the operational reliability of the spacecraft and supporting systems, and demonstrated man's ability to perform effectively under zero-gravity conditions. The missions also established the effectiveness of the recovery system and the worldwide network of radio and radar stations for tracking, communications and collection of data.



On February 20, Astronaut John H. Glenn, Jr., became the first American to achieve orbital flight. Astronaut Glenn completed three full orbits in the Friendship 7 spacecraft in the course of five hours. All test objectives of the flight were accomplished, including manual control of the spacecraft and scientific observations of the earth, clouds, and stars.

The second manned orbital flight of Project MERCURY was conducted on May 24, 1962, when Astronaut M. Scott Carpenter's Aurora 7 was launched into an almost perfect trajectory. The spacecraft also circled the earth three times in a five-hour period. Astronaut Carpenter continued the observations of space phenomena that were noted by Astronaut Glenn.

A third manned orbital flight -- that of Walter M. Schirra, Jr., in Sigma 7, on October 3 -- doubled the number of orbits of the two previous manned flights and provided excellent data on the operation of the capsule and its systems for longer flights.

The year's progress paved the way for flights in a modified MERCURY spacecraft lasting a full day. Late in the year, Astronaut L. Gordon Cooper was selected for a one-day flight scheduled in the spring of 1963. Alan B. Shepard, Jr., will be his alternate.

### Project GEMINI

After Project MERCURY in NASA's sequence leading to manned lunar landing and further exploration of space is Project GEMINI. This is the development and flight of a two-man MERCURY-type spacecraft. The GEMINI missions will be used to develop the techniques of rendezvous and docking (joining two objects in orbit) and to test the astronauts' ability to carry out varied tasks under prolonged weightlessness.

Plans confirmed during 1962 call for an unmanned, suborbital qualification flight of the GEMINI capsule in 1963. Manned operational flights lasting up to two weeks will follow in 1964 and will be succeeded by rendezvous and docking missions.

Considerable progress was achieved in the development of all elements of the GEMINI system during 1962. To realize the goals of the GEMINI program in the shortest possible time and within the greatest possible margin of reliability, modifications were made in the MERCURY spacecraft and its subsystems. The same contractor was employed in the spacecraft development.

NASA began flight tests of the ejection seats that will provide emergency escape for the GEMINI astronauts during launch and of the paraglider, a device that will substitute for the parachutes and provide improved landing control in later GEMINI flights.

The U.S. Air Force conducted several successful flight tests of the TITAN II, a modified form of which will be the GEMINI launch vehicle.

### Project APOLLO

During the year, NASA progressed with the development of spacecraft and launch

vehicles and the design and construction of the ground facilities required for manned lunar landing and return in Project APOLLO. Following intensive study, the Lunar Orbital Rendezvous technique was selected for the first manned flights to the moon.

Under this technique, an Advanced SATURN will launch an APOLLO spacecraft on a trajectory that will carry it to the vicinity of the moon. The APOLLO will consist of three units, called modules -- the Command Module, the Service Module, and the Lunar Excursion Module. The Command Module will house the three astronauts on takeoff from Cape Canaveral and on return to the earth's atmosphere. The Service Module will carry a propulsion system for maneuvering in mid-course, into orbit about the moon, and into the flight path back to the earth. The Lunar Excursion Module, carrying a separate propulsion system, will transport two astronauts from lunar orbit to the moon's surface and back into lunar orbit for rendezvous with the two other modules of the APOLLO spacecraft.

The selection of contractors for all major APOLLO systems was completed during the year with the naming of a contractor to design, develop, and produce the Lunar Excursion Module. Design and development of the Command and Service Modules progressed steadily through wind-tunnel tests, parachute drop tests, and firings of rocket engines.

#### New Astronaut Candidates Selected

In addition to design and development activities, NASA announced the selection of nine new astronaut candidates. Flight crews for Projects GEMINI and APOLLO will be selected from the original astronauts and the new candidates.

#### Manned Spacecraft Center

The Manned Spacecraft Center, in charge of manned space flight operations, the development and testing of spacecraft, and the training of flight crews, moved from Langley Air Force Base, Virginia, to Houston, Texas. Construction of test laboratories and engineering buildings began on a 1,600-acre site at Clear Lake, near Houston. NASA approved the basic design and concept of an Integrated Mission Control Center at Houston, which will be the primary earth station for the control of manned space flight operations, beginning in the later phases of Project GEMINI and extending through Project APOLLO.

### SCIENTIFIC INVESTIGATIONS IN SPACE

#### Scientific Knowledge Expanded

During 1962 NASA continued to acquire scientific information from new flights, from analyses of previously accumulated data, and from supporting ground based programs. Two international satellites were launched, and scientific experimentation was added on manned orbital space flights and on the second SATURN development test flight. Sounding rockets continued to be used in research and a new bio-sciences program was initiated.

## NEW FLIGHTS

### RANGER III

On January 26, RANGER III was launched on an intended lunar trajectory. However, an electronic component in the ATLAS malfunctioned and caused the spacecraft to be injected with too much velocity. As a result, the mid-course correction could not be made and RANGER III went into orbit around the sun. Nevertheless, the spacecraft did provide the first measurement of interplanetary gamma ray flux. Preliminary analysis of the data indicates that the flux is much higher than previously estimated.

### Orbiting Solar Observatory

On March 7, NASA launched the first Orbiting Solar Observatory, OSO-1. This highly complex scientific satellite, designed to study the sun from above the earth's atmosphere, carried the first instrumentation capable of making solar studies for more than a few minutes. It reported continuously for three months and thereafter intermittently for several weeks. Instrumentation on OSO-1 made the first extended studies of the solar ultraviolet spectrum and of the solar X-ray emissions and made the first observation of the ultraviolet Lyman-alpha emission from a solar flare.

### Electron Density Probe

On March 29, NASA launched the P-21a space probe to study electron density in the nighttime atmosphere. Its three experiments furnished information on the electron density in the nighttime atmosphere, on composition, and on the positive ions along the path of the spacecraft. The flight also defined the upper limits of a region of the ionosphere.

### RANGER IV

On April 23, the RANGER IV spacecraft was launched on a lunar impact trajectory. A malfunction prevented the spacecraft from achieving any of its scientific or technical objectives, although it did impact the moon some 66 hours after launch.

### ARIEL

ARIEL was successfully launched on April 26. The first international satellite launched by the United States, it carried British built experiments to study cosmic rays and electron properties in the upper atmosphere and solar radiation in the X-ray and ultraviolet regions.

### MARINER II

MARINER II, launched August 27, successfully performed a mid-course maneuver on September 4, which put it on course for a Venus fly-by, on December 14, at a distance from Venus of 21,600 miles.

During the fly-by, MARINER experiments acquired data which will yield important information concerning the planet's surface temperature and details of its atmosphere, its magnetic field, and possible radiation belts.

Analysis of interplanetary data returned by the instruments aboard MARINER II indicates that very small particles (micrometeorites) are at least a thousand times less concentrated farther out in space than near the earth. This information has an important bearing on spacecraft design for planetary missions.

MARINER instruments have also found that the solar plasma, an ionized gas emitted from the sun, is present at all times to some degree in interplanetary space. The plasma flow varies, sometimes slowly, other times abruptly. Abrupt changes in the plasma flow and in the interplanetary magnetic field coincide. The energy of the plasma is much greater than that of the magnetic field; consequently the plasma can push the magnetic field about. This finding supports the theory that solar plasma distorts the interplanetary magnetic field which in turn affects the number of cosmic rays from the sun and outer space that reach the earth.

MARINER II measurements of the interplanetary field provided a second set of measurements taken at a great distance from the earth and indicated agreement with the limited data from PIONEER V, concerning the three dimensional nature of the field.

### ALOUETTE

Another international satellite, the first completely built by foreign scientists and launched by NASA, was the Canadian ALOUETTE. Launched on September 29, its primary purpose was to study the electron densities in the atmosphere and secondarily to study the energetic particles and cosmic rays coming to the earth.

### EXPLORER

EXPLORER XIV was launched on October 2, into a highly eccentric orbit, with an apogee of 61,000 miles. It carried instrumentation to study the charged particles trapped in the earth's radiation belt, cosmic rays from the sun and from galactic space, the earth's magnetic field, plasmas emitted by the sun, and damage in space to solar cells.

EXPLORER XV was launched on October 27, as part of an intensive study of all aspects of the artificial or enhanced radiation belt generated by a high altitude nuclear explosion.

### RANGER V

On October 18, RANGER V, the last of a planned series of lunar hard landing capsules, was launched. The spacecraft missed the moon by approximately 450 miles and went into orbit around the sun.

### Data From Earlier Flights

An analysis of data from EXPLORER VIII (launched November 3, 1960), substantiated earlier speculation that helium exists in the highest atmosphere. Data

from EXPLORER 1X (a light 12-foot sphere launched February 16, 1961), showed that at about 440 miles the density of the atmosphere varies with solar activity, day-night transitions, and solar winds of protons and electrons.

#### Other Programs Assisting Scientific Investigations

The MERCURY program manned space flights furnished an opportunity to use man to carry out experiments in space. Among the experiments conducted, one on the second manned orbital space flight located the yellow airglow layer in the atmosphere at an altitude of about 50 miles.

The SATURN test flight on April 25 was used to investigate the behavior of a large volume of water released in the upper atmosphere.

Effective July 1, 1962, NASA established discipline-oriented subcommittees of the Space Sciences Steering Committee to replace the previous combination of discipline - and program - oriented subcommittees. The major discipline areas are astronomy, biosciences, ionospheres and radio physics, particles and fields, planetary atmospheres, planetology, and solar physics.

#### Sounding Rockets

During 1962, NASA made 54 successful launches of sounding rockets. These have studied electron and atmosphere temperatures, density, the ionosphere, winds in the atmosphere, airglow, and atmospheric composition. The rockets also carried instrumentation for studies of the ultraviolet spectrum of the sun, for studies of cosmic rays, for stellar photometry, and for X-ray mapping of the night sky. Rockets continued to furnish most of the information about the atmosphere between the highest altitudes obtainable by balloons and the lowest available to satellites. In addition, they are a ready and simple way to carry out preliminary experiments for observations from above the atmosphere, and for testing instrumentation to be carried in the satellites.

### BIOSCIENCE PROGRAMS

#### Spectral Analysis of Mars

In cooperation with a number of government and private organizations, NASA has developed an infrared planetary observatory in the stratosphere to obtain spectral analysis of Mars during the opposition of that planet around February 1963. Subsystems have been completed and tested. This balloon-lifted experiment will carry the observational and data recording equipment above the spectral blocking effects of the terrestrial atmospheric moisture and carbon dioxide to obtain a broad and high resolution spectrum unobtainable from the ground. The experiment is designed to provide new data concerning the presence of life and related substances on Mars as well as information on the composition of the Martian atmosphere.

#### Devices for Detection of Life on Mars

Two devices for the direct detection of life on Mars were designed and developed. These instruments, "Gulliver" and the "multivator," though based on different principles, both assume that, within certain limits, life on Mars is biochemically

or metabolically similar to terrestrial biological systems. The devices are fully miniaturized, weigh less than two pounds each, and require minimum power for acquisition and communication of information. Many other methods of detecting whether or not life exists on Mars are being designed by NASA.

### Life in the Earth's Upper Atmosphere

NASA conducted a limited program in aerobiology to determine the distribution and nature of microorganisms in the upper terrestrial atmosphere. Such information will be useful in determining the source of such organisms, their ability to survive the stratosphere environment, their spread around the earth by winds, updrafts and turbulence, whether they are pathogens, mold spores, pollen grains, or innocuous non-spore formers. Preliminary and unconfirmed results indicate a stratum between 65,000 and 45,000 feet where a high number of pigmented bacteria, yeasts, and molds of non-sporulating, non-pathogenic types were found in a viable state.

## APPLICATIONS PROGRAMS

NASA continued to make progress in its applications programs. Research and development activities achieved significant results with the meteorological systems and the communication systems.

## METEOROLOGICAL SYSTEMS

### TIROS

The TIROS meteorological satellites, though designed by NASA as research and development spacecraft, have been so successful that data supplied by them has been extensively used by the Weather Bureau and other U. S. and foreign weather services. To date, there have been six successful launchings. TIROS I and II were launched in 1960; TIROS III in 1961. Those launched this year were TIROS IV on February 8, TIROS V on June 19, and TIROS VI on September 18. The success of the TIROS satellites in supplying data for operational weather analysis and forecasting use has dictated the extension of the project until data from the more advanced NIMBUS becomes readily available.

Since the first of these meteorological satellites was launched they have supplied the following: 148,851 usable pictures;\* 4,390 cloud cover analyses; 693 special satellite storm advisories; 264 adjustments to NMC analyses; ten hurricanes and 21 typhoons observed and tracked.

However, TIROS has these inherent limitations: Its orbital inclination limits its geographic coverage, and it is space oriented -- looking out into space more than half of the time.

### NIMBUS

NIMBUS is designed to lead to an operational meteorological system. Its near-polar orbit will enable it to observe virtually the entire earth area once a day; it will be earth oriented -- looking at the earth during its entire orbit. Furthermore,

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\* All numbers are as of November 30, 1962.

infrared radiation sensors are being considered which may lead to the development of nighttime cloud data on an operational basis, even though these data may not be as definitive as TV pictures.

NIMBUS spacecraft subsystems have been demonstrated in the pre-prototype stage. Major subsystems are now undergoing prototype environmental testing. Spacecraft prototype and flight model testing have been initiated and the first launch scheduled for late 1963.

Studies are under way to determine the feasibility of a synchronous (24-hour orbit) meteorological satellite system. Preliminary considerations indicate that it would provide observations of weather systems too short lived to assure viewing by NIMBUS (i. e. tornadoes, thunderstorms, squall lines, etc.). It would include instrumentation that would be directable upon command from earth and therefore could allow viewing and tracking any meteorological pattern of interest. It would supplement rather than replace NIMBUS.

### Meteorological Sounding Rockets

Meteorological sounding rockets for exploring the atmosphere above the operating range of balloons (100,000 feet) and below the effective observational altitude of satellites (100 miles) are being improved by continuous development and testing.

Small meteorological sounding rockets are effective between 20 and 45 miles. An overall system for these rockets (motor, sensors, and data acquisition) is being considered for development. Such a system could provide routine measurements of basic meteorological data using a reliable, simplified, self-sufficient sounding system suitable for operational meteorological rocket networks. About 75 small meteorological sounding rockets were flown this year, some launched for the Navy and Air Force.

About 60 large meteorological sounding rockets are being used for basic meteorological measurements at altitudes between 40 and 70 miles. In developing sodium vapor, acoustical grenade, and pitot tube techniques, about 22 large meteorological sounding rockets were flown in 1962.

### Communications Systems

Operational communications satellites promise to open up a whole new era in modern communications. Therefore, NASA's communications satellite research and development program includes studies of various types of such satellites of potential use in operational systems.

One type under study -- the passive satellite -- is in effect a radio mirror in the sky reflecting a signal from a ground transmitting station to a ground receiving station. Another is the active satellite that carries a power supply, receives a signal from a ground station, amplifies it, and retransmits it to a ground receiving station. Operating altitudes for communications satellites are classified as low or intermediate (up to 12,000 miles) and synchronous (22,300 miles). Ideally as few as three satellites at the synchronous altitude could provide essentially world-wide communications.

## Communications Satellite Act of 1962

An important step in the eventual establishment of an operational communications satellite system was the passage, on August 31, of the Communications Satellite Act of 1962. This legislation, based upon the President's recommendations, authorized the establishment of a private corporation, concerning which NASA was given a number of technical responsibilities.

### TELSTAR

On July 10, NASA launched the TELSTAR low altitude active repeater communications satellite for a privately owned and operated communications company. In accordance with an agreement of July 27, 1961, the responsibility for financing design and construction of the satellite, as well as for ground station development, was assumed by the company.

Live transmission of voice and TV picture using the satellite as a relay was accomplished on the day of launch. In rapid succession during the first week of operation, the feasibility of live transatlantic TV programming (black and white, and color) was demonstrated, transatlantic telephone conversations via the satellite were held, and much useful information was telemetered from the scientific instrumentation carried on board.

### RELAY

NASA's investigations in the low altitude active repeater satellite field will continue with the RELAY project. RELAY differs from TELSTAR in configuration and technical details and is directed toward providing additional information on design and technique that will assist in the development of long life components and in the ultimate accomplishment of an operational communications satellite system. The spacecraft was launched on December 13 by a DELTA vehicle. Although the orbit achieved was satisfactory, difficulties with the power supply voltage impaired communications transmissions initially.

### SYNCOM

NASA's entry in the synchronous communications satellite field is Project SYNCOM. The 65-pound satellite is scheduled for its first flight early in 1963.

Meanwhile a study contract has been let to investigate the problems involved in developing an advanced synchronous orbiting communications satellite with increased capability and capacity. Decision to proceed with an advanced synchronous satellite flight program will be made after completion of this study.

### Passive Communications Satellites

As part of the program to examine the alternative systems proposed for communications satellites NASA is continuing its studies of the passive system. A satellite of this type is ECHO I launched on August 12, 1960, and still in earth orbit though somewhat wrinkled. An improved ECHO-type passive communications balloon, 135 feet in diameter and weighing 500 pounds, is now under development. It is scheduled to be launched during the first half of 1963.



## ADVANCED RESEARCH AND TECHNOLOGY

During 1962, NASA's advanced research activities continued to investigate a wide range of problems associated with space and aeronautics missions.

### RESEARCH RELATED TO SPACE ACTIVITIES

In the overall space activities field, NASA studied problems related to space vehicles (manned and unmanned), electronics and control, nuclear, electric and chemical propulsion and power generation, life support systems, and various materials that have potential space uses.

#### Space Vehicle Concepts

Studies were made of possible future missions of both space vehicles and launch vehicles to establish the most fruitful directions for research endeavors. These studies include feasibility of space stations, the potential of nuclear rocket transportation, and research problems facing manned flight to the planets. Of particular importance have been studies of design concepts of vehicles that could be landed like an airplane and those that could be recovered and re-used.

High-energy Radiation -- Studies of the threat posed by high energy radiations to manned space flight continue to suggest the necessity for extensive shielding. As one possible solution to the problem, a new shielding technique under study involves deflection of the particles through utilization of high magnetic fields.

Spacecraft Temperature Control -- A non-fluctuating "room temperature environment" in space vehicles is necessary. Research attention is being given to advanced "passive" and "active" techniques for reliable, long-time temperature control.

Meteoroid Hazard -- The threat of meteoroid impact in space is under study through special satellite experiments and through observations of natural and artificial meteors. The first of a series of micrometeoroid satellites was launched December 16 from Wallops Station, as EXPLORER XVI. Two more satellite experiments are to be flown to determine the frequency of meteoroid penetration of thin sheets of metal. The laboratory study of meteoroid impact phenomena and vehicle protection is emphasizing particle acceleration techniques (such as electrostatic accelerators and light gas guns) to produce velocities above 30,000 feet per second.

Aerothermodynamics -- NASA made substantial progress in determining the heating rates and flight characteristics of several spacecraft configurations upon reentry at speeds up to 30,000 miles per hour. Important differences have been determined regarding the heating and flight characteristics of spacecraft operating in Martian and Venusian atmospheres as compared to the Earth's atmosphere. Also, substantial progress was made on improved landing and recovery devices such as inflatable paragliders and large clustered parachutes.

X-20 -- The large amount of technical support which NASA has provided for the X-20, principally in the form of wind tunnel and structural testing, drew toward termination as the project comes closer to flight status. Attention is now being focused on NASA's role in support of the flight operations.

## Electronics and Control

Cryogenic (Superconductive) Inertial Sensors -- Research on superconductive suspension of gyroscope rotors uncovered a phenomenon of alternating field losses in superconductors. The indication is that the cryogenic rotor materials presently available may not become completely superconductive; improved materials may be required before cryogenic inertial sensor development becomes feasible.

Horizon Sensor -- Project SCANNER, a small flight project program, seeks to improve definition of the earth's horizon gradient. The first flight of this program revealed that the earth's horizon may be sharply defined.

Rendezvous -- One of NASA's special studies led to the initial conclusion that simple manual instrumentation may be adequate for the docking phase of rendezvous. Further flights to confirm this early result and to determine the sharpness of the horizon more precisely are planned.

Another flight to study the horizon under different sun illumination conditions is planned for 1963. In addition, NASA initiated development of instrumentation to be used in later flights to more precisely determine the sharpness of the horizon.

Simulating of the docking problem has shown that pilots can safely perform the docking function with a tenth of a foot per second velocity error and with less than a foot of position error. This study will permit important structural and instrumental weight saving for GEMINI and APOLLO.

Precision Attitude Control of Manned Spacecraft -- Tests of a man's ability to control the attitude of a simulated spacecraft indicated that the axes of the simulator can be pointed within  $\pm 5$  seconds of arc of the desired orientation. During these tests the man was seated off the simulator so that gravitational effects would not introduce spurious spacecraft motion.

Micrometeoroid Detection -- Important results were achieved in the field of instrumentation for the detection and determination of characteristics of micrometeoroids. NASA developed a method for detecting both the number and velocity of such particles striking an instrument which can be carried aloft in a spacecraft vehicle. The Agency also developed an instrument for measuring the force of the impact of micrometeoroids.

Monitoring Vital Human Functions -- Ground tests were made of a prototype device which, when taped to a man's chest, monitors and transmits an excellent cardiograph as well as respiration rate and volume data. This device is being reduced by microelectronic techniques to a size about one-half inch square and a quarter inch thick.

Launch Checkout and Countdown System -- NASA is gradually introducing computer countdown and checkout in the SATURN series of vehicles. A developmental system capable of checking out the complex Orbiting Geophysical Observer (OGO) is in operation. A system of checkout and countdown by computer allows rapid launch site analysis of the space vehicle by checking thousands of measurements per second.

Television Improvements -- NASA made initial improvements in TV picture transmission from spacecraft. This work consists of the application of digital computer programs to remove certain types of persistent defects in pictures and to squeeze more information into a television channel.

Communications through Ionized Plasma Sheaths -- A major problem of manned space flight is the difficulty of communicating through the ionized plasma sheath created by a space vehicle reentering the atmosphere. An R&D investigation shows that water added to the ionized flow field suppresses the plasma, and radio signals from the spacecraft are not blacked out. The data, which are based on laboratory experiments, are to be confirmed in scheduled flight tests.

Microelectronics -- NASA is planning a two-pronged effort to obtain the higher reliability promised by microelectronics: (1) studies to identify potential space applications, criteria for application, and limitations of microelectronic applications; and (2) expanded effort to solve electronic technical problems peculiar to space environment conditions.

Optical Communications - S-66 Satellite Tracking -- Fabrication of a laser (optical) system to be employed in tracking the S-66 satellite was initiated and partially completed during 1962. The completed portion is the satellite exterior paneling which consists of an ensemble of optical corner reflectors which will return all of the incident laser light to the tracking site. The laser transmitter (optical source) and television tracking systems are expected to be operational by mid-1963.

#### Chemical Power and Power Generation

Launch Vehicle Engines -- In the field of launch engines, new and novel design and operating concepts evolved and are in the early phases of experimental verification. This work is being done to enable the future development of large liquid propellant rocket engines in the 6 to 40 megapound thrust range.

Spacecraft Engines -- Work on spacecraft engines is being conducted on advanced chamber and nozzle types and in the important area of variable thrust control. Some of the variable control thrust projects are already being considered for application to the manned lunar program.

Solid Propulsion Systems Technology -- Two important programs were initiated during 1962 to determine the application of solid propulsion systems for space missions. In the motor components and materials areas, a program was started to evaluate and develop space resistant components, cases, insulation materials and propellants capable of withstanding hard vacuum, radiation, and the temperature environments of space, the moon, and the planets.

Space Power Technology -- NASA made progress toward development of radiation resistant or tolerant solar cells and solar power systems based on devices such as thermionic diodes. A prototype solar thermionic system under development generated electric power from solar energy in ground tests. The development of a prototype 3 k.w. solar mechanical system which uses mercury vapor to drive a turbo alternator passed several important milestones.

In the chemical power area NASA established a special pilot production facility for manufacturing high quality nickel cadmium batteries for space use. Development of the silver cadmium battery reached the flight demonstration stage (used in ARIEL). Development of the Bacon type fuel cell prototype system contributed directly to the selection of that system for the APOLLO vehicle. Work was also started on an internal combustion hydrogen/oxygen engine for future space missions.

#### Biotechnology and Human Research

Life support systems adequate for several days of space flight were developed, and research is continuing on the life support systems required for lunar base and deep space flight projects. These include physical, chemical and biological means of developing stored, partially regenerative and regenerative life support systems. Development of extravehicular space suits with portable life support systems is under study. Studies in food and waste management, radiation shielding systems, atmospheric conditioning and ventilation systems, bio-instrumentation, psycho-physiological monitoring, display and control systems, and psycho-physiological experiments are being pursued.

#### Advanced Studies

In the overall area of advanced studies, NASA conducted research in numerous projects that, when completed, may lead to applications in vehicle development, support systems, and instrumentation.

Plasma Research -- NASA's plasma physics research indicated that plasma accelerators are feasible for use as high heat-high energy wind tunnels necessary for reentry simulation.

Electrophysics -- Two contracts have been initiated for fundamental physics research on LASERS and MASERS; that is, the generation, modulation, detection and amplification of coherent electromagnetic waves by the principle of stimulated emission.

Reentry Materials -- A multi-stage test vehicle, flown during the year, provided information on the ability of materials to withstand heat-flux and aerodynamic loads experienced during reentry nearly as severe as those APOLLO will encounter.

Passive Communication Devices -- A rigidized inflatable polymeric structure which can remain spherical, even after the inflation gas has completely leaked out into space, was developed. It consists of a three-layer laminate of very thin aluminum foil on each side of a thin film of Mylar.

### AERONAUTICS RESEARCH ACTIVITIES

Important aeronautical investigations during the year were conducted in the areas of V/STOL aircraft, a supersonic transport, and hypersonic vehicles. Studies of configurations suitable for a commercial supersonic transport indicated the technical practicality of such a vehicle. Work on V/STOL vehicles emerged from the "test bed" stage to the operational prototype stage.

## Flight Tests

In addition to flight test activity on V/STOL test beds such as the X-14 (a deflected jet airplane) and the VZ-2 (a two propeller tilt wing airplane), the first flights were made on the PARESEV (Paraglider Research Vehicle). The PARESEV was designed and built to investigate stability and control problems associated with returning payloads from space. The PARESEV is a manned glider which if successful could be used for controlled return of the GEMINI spacecraft.

## X-15 Research Airplane Program

The X-15 Research Airplane Program, conducted in cooperation with the Department of Defense, continued to provide data on manned, maneuverable flight during 1962. The research airplane was flown to heights of 250,000 feet and 314,750 feet during the year. The flights were official world (F.A.I.) records set by Joseph A. Walker, NASA, and Major Robert M. White, USAF, respectively. Walker also flew the X-15 to a speed of 4,104 m. p. h., on June 27, 1962. Information on aerodynamic and structural heating, structural dynamics, supersonic and hypersonic aerodynamics, and stability and control was obtained, evaluated, and reported. Equally important, however, is the fact that a manned system, designed for flight at speeds to 6,600 feet per second and to altitudes of 250,000 feet provides extensive operational experience for advanced systems on a routine basis. In this sense, the X-15 program has provided invaluable experience for future aeronautical and space activities of the United States.

As the basic research programs are completed, follow-on programs are planned to explore areas already partially investigated, such as cockpit display, boundary-layer noise, skin friction at high Reynolds numbers, and structural panel tests.

## Air Breathing Propulsion

Air breathing propulsion research efforts are being concentrated in the supersonic and hypersonic regime. Principal efforts in the supersonic area are in support of the commercial supersonic transport. Supersonic transport engine cycle analysis and mission analysis as well as investigations of engine component matching characteristics are being studied extensively. Experimental research is being conducted on inlets and exhaust nozzles.

In the hypersonic area, NASA is acquiring research data to provide a basis for determining the feasibility of air breathing propulsion systems for hypersonic vehicles. The work in this area is closely coordinated with the air breathing propulsion research efforts of the USAF. Particular attention is being given to propulsion system analysis, mission analysis, hypersonic inlets, supersonic combustion and the exhaust nozzle recombination problem.

## Aerodynamics

In aeronautical research, a goal is to develop an aircraft which has extended-range performance at supersonic speeds while retaining useful subsonic, takeoff, and landing characteristics. Various aerodynamic solutions to this problem arrived at during the past year (detailed component and configuration refinements, alternate airframe concepts) contributed materially to the technical feasibility of advanced

high-speed aircraft.

### V/STOL Aircraft

Research on vertical and short takeoff and landing aircraft (including helicopters) continued for a wide variety of concepts. The helicopter remains the best machine for long hovering times; jet propulsion, with auxiliary devices for jet lift, provides the highest maximum speeds but very short hovering times. The propeller-driven tilt-wing principle appears most suitable for military or commercial transport purposes at intermediate speeds and hovering times.

### Structures Studies

Flight investigation of turbulence within severe thunderstorms led to a better understanding of the characteristics of severe turbulence, the prediction of the loads, and the response of the structure to the unsteady forces.

## NUCLEAR PROPULSION AND POWER GENERATION

Work continued on the nuclear rocket program (Project ROVER), the nuclear electric power generation program, and the electric propulsion (electric rocket engine) program. The objective: The early and practical utilization of nuclear systems for space application. The development of these systems is expected to provide the means for manned exploration of the planets and other extensive journeys into space.

### The Nuclear Rocket Program

Nuclear rocket development involves difficult new technologies: The application of extremely high and low temperatures, remotely operated ground support equipment and facilities, and -- perhaps most difficult -- greater nuclear reactor performance than that required for other applications. Progress in all of these areas has been considerable.

The nuclear rocket program consists of three projects and a vigorous research and technology program aimed at providing the technology for improved systems. The three projects are: (1) KIWI, designed to develop the basic technology for the first-generation nuclear rocket reactor; (2) NERVA (Nuclear Engine for Rocket Vehicle Application), intended to develop a flight engine for nuclear rocket-powered upper stage vehicles; and (3) RIFT (Reactor In Flight Test), intended to provide flight verification of the NERVA nuclear rocket propulsion system.

Reactor research progress included operation of two KIWI reactors (BIB and B4A) in which liquid hydrogen was used as a propellant for the first time. Successful reactor startups with liquid hydrogen showed that no reactor control difficulties are caused by the hydrogen. A variety of important data was obtained in these tests and, as needed, design modifications are being made for subsequent development testing. Major progress was required and achieved in the development of liquid hydrogen pumps and regeneratively cooled nozzles in connection with these projects.

The goal of the NERVA project is development of flight engines for operational nuclear rocket-powered upper stage vehicles. NERVA development is being conducted under contract to the AEC-NASA Space Nuclear Propulsion Office. A KIWI

reactor design has been selected as the basis for flight reactor development. The reactor structure is being designed to withstand the greater loads to be encountered in flight and ground testing. Development has also begun on the critical non-nuclear components of the engine.

One facility, Test Cell C, was essentially completed. Construction of additional facilities began at the Nuclear Rocket Development Station, Jackass Flats, Nevada. These include an Engine Test Stand (ETS-1) and an Engine Maintenance and Disassembly (E-MAD) facility.

NERVA will be flight tested in an upper stage compatible with the Advanced SATURN vehicle. The design and development program for this stage has been termed RIFT. NASA selected the prime contractor for the RIFT project, and work began on the major technology problems, such as tank design and insulation, and radiation effects.

### Electric Power Generation

The SNAP-8 Electric Power Generation System will provide power for advanced space missions, such as lunar stations or orbiting space platforms, and for interplanetary communications. In addition, SNAP-8 may provide an early electrical propulsion capability. It is also designed to provide some of the advanced technology which will be required for higher powered nuclear electric systems in the megawatt range.

During 1962, component and systems development continued. The first reactor assembly went critical, and the power conversion system was simplified and redesigned. New facilities were constructed and put into operation.

NASA continued a broad program to solve advanced systems problems and to develop system technology. The program included work on experimental high-temperature, high-powered vapor turbines; liquid metal lubrication; two-phase alkali metal heat transfer; compact refractory heat exchangers; and projects dealing with system materials development for both turboelectric and thermionic conversion systems.

### Electric Propulsion

The NASA electric rocket engine program is oriented toward (1) high-power level engines (30 k. w. to 10 m. w.) which are most useful for interplanetary missions; (2) small-power level engines (3 k. w. or less) which are most useful for attitude control, station keeping, and orbital transfer of small satellites such as the 24-hour communications satellite and scientific satellites; and (3) a general research and technology program to provide the basic information leading to the development of improved engines.

Three general categories of electric propulsion engines -- arc jet, ion, and plasma -- are being developed under 58 research and development contracts.

Arc Jet Engines -- NASA is developing a 1-3 k. w. arc jet engine for orbital transfer of small satellites. The current program places emphasis on ground life tests for continuous operation in space of from 6 to 12 months.

Development of laboratory models of 30-k. w. d. c. and a. c. arc jet engines continued. These models underwent vacuum tests for cooling system evaluation and component compatibility interactions.

Ion Engines -- A one-year contract was awarded for the development of a 1-k. w. prototype ion engine model for attitude spacecraft orientation control and stabilization systems.

Progress was made in the development of the following ion engine modules: (1) an experimental contact ionization thrust module that will develop .0002 to .01 pounds of thrust and will lead to the development of large (30-k. w. to 10-m. w.) ion engine systems (.1- to 10-lb. thrust); (2) a 3-k. 2. (.01-lb.) engine module of large electron bombardment ion engines; and (3) a small .006-lb. -thrust (1-k. w.) engine module developed by NASA's Lewis Research Center. This work is preliminary to flight tests that will provide basic information on ion engines operating in a true space environment.

Plasma (MHD) Engine Feasibility -- A number of studies were sponsored to determine the feasibility of various plasma generation and acceleration techniques and their potential for space propulsion application.

### TRACKING AND DATA ACQUISITION

During 1962, NASA developed its ground tracking and data acquisition networks into a worldwide communications system that reports or records events as they occur. These networks support the Agency's various operational missions, including those performed by manned satellites, scientific satellites, and deep space probes.

#### Manned Network

The Manned Network supported the three MERCURY manned orbital flights. The network used three additional tracking vessels (in the Midway recovery area) for the 6-orbit mission.

#### Optical Network

The Baker-Nunn Camera stations, operated for NASA by the Smithsonian Astrophysical Observatory, obtained about 2,000 photographs of satellites per month.

#### New Antennas

The capability of the Satellite Network was strengthened by the installation and checkout of an 85-foot-in-diameter parabolic antenna at Fairbanks, Alaska. Construction progressed on three other antennas: (1) a second 85-foot antenna at Alaska for the NIMBUS Operation System; (2) an 85-foot dish at Rosman, North Carolina; and (3) a 40-foot antenna at Mojave, California, for Project RELAY.

The Deep Space Instrumentation Facility at Goldstone, California, was expanded by (1) the installation and checkout of an 85-foot-in-diameter parabolic antenna (operational for the launch of MARINERS 1 and 2) and a two-way precision Doppler system; and (2) the construction of a 30-foot parabolic dish to be used in research and development work in perfecting a range and range rate system employing digital



techniques. NASA completed a preliminary advanced study for the final design of and criteria for a 210-foot advanced antenna system at the Goldstone facility.

### UNIVERSITY PROGRAMS

To expand university research and training in the space sciences and technology in keeping pace with the Nation's rapidly accelerating space effort, NASA, during 1962, established a Sustaining University Program under its Office of Grants and Research Contracts.

The first grants under this program were made to five universities in August 1962, to build research facilities. In addition, ten universities were awarded training grants to support pre-doctoral graduate students in space-related science studies. Each will train 10 students during the first year.

### INTERNATIONAL PROGRAMS

By the close of 1962, 61 political jurisdictions, including the U.S.S.R., had joined NASA in flight, flight-support, or training programs in the peaceful uses of outer space as envisioned by the National Aeronautics and Space Act of 1958.

#### Satellite Projects

On April 26, the first international satellite, ARIEL (S-51), was launched by a NASA DELTA vehicle from Cape Canaveral. The U.S.-built spacecraft contained six experiments designed and built by British scientists. Over 1,000 hours of useful data on ionospheric characteristics and variations were received during the first three months after launching, and useful data continues to be provided.

The satellite ALOUETTE (S-27), designed, funded, engineered, and constructed entirely by the Canadian Telecommunications Research Establishment, was successfully launched into a near-polar orbit by NASA on September 28, from the Pacific coast. The Canadian satellite, the first completely designed and built by a nation other than the U.S. or U.S.S.R., utilized a swept frequency transmitter to sound the ionosphere from above for the first time. The launching, the first by NASA from the west coast, also marked the Agency's initial use of a THOR-AGENA B vehicle.

On September 5, Vice President Johnson and Italian Foreign Minister Piccioni exchanged documents in Rome confirming the SAN MARCO cooperative program expected to culminate in the first launching of a scientific satellite into an equatorial orbit from a complex of towable platforms located in the Indian Ocean. The Italian satellite will measure atmospheric drag in the equatorial plane.

The United States and the Soviet Union have agreed to cooperate in coordinated launchings of weather and geomagnetic satellites, and in the exchange of data, and in experiments using the passive communications satellite ECHO II. The agreement, which was announced at the United Nations December 5, resulted from discussions led by the Deputy Administrator of NASA and an Academician of the Soviet Academy of Sciences.

#### Sounding Rockets

Joint sounding rocket launchings were conducted this year in Sweden, Norway (with

Denmark participating, and Pakistan. Additional scientific soundings were conducted in Canada with the cooperation of that government. The Swedish launchings produced the first substantive data on a rare phenomena of the northern skies -- the high altitude night time glowing clouds observed in Arctic areas.

Additional launchings from NASA's Wallops Island Station were conducted in joint programs designed to place Australian and Japanese experiments deep in the ionosphere. Canadian rockets were launched by NASA from Wallops in further tests.

In each case, NASA and the cooperating country divide responsibility for rockets, flight experiments, and ground instrumentation. Although the respective contributions need not be equivalent, each side finances its own share of the work with no exchange of funds.

A new scientific sounding rocket agreement was worked out with India to explore the equatorial electrojet -- an electric current flowing along the magnetic equator at an altitude of about 100 miles on the sunlit side of the earth. The program has been related to the proposal, made to and approved by the UN General Assembly, for an international sounding rocket range on the geomagnetic equator.

## GROUND-BASED SUPPORT

### Weather and Communications Satellites

Forty-four nations have united with NASA in various ground-based programs in experimenting with satellites in meteorology and communications.

An increasing number of foreign weather services have mounted special observations of cloud cover synchronized with the passes of NASA's TIROS satellites overhead. About 35 members of the World Meteorological Organization have participated in this program at the joint invitation of NASA and the U. S. Weather Bureau.

International experimentation in television and other telecommunications by TELSTAR was made possible through a cooperative program in which England and France provided, with their own funds, major ground terminals on their own territories. These terminals will be available, with additional facilities being developed by Germany, Italy, Brazil, and Japan, for NASA experimental communication satellites such as RELAY.

### Scientific Satellites

Twenty countries have indicated their desire to cooperate in an investigation of the ionosphere through ground-based studies of radio signals to be sent on seven frequencies from the polar ionosphere satellite (S-66), schedule for launch in 1963.

### Training Programs

The NASA program for senior foreign scientists at the postdoctoral level was expanded to include all NASA centers. This program gives these scientists opportunities to contribute their talents to theoretical and experimental programs. Thirty-eight scientists from 19 countries have participated in this program. In a new Fellowship program, graduate students sponsored by their national space committees

or national research councils may qualify for NASA fellowships at 20 U. S. universities engaged in space research programs. Nineteen fellows from eight countries have come under this phase of personnel exchange.

Training in project-related activities, such as sounding rocket launchings, tracking, payload design and preparation, is available at NASA centers in connection with cooperative programs. Some 48 technicians, supported by their home sponsoring agencies, have come to the U. S. from 14 countries under this plan.

Further, 17 foreign students attended Columbia's University's Summer Institute in Space Sciences under a NASA grant.

#### MANAGEMENT, SUPPORT FUNCTIONS, SERVICES AND PROCUREMENT

During 1962, NASA augmented its field organization and improved budgetary procedures as it planned more efficient management of its portions of the Nation's growing space program.

NASA strengthened the Office of the Associate Administrator with the addition of two additional Deputy Associate Administrators, to make a total of three, and realigned functions within that office.

Two of the three deputies were delegated responsibility for the supervision of field centers on institutional matters. One of these two deputies, who also occupies the post of Director of Manned Space Flight, supervises the three centers most directly concerned with manned flight -- the Manned Spacecraft Center, Houston, Texas; the Marshall Space Flight Center, Huntsville, Alabama; and the Launch Operations Center, Cape Canaveral, Florida. The other deputy supervises all other NASA field centers.

The third deputy, designated Deputy Associate Administrator for Defense Affairs, will maintain liaison between NASA and DOD. He will be the main point of contact between the Administrator's office and the military services.

To insure maximum possible use of common facilities, services, and support personnel with the Department of Defense, NASA, in March, established its launch facilities at the Atlantic and Pacific Missile Ranges as independent field installations. Accordingly, the launch operations center at Cape Canaveral, Fla., and the launch operations office at Point Mugu, Calif., in reporting directly to NASA Headquarters, have improved the responsiveness of the Centers to the manned lunar-landing programs and other launch requirements.

In May the Agency provided an on-site office at the headquarters of a major contractor for more effective direction of contracts in the APOLLO and Advanced SATURN manned lunar landing program. Two months later NASA set up a northeastern operations office in Boston for closer liaison with industrial contractors, research institutions, and other government agencies in that area.

# Chapter IV

## Department of Defense

### INTRODUCTION

As their contribution to the national space program, the Department of Defense, during 1962, expanded the research and development effort designed to keep the peace. These efforts are based on the belief that the capability to discourage or deter an attack via space is essential to keep the peace on this new frontier of man's endeavor.

DOD space projects fall into two principal categories: First, those projects directed at clear, identifiable military needs and requirements. Examples include the development of communications, navigation, and ballistic missile early warning satellite systems. The second class of projects is designed to investigate promising military space capabilities which will create a broad flexible technological base and to develop devices and subsystems which can be readily adapted for the design and engineering of major systems as future military space requirements and needs are identified: A prime example of a major project in this latter category is the TITAN III standardized launch vehicle which was approved for development in August 1962.

TITAN III will be capable of performing a wide variety of space missions involving a broad span of payload weights. It is expected to serve as a general purpose launch vehicle for more than a decade, performing a role in space operations for the DOD and NASA, as appropriate. Thus, it represents a major technological building block upon which the structure of the future military space capability will be built as part of the National Launch Vehicle Program.

Space efforts of the Department of Defense are fully coordinated with the activities of NASA and other government agencies in order to assure that planning for potential military applications of the future properly considers and applies all appropriate aspects of research and development in space with special emphasis on minimizing duplication. Military space efforts are properly integrated as an essential element of a consolidated National Space Program in which many government agencies are participants.

Cooperation and accord at the management and operating levels in DOD and NASA contribute to the complementary characteristics of the collective space efforts. For example, the military communications satellite system is being developed to satisfy the peculiar requirements of the DOD for reliability, security, resistance to countermeasures, access to remote areas, and use by mobile units. It will supplement, but not replace or duplicate, space communications systems being developed by NASA and the electronics and communications industry.

Concurrent with its efforts to advance and exploit space technology, the Department of Defense sustained its traditional interest and participation in programs devoted to the advancement of aeronautics. Continuing progress in this important area was made during the past year.

Selected portions of the DOD program in the areas of space technology and aeronautics are highlighted in the following sections:

## SPACE DEVELOPMENT ACTIVITIES

### Standardized Space Boosters

During the year substantial progress has been made in developing standard configurations of our first generation of space boosters. These include the ATLAS and THOR boosters and the AGENA upper stage vehicle. Objectives of the standardization program are: increased reliability, increased producibility, increased flexibility in assignment of vehicles from one program to another and decreased overall space program costs.

The THOR space booster was standardized on a step by step basis during actual use. Initial standard THOR vehicles were delivered in mid-1962. The AGENA standardization was undertaken as a program on an accelerated schedule. Initial vehicles were delivered in April 1962 and flown in June and July 1962. The Standard Atlas program is being pursued in a similar manner to the AGENA program. Initial vehicles were delivered late in calendar year 1962.

### TITAN III

The TITAN III is a standardized space launch system which will be developed and utilized as part of the National Launch Vehicle Program as outlined in the joint agreement between the Secretary of Defense and the Administrator of NASA. This launch vehicle, to be developed by the Air Force, will meet Department of Defense and NASA future needs to place 5,000 to 25,000 pounds of payload in low earth orbits. The TITAN III takes full advantage of the Department of Defense's investment in the two stages of the TITAN II ICBM, with minimum modifications, along with large solid motors and a new upper stage as the essential building blocks.

The TITAN III system was the first large program to utilize new DOD procurement procedures. Before program approval was given, a program definition phase (Phase I) was established and funds were released in December 1961 to determine costs, vehicle performance, and appropriate model configuration, as well as to select the prime contractor and establish the overall DOD management organization. The Phase I program definition effort was completed in the second quarter of calendar year 1962 and the objectives of the Phase I efforts have been verified by the Air Force and the Department of Defense.

The basic program for TITAN III is believed better defined than any large scale development undertaken in many years. Unique new management arrangements have been established for the conduct of this program. One important aspect is that approximately 75% of Fiscal Year 1963 contract funds for research and development are being disbursed under incentive type contract arrangements. These contracts were fully defined before the program schedule was given a "go-ahead."

### TRANSIT

The TRANSIT satellite navigation system developmental program is progressing

as planned, and should be available for worldwide fleet operational deployment in the second quarter of calendar year 1963. During 1962, principal research efforts were concentrated on increased system reliability and accuracy, the refinement of refraction and geodetic data, satellite power and stabilization technology, and prototype development of shipboard navigation equipment.

The launch of TRANSIT IVB on 15 November 1961 marked the last planned launch of a TRANSIT satellite from the Atlantic Missile Range. All future launches - except for four THOR ABLE-STAR launches - are programmed for SCOUT vehicles to be launched from the Pacific Missile Range. A TRANSIT VA satellite was launched December 19, 1962.

When operational, the TRANSIT system will provide reliable, worldwide, all-weather navigation for important units of the Navy.

### Communications Satellite Program

In May 1962, the Secretary of Defense re-oriented the Department of Defense communications satellite program. In this re-orientation, he directed the Defense Communications Agency to provide overall management and integrate the ground and space systems into the Defense Communications System. The Secretary directed the Air Force to develop two communications satellites - one a medium altitude system using many satellites, and one a synchronous altitude system using relatively few satellites. The Secretary directed the Army to develop the ground communications environment.

The Department of Defense has also continued its participation in NASA's SYCOM program. Two fixed DOD ground stations neared completion at Fort Dix (New Jersey) and Camp Roberts (California), the installation of a terminal aboard the U. S. N. S. Kingsport was accomplished, and mobile stations were developed. Communications experiments utilizing the SYCOM satellite will be conducted during 1963.

To provide experience for personnel who are participating in the NASA and DOD communications satellite programs and in order to evaluate past efforts of developing mobile terminals, a program was initiated utilizing ground stations developed for the commercial TELSTAR system.

The Navy, the Air Force, and the Army have communications programs aimed at utilizing the moon, and other passive and semi-active reflectors. Additionally, the Navy is considering the use of a satellite relay to communicate with submerged submarines.

### X-20 Development

The X-20 project formerly DYNA-SOAR is aimed at the development of a small piloted glider to be boosted into space flight by a TITAN III booster from the Cape Canaveral missile test site.

The X-20 program is financed and administered by the Air Force and supported by the NASA. The purpose of the program is to construct and test a manned military space research vehicle which will explore the problems and conditions of hypersonic flight beyond the range of the X-15 research aircraft by achieving orbital velocity. The program will demonstrate the capabilities of pilot controlled re-entry and recovery from orbit. The pilot of the X-20 glider will have the ability

to control his return to earth by extending his flight path by several thousand miles straight ahead or to either side followed by conventional landing. This will enable the pilot to select the time when he will initiate re-entry and to control the point where he will land.

During 1962, the X-20 designs were finalized in conjunction with the selection of the TITAN III as the launch vehicle. Development on the glider subsystem has proceeded to a point where fabrication of the first gliders is expected to begin this year.

### Inspector

Work is continuing on the Satellite Inspector Program to demonstrate rendezvous and inspection of a non-cooperative object in space by orbiting with it. Program assessment resulted in the termination of a prototype co-orbital demonstration system and initiation of an inspection system definition study. Efforts continued in close coordination with the NASA GEMINI program. A joint DOD-NASA study of both programs was accomplished and areas of mutual development effort identified.

### ICBM Alarm

The objective of this program is the research and development of a space-based attack alarm system intended to maintain continuous surveillance over ballistic missile launches on a global basis. Such a system would consist of unmanned satellites carrying infrared sensors which can detect ballistic missiles in powered flight as they emerge from the atmosphere.

During 1962 several technical advances were made in furthering this development. Infrared measurements from ground-based, airborne, and orbital tests yielded new scientific data on target and background discrimination techniques.

### ANNA

The ANNA geodetic satellite program is a tri-service project under Navy management with NASA cooperation. The satellite combines three separate systems developed independently by the military services. The Navy system employs the principle of radio doppler, essentially that used in the TRANSIT navigation satellite. The Army system employs a radio ranging transponder called SECOR, that is, "Sequential Collation of Range." The Air Force system employs a high intensity flashing light or optical beacon.

Purpose of ANNA is to provide locations of tracking stations to an accuracy of 100 feet relative to the center of the earth, and to define the earth's mean attraction potential to an accuracy of 5 parts in 10 million. These accuracies are required to provide a framework for subsequent mapping, navigation, reconnaissance and other applications requiring this precision.

ANNA IA was launched on May 10, 1962 but did not achieve orbit due to the failure of the booster second stage.

ANNA IB was launched on 31 October 1962 and is presently furnishing geodetic data.

## Large Solid Propellant Motor Program

In accordance with the agreement between the Secretary of Defense and the Administrator of NASA, the Department of Defense is conducting advanced state-of-the-art technical development in the field of very large solid rocket engines with the dual objectives of advancing knowledge and the development of such engines.

Large solid motors with diameters up to 120 inches are already under development. A 100 inch diameter three-segment motor was successfully fired in February 1962. A 120 inch diameter motor, 40 feet in length, was fired in May 1962 producing 400,000 pounds thrust for a burning time of 130 seconds. On 15 September 1962, a 96 inch tapered diameter two center segment motor incorporating a dual thrust vector control system, hypergolic ignition, and a radial-segment motor was successfully fired. This development work has provided design data on grain configuration, burn rates, and internal pressures.

The development of large solid propellant motors with diameters of 156 inches and 260 inches is being investigated. The 156 inch motor is the largest segmented solid propellant motor capable of rail transportation from current production facilities to coastal launching sites. The 260 inch motor may demonstrate the feasibility of very large monolithic motors and provide technical foundations for further developments. Development of this large motor will also provide pertinent background data in procedures and processes for fabrication, propellant production and handling, testing and facility requirements.

## Nuclear Detection Satellite

A joint DOD/AEC program of satellite-based detection of nuclear tests in space is being conducted. Its objective is to confirm experimentally detector sensitivity, reliability, and system performance capability in the space environment by conducting experiments to obtain data on the background effects of the natural radiation environment in space. Of particular interest are possible natural radiations in space which might be similar to those expected from a nuclear detonation in space. The program consists of cooperative flights with other space programs and high altitude flights of spacecraft designed specifically for the program.

## AERONAUTICS DEVELOPMENT ACTIVITIES

### Laminar Flow Control Demonstration Aircraft

The laminar flow control aircraft program is intended to demonstrate that the design and manufacture of a wing capable of achieving laminar flow by means of suction through a large number of very fine slots in the surface is practical. It is intended to determine quantitatively through a full scale flight demonstration the magnitude of drag reduction possible and to assess the maintenance requirements in an operation environment,

The achievement of greatly reduced aerodynamic drag through laminar flow control would result in increased payload or range for aircraft designed to incorporate this feature. The FAA has assisted in financing the program which is also of interest to nonmilitary activities. Two demonstration aircraft are designed X-21A's.



### X-15 Research Aircraft

The X-15 aircraft were built to provide exploratory data on aerodynamic, structural and physiological problems of manned flight at hypersonic speeds and space equivalent altitudes.

The range of performance has gradually been expanded as speed and altitude have been increased. Maximum altitude reached so far is 314,750 feet and the maximum speed has been 4,151 MPH. Concurrently with this effort additional flights have been devoted to aerodynamic research, heat transfer investigation, development of flight controls, and re-entry techniques.

The X-15's will continue gradually to expand the flight envelope where data from earlier flights indicate that an ample margin of safety exists. In addition to the above objectives, the X-15's may be used as test bed aircraft for a group of advanced experiments in aeronautical and space sciences. Some of the primary projects in the program are ultraviolet stellar photography, improvement of attitude and guidance references for orbiting spacecraft by means of a horizon scanner, high altitude density measurements using an alphasatron ionization gauge, collection of infrared and ultraviolet data at extreme altitude, advanced vehicle systems and structural materials.

### Tri-Service VTOL Development Program

In July 1960, the Assistant Secretaries of the Air Force, Army, and Navy (Research and Development) agreed that it was desirable to conduct a tri-service program to determine the operational suitability of vertical take-off and landing (VTOL) aircraft. The three services had conducted research on the technical feasibility of the various configurations of VTOL aircraft, but the military usefulness had not been determined. Since such a project would have joint interest, a tri-service program to cover approximately a five-year period was established in Fiscal Year 1961.

In January 1962, it was agreed that the Tri-Service VTOL Program should be equally funded by the three services and consist of the following tasks:

- a. A VTOL tilt-wing transport aircraft, designated the XC-142A, with executive management assigned to the Air Force.
- b. A VTOL tandem tilt-propeller aircraft, designated the X-19A with executive management assigned to the Air Force.
- c. A VTOL tandem rotating ducted fan research airplane, now designated X-22A, with executive management assigned to the Navy.

### V/STOL Surveillance Aircraft Program

In 1961, the Army initiated the development of V/STOL (Vertical/Short Take Off and Landing) research aircraft applicable to the battlefield surveillance and target acquisition roles. This program will provide technical and limited operational information that will further define the characteristics of the replacement for the

present OV-1A (Mohawk) series.

Three design approaches will be evaluated during Fiscal Year 1963 and Fiscal Year 1964 which are identified as follows:

- a. XV-4A (Hummingbird)
- b. XV-5A (Fan in wing)
- c. XV-6A (P=1127)

### SPACE GROUND SUPPORT

#### Space Detection and Tracking System (SPADATS)

The NORAD Space Detection and Tracking Center at Ent Air Force Base, Colorado, are operated for the Space Detection and Tracking System (SPADATS) by the USAF Air Defense Command (ADC). The U. S. Navy operates the SPASUR system, an interferometer fence extending from the East Coast to the West Coast, as an element of the SPADATS. A full backup capability to the SPADATS center exists at L. G. Hanscomb AFB, Bedford, Massachusetts and an ADC detachment is on duty to operate the center in the standby mode.

Significant progress has been made in 1962 on improvement of the capability of the SPADATS.

Procurement of a high resolution radar sensor in Alaska has been initiated.

Construction has started on a SPADATS phased array radar at Eglin Air Force Base, which will have considerably improved capability for satellite detection and tracking over existing sensors. When completed, the radar will be able to detect simultaneously and track large numbers of orbital objects in real time. The capability will exist for on-site determination of orbital parameters.

Work was completed on a fully automatic, digitalized computation and data analysis system for SPASUR. This system underwent improvements in 1962 and reached full operational status as an element of SPADATS on 1 January 1963. The automatic system is capable of full evaluation of any satellite contact within 5 seconds after passage through the fence.

#### DOD National Ranges

The National Ranges, which are operated by the DOD, consist of the Atlantic Missile Range (AMR), the Pacific Missile Range (PMR), and the White Sands Missile Range (WSMR). The planned growth of the ranges to support the expanding space efforts is progressing on schedule.

DOD support to the manned MERCURY launches and recoveries during the past year has been extensive and has been a major contribution to the success of those space program milestones. In addition to the launch facilities of the AMR, tracking and data coverage was provided by the AMR, PMR, WSMR, and other DOD installations. DOD recovery forces have successfully recovered astronauts from both the Atlantic

and Pacific Ocean areas. Seventeen thousand DOD personnel were engaged in support of the October 1962 six orbit MERCURY shot.

Continued improvements were made in the land and shipborne capabilities of the National Ranges, for tracking, telemetry, data transmission and data reduction.

At the AMR, the Air Force is proceeding with plans for a TITAN III installation. A TITAN II weapon system launch complex will be converted to accommodate the initial phase of TITAN III development, and a new Integrate-Transfer-Launch (ITL) facility will be constructed. The ITL facility will permit assembly and checkout of the TITAN III in the vertical position and transfer by means of rails to the launch position after checkout while remaining in the vertical position. Plans are also proceeding at the AMR for the conversion of existing launch facilities for the GEMINI and GEMINI target, Nuclear Detection Satellite, and Satellite Inspection Programs.

At the PMR a new probe launch complex and SCOUT launch complex were completed and other launch pads are under construction. These will accommodate both DOD and NASA activities for both probe and orbital vehicle launches.

WSMR will be the sites of the APOLLO abort system (LITTLE JOE II) tests and a NASA-operated APOLLO propulsion development facility.

#### Churchill Research Range

In October 1961, the Department of Defense assigned the responsibility for operating the Rocket Research Facility at Fort Churchill, Canada, to the U. S. Air Force, effective 1 July 1962. The range extends approximately 400 miles eastward over the Hudson Bay and southward along the coast for about 100 miles. The range is used by scientists from U. S. Air Force, U. S. Navy, NASA, Canadian Defence Research Board and the National Research Council. Inter-governmental coordination of activities of the range are carried out through the Operational Coordinating Group, an official, joint U. S. -Canada working group concerned with the range operation.

### SUPPORTING RESEARCH AND TECHNOLOGY

#### Vehicle Flight Control

The vehicle flight control program is intended to develop an integrated flight control capability for manned and unmanned aerospace vehicles. The program includes display, data sensors, computers, and adaptive controls. The X-15 research aircraft is being used as a test bed. The adaptive control portion of this program has been installed and has completed the acceptance flight test program.

#### Aerospaceplane

The Air Force is investigating advanced developments to determine the feasibility of the aerospaceplane concept. The concept embodies a manned maneuverable and reusable vehicle capable of placing large payloads in orbit. Feasibility studies have been initiated in propulsion and structure.

## Other Aeronautical Research

Programs have continued to increase the aerodynamic and flying quality performance of current type subsonic and supersonic aircraft. Applied research is being conducted also in the aerodynamics and stability and control of V/STOL vehicles.

### Crew Escape for Flight Vehicles

Until 1956, the applied research program in crew escape was focused on the ejection seat method of emergency escape. Shortly thereafter, it became apparent that the open ejection seat was not adequate for future high performance vehicles. Programs were initiated to investigate (a) the encapsulated seat, (b) ejectable nose section capsule, and (c) re-entry type of escape systems.

During 1962, advances were made in increasing the temperature capabilities of propellant actuated devices from 200°F to 400°F. Design criteria for two pure rocket escape system ejection devices were obtained and experimental firings successfully conducted. Work was begun in 1962 toward the establishment of non-separable escape concepts where a large crew and mission duration preclude separable re-entry escape systems. Also, in 1962, full-scale models of an ejectable nose emergency escape capsule are being track tested at Edwards Air Force Base. Seven track tests were scheduled for 1962 including a 900 knot run.

### Electrical Propulsion

The Department of Defense has continued research and development of several forms of electrical propulsion. These efforts have been closely integrated with the NASA efforts. The DOD has particular interest in application of electrical propulsion for attitude control, stationkeeping, orbit adjustment and other situations where the characteristics of high specific impulse and low thrust are useful. A ballistic space test of an ion engine was carried out in the latter part of 1962 but a power failure prevented useful results. A small plasma engine was developed to maintain the spin rate of a satellite. Other electric propulsion engines will be tested in conjunction with orbital tests of SNAP units.

### Advanced Air-breathing Propulsion

A three-year effort has been completed on increasing the performance parameters for all jet type propulsive devices. Two different principles using separate approaches to reduce weight and increase performance were tested for approximately 50 hours in two test engines.

A high work per stage and high efficiency compressor were used in both concepts. Two different engineering approaches were used to decrease the combustor size by 50% and both engines used a single high work per stage turbine to drive the compressor. This enabled the construction of a very short engine with only two bearings instead of the usual 4 to 6. The design goal was 10 lbs. of thrust for each pound of engine weight compared with the normal practice which gives 5 to 6 lbs. of thrust for each pound of engine weight.

The features proven by these experimental tests when used in a design for a jet engine will permit lighter engines with higher efficiencies.

## Space Power Equipment

The Department of Defense continued to examine various concepts for meeting the anticipated high electrical power requirements of future satellites. For possible requirements of more than several hundred watts careful consideration has been given to both nuclear and solar powered generators. In 1962, significant management action was accomplished to insure vigorous development of a nuclear power unit to generate several hundred kilowatts of electrical power.

SPUR was initiated in 1960. The study, design and test effort has thus far evolved a power system concept which uses a liquid metal cooled fast reactor supplying thermal energy by means of a potassium Rankine cycle conversion loop to turbine driven electric generator. The tests conducted included material compatibility tests, both static and dynamic, fuel element property evaluations, compatibility tests of the fuel element materials and cladding, creep-rupture tests of the turbine and pump materials, potassium-lubricated-bearing tests, and boiling and condensing potassium heat transfer tests.

The Department of Defense by letter dated October 2, 1961, requested the Atomic Energy Commission to expand its efforts in experimental space power reactors toward the SPUR design criteria. In the ensuing months, the AEC initiated the SNAP-50 reactor development in the power range needed by SPUR. Meetings between the Chairman, AEC, the Administrator of NASA, and the Secretary of the Air Force resulted in a memorandum of understanding between DOD, AEC, and NASA on the management by AEC of an integrated SNAP-50/SPUR program.

Progress was made during the year in the SNAPSHOT program which is a companion to the AEC SNAP program. SNAPSHOT will provide vehicles and services for orbital proof tests of SNAP 10A and SNAP 2. The first orbital flights of this program are scheduled for 1964 and will use the ATLAS/AGENA launch vehicle to place SNAP 10A in orbit.

## Hi-Definition Radar

A program has been initiated to demonstrate a technological capability to build high resolution, long range, space tracking radar.

The program is intended to provide the technology necessary for greatly improved detection, identification and tracking of orbital or ballistic objects.

## Infrared

Infrared detectors have been developed which have many applications in satellite and space systems. Satellite systems require IR detectors for horizon scanners used in vehicle stabilization, in star trackers used for navigation, for IR space communications, for detection and tracking systems used for satellite rendezvous, and various other applications. Presently available long wave length detectors, with response in the S-14 micron region (necessary for cold body detection) require cooling to liquid nitrogen, neon, hydrogen, and even helium temperatures (-268.9°C). Special miniature cryostats, requiring low power input, but reliably providing these temperatures continuously for long periods of time, are being developed. Long wave length detectors requiring less cooling, or no cooling at all,

must also be developed for greater reliability and lower electrical power requirements.

### Ultraviolet

The ultraviolet region of the spectrum is also being explored primarily from the point of view of utilizing this region for image formation outside the earth's atmosphere where ultraviolet energy is not attenuated. Ultraviolet background measurements have been made in cooperation with NASA.

Extensive work in the field of optics in recent months has provided many advancements of considerable importance to peaceful exploitation of the aerospace environment. Optical sensors have long been recognized as providing a means toward achieving high resolution and high angular accuracy, but to achieve this potential high performance, large diameter optical elements and mirrors are required. Recent experiments have resulted in new lightweight mirrors of large diameter capable of maintaining a precise optical shape.

### LASERS

The explosive field of LASER (Light Amplification by Stimulated Emission of Radiation) research is also resulting in techniques that will make this device a valuable tool, in connection with optical sensors, for many operations in aerospace vehicles. It will provide extremely sensitive and high resolution devices, for example, guidance and exploration.

In this area of research, there has been extensive coordination even on an international basis. The recent NATO-SADTC Symposium on Technical and Military Applications of LASER Techniques was held in France, summer of 1962.

### Data Handling

The many problems associated with handling pictorial data or the output of imaging sensors is also under study. Photo-tape is one result of these efforts. It is essentially like the sensitive element of a TV picture tube except that it is flexible and can be rolled up and the information stored for later readout. It is relatively insensitive to nuclear radiation, reuseable and combines some of the best features of TV and photography. It is being considered for use in the NIMBUS type meteorological satellites. The effect of radiation, which exists more intensely in space, on photography and image forming systems is being evaluated. The effect of the earth's atmosphere on image forming sensors is also under extensive study. Atmosphere affects performance of sensors in three ways. The natural turbulence places a limit on resolution under some conditions of operation, induced turbulence due to passage of a vehicle through the atmosphere places other limitations, and, finally, depending upon vehicle skin temperature and meteorological conditions, the atmosphere reduces the ability of an image forming sensor to provide proper contrast discrimination. These problems and techniques for solving them, carry high priority and success in this field has many peaceful applications.

## Environmental Research Rocket and Satellite Support

The environmental research rocket and satellite support program provides rocket boosters, spacecraft equipments, and associated services, to place research experiments in the space environment for scientific purposes. The purpose of the program is to consolidate all booster services and flight hardware procurement for space environmental research under a single manager in order to obtain the economies gained by central purchase of rocket vehicles and allied equipments in standardized configuration, central assignment and full utilization of payload space, and provision of standard ground support. The types of rocket vehicles used by this program cover a wide range.

The program also utilized pods which are attached to the exterior of ATLAS and TITAN II developmental and test vehicles in a piggyback fashion. In this way, surplus weight-lifting capacity of test ICBM's is used for valuable scientific research as an adjunct to their primary mission, without the normally associated high booster costs. During 1962, 49 environmental research experiments were carried in scientific passenger pods on ATLAS boosters. The experiments covered research in the life sciences, electromagnetic propagation, aeronomy, ionospheric physics, energetic particles and fields, energy conversion, and re-entry physics.

Eight NASA-Air Force SCOUT orbital vehicles, and seven BLUE SCOUT, JR. deep space probes were purchased in 1962 with delivery, and subsequent launch scheduled to begin in early 1963. These vehicles will be used for research in radar detection and resolution, energy conversion, geo-space magnetohydrodynamics, energetic particles and fields, and life sciences.

During 1962, approximately 50 research sounding rockets were launched and the data obtained were furnished to other interested organizations. Most of these were fired from the White Sands Missile Range and the Eglin Gulf Test Range. Employed in this program were a wide variety of vehicles which had the capability to carry geophysical sensors weighing from 10 to 200 pounds to altitudes over 1000 miles. Several series of rocket launchings have been made for repeated experiments for determination of variations in upper atmospheric kinetic, composition and chemical properties.

The highest re-entry speed ever obtained for a man-made object, 14 km per second, was achieved last May. The re-entry body was a steel ball of about 3/4 inch diameter which was propelled downward from a height of about 200 miles. The ball became an artificial meteor, creating a bright trail visible in Virginia and North Carolina. A six-stage solid-fueled rocket, TRAILBLAZER 2, was used in the experiment. The last four stages were used to propel the artificial meteor downward. The rocket was launched from Wallops Island.

## Space Technology Satellites

The Air Force continued its launch of space technology satellite at an increasing rate during 1962. The program consists of testing components, propulsion, guidance systems, and techniques used in various U. S. space projects. Space capsule recovery is foremost among techniques being developed.

A standardized second stage and satellite vehicle was tested and all missions utilizing it were fully successful. The vehicle will be used for many of the Air Force, Navy, and NASA programs in the future. The payload capacity of space technology space vehicles has provided a most fruitful opportunity for scientific measurements. Instrument modules for experiments are carried as part of the payloads.

During 1962, thirteen of these research payload modules have been carried into orbit aboard space vehicles and research data have been made available to interested agencies. Each of these modules usually contains a number of experiments. About 65 experiments have been placed in orbit this past year. The instruments flown on these satellites were designed to measure density, micrometeorites, cosmic radiation, electron and ion densities, magnetic fields, and galactic radio noise.

Examples of experiments which were performed during 1962 are:

a. A plasma probe was flown five times to obtain data regarding the electrical structure of the F region of the ionosphere. Density and temperature of both the positive and negative particles of the ionosphere were measured.

b. A standing wave impedance probe was flown six times which consists of a 24 foot balance dipole antenna which was unrolled in orbit. Observations are interpreted in terms of electron density at satellite altitude.

c. Nuclear emulsions have been flown and recovered from twelve flights. These emulsions are studied to determine the flow of energetic particles trapped in the geomagnetic field and also to learn more about incident cosmic rays.

d. Many active experiments have flown to measure properties of the Van Allen Radiation Belt. These measurements were especially important during 1962 due to the enhancement of the belts caused by the U. S. and Soviet high altitude nuclear tests.

### ASSET

The Air Force Aerothermodynamic/Elastic Structural Systems Environmental Test (ASSET) program was initiated to provide an economical and feasible means to supplement and verify the validity of ground facility data by obtaining basic knowledge of the actual free flight environment in the critical heating regime surrounding hypersonic re-entry vehicles with lifting surfaces. Four test vehicles will be boosted into a re-entry trajectory by the THOR/DELTA and THOR boosters. These unmanned vehicles are designed to test full scale components of various structural concepts and materials. The first launch is scheduled for Mid-1963.

### General Support, Research and Development

Our efforts in space are undertaken not only to meet certain well-defined military needs and requirements, but also to create a vigorous and broad base of new technology which will allow us to undertake development of future systems to fulfill a clear, identifiable military need or requirement. The DOD is supporting exploratory and advanced developments aimed specifically at the evolution of



"technological building blocks" for space. These developments (some of which have been covered in the foregoing) include a great variety of efforts in bio-astronautics, the development of advanced sensors, the evolution of advanced propulsion systems and power supplies, developments in materials, and a multitude of exploration and research efforts aimed at learning more about space flight and the space environment.

#### COOPERATION WITH OTHER GOVERNMENT AGENCIES

Close coordination and cooperation with other government agencies was continued and enhanced during 1962. Examples of this have been cited already in some of the projects discussed above such as standardized space boosters, large solid propellant motor program, X-20, X-15, space nuclear detection and ANNA.

Additional examples have been mentioned in the description of activities at the National Ranges. In addition to the above, the following are considered worthy of special mention:

Participation with the NASA in the Aeronautics and Astronautics Coordinating Board for the purpose of coordinating the activities of the DOD and NASA to avoid undesirable duplication to achieve efficient utilization of available resources, to identify problems requiring solution, and to exchange information.

Participation in the Joint Meteorological Satellite Advisory Committee.

Participation with the AEC in the development and use of space nuclear power units.

To insure effective and coordinated management of DOD support to programs of NASA, the DOD issued a Directive on 24 February 1962. This Directive specifies that basic agreements for support will be made between Secretary of Defense and the Administrator, NASA. It defines the responsibilities within the DOD for the support of NASA including assignment of responsibility to the Secretary of the Air Force for research and development, test and engineering of satellites, boosters, space probes, and associated systems necessary to support NASA.

The Air Force created the Office of a Deputy to Commander, Air Force Systems Command, for Manned Space Flight as follow-on to the DOD assignment of Space RDT&E to the Air Force. This Deputy maintains an office in NASA Headquarters in order to help assure the closest management level interplay between the two agencies responsible for the national space program.

A memorandum of agreement between the Air Force and the Federal Aviation Agency was signed into effect on 4 September. It relates to Research, Development, Test and Evaluation (RDT&E) required to meet the needs for safe and efficient navigation and traffic control of all civil and military aviation. The purposes of this agreement are to:

- a. Insure timely response and full consideration of USAF requirements in FAA programs.

- b. Provide the mechanism whereby USAF and FAA will coordinate and cooperate in RDT&E projects of mutual interest.
- c. Enable each agency to observe and participate in RDT&E programs to the extent necessary to discharge their respective agency responsibilities and effect overall Government economies.

Closer relationships have also been established with the National Aeronautics and Space Council and specific contact points for particular areas of interest have been established.

# Chapter V

## Atomic Energy Commission

### INTRODUCTION

The Atomic Energy Commission's efforts in behalf of the nation's space and aeronautics programs are directed toward the development of (1) compact space and satellite power sources (Project SNAP); (2) reactors for nuclear rocket engines capable of accomplishing operational space missions (Project ROVER); (3) an advanced-type reactor which can be incorporated into a ramjet engine to propel high-speed, low-altitude, extended-range missiles (Project PLUTO); and (4) satellite-based instruments and systems to detect nuclear explosions in space (Project VELA HOTEL).

### PROJECT SNAP

Radioisotope-fueled generators, capable of achieving power levels of the order of tens and hundreds of watts, and small nuclear reactors, capable of delivering kilowatts--and eventually megawatts--of power are the two systems being developed by the AEC to provide nuclear auxiliary power for spacecraft and satellites.

#### Radioisotope-fueled generators:

Using the basic technology of the grapefruit-sized Plutonium-238 fueled SNAP-3 type generators which were successfully placed in orbit in 1961 as supplemental power sources in the Navy's TRANSIT-4 navigational satellites, three heavier, higher-powered, larger-sized, Pu-238-fueled generators with a design lifetime of 5 to 10 years--designated SNAP-9A--were this year fabricated, fueled, tested, and delivered for use in the Navy's operational prototype TRANSIT-5 series of navigational satellites. These generators are designed to supply all of the power (25 watts) for this series of satellites which are being launched from the Point Arguello Naval Missile Facility, and are sending out signals by which navigators throughout the world can electronically determine their exact position.

Major SNAP-9A effort in 1962 was devoted to testing the integrity of the capsule in which the Pu-238 fuel for the generators is encased. Generators and bare fuel capsules were subjected to rigorous impact and fire tests to substantiate that the unit would safely survive launch aborts, but would, upon re-entry from space, burn up to very fine particles which would disperse harmlessly before reaching the earth.

Early in 1962 the AEC initiated a contract effort to develop the SNAP-11 Curium-242-fueled thermoelectric generator required by NASA for their unmanned soft lunar exploration program--Project SURVEYOR. Prototype units with a mission lifetime of 120 days are being developed. Operational fueled units will be available to NASA for launchings beginning in 1965. These generators will be designed to supply continuous electrical power for the radio transmitters and other instruments aboard the spacecraft under the extreme environments of the lunar surface.

Fabrication of the low-powered cesium-vapor thermionic generator--designated SNAP-13--which is being developed to demonstrate the feasibility of using a radioisotope heat source in such an energy conversion device, encountered some difficulty when two prototype electrically heated generators exhibited heater failure during test. Replacement prototype units incorporating improved heater design were fabricated, and the units now have successfully completed life tests. Development tests are continuing, and no delay is expected in completing a fueled SNAP-13 generator during 1963. The SNAP-13 has been designed in line with the SURVEYOR system requirements so it may serve as a standby unit for SNAP-11, delivering the same amount of power for about one-half the weight.

In August, the AEC awarded a 4-month study contract to develop a conceptual design for a 500-watt thermionic generator which can be fueled with radioisotopes such as Cerium-144, Plutonium-238, or Polonium-210 and might have application in communications satellites or in other space systems which need relatively large amounts of power.

Polonium-210 is attractive for heat source applications, particularly in lunar probe spacecraft, because of its high specific activity and very low beta and gamma radiation. Its limiting high vapor pressure at elevated temperatures has been reduced by combining it with the rare earth elements to form high melting compounds which give the desirable heat characteristics with negligible gamma radiation. Several of these research compounds appear attractive as heat sources.

In recent months the possibility of using Curium-244 has become of interest for relatively high power, long-life missions. Besides having a half-life of 19 years, its specific power is approximately five times greater than Plutonium-238. Being an alpha-emitter, it presents relatively insignificant external radiation hazards. At present, studies are underway to determine production capabilities of this radioisotope.

#### Small Nuclear Reactors:

SNAP-2, the very compact 3-electrical-kilowatt reactor-turboelectric system for space applications, will be ready for orbital testing in 1965. Development of the miniaturized rotating power conversion equipment for operation with the SNAP-2 Developmental System continues to be the pacing item in the program. Intensified effort to develop a flight-qualified power conversion system was initiated early in the year, and a preliminary design completed in July. Following exhaustive testing of the system, it will be mated to the SNAP-2 reactor and the combined reactor-power conversion unit will be ground tested in 1964. After this testing program is completed, a flight-qualified system will be delivered to the Air Force for mounting in a satellite nosecone for the orbital tests.

The SNAP-8 system, which is being developed as a joint AEC-NASA effort, will consist of a scaled-up AEC-developed SNAP-2 reactor plus a NASA-developed 30 kilowatt electrical dynamic conversion system. Assembly of the first SNAP-8 Experimental Reactor (S8ER) to demonstrate reactor operation and measure reactor performance parameters was completed early in September, and initial criticality of the S8ER was reached on September 17. Fabrication of the fuel rods for the S8ER was temporarily suspended during the year pending resolution of several fabrication problems which caused a large number of them to be rejected at final

inspection. This suspension made criticality of the S8ER slip by about six months, but appears to have had no adverse effect upon the over-all SNAP-8 schedule which calls for delivery to NASA by 1965 of a flight-capable reactor and controls which have undergone nuclear and environmental tests. NASA has not yet assigned a first mission to SNAP-8, but its higher power and lower power-to-weight ratio make it a candidate for any number of advanced space missions.

During the year, SNAP-10A, a compact SNAP-2-type reactor coupled to a combined thermoelectric converter-radiator, has undergone environmental, electrical, and thermal systems tests. A major effort has been devoted to validating the safety of its design under conditions of a launch abort or failure to inject into orbit. The first ground test of a SNAP-10A flight system is expected to be operating at full power early in 1963, and its first flight test is scheduled for later in 1963. This flight will be of major significance because it will be the first test of a reactor in orbit.

Work was begun early in the year on the development of a compact, high-temperature, lithium-cooled reactor--designated SNAP-50--which would be capable of providing nuclear-electric power in the 300 to 1,000 electrical kilowatt range for use in ion propulsion systems and in advanced communication satellites and other space applications requiring large amounts of electrical power and high power-to-weight ratios. Initial SNAP-50 program effort, which will continue through Fiscal Year 1963, includes space powerplant design studies, materials and fuels development, and the initiation of component design and engineering. The SNAP-50 reactor program is being combined with the Air Force SPUR (conversion machinery) program to provide, under AEC management, a research and development program leading to a complete nuclear-electric power plant.

For more effective management of the large and complex SNAP program, a position of SNAP Program Manager was established within the AEC during the year to serve as the focal point for all SNAP program direction and responsibility. SPUR/SNAP-50 program management will be accomplished through a SPUR/SNAP-50 Program Office to be headed by an Air Force officer. The SPUR/SNAP-50 Project Manager will have an Air Force and a NASA deputy to assist in carrying out the joint developmental effort and to provide liaison with the nuclear electric power programs of their agencies.

#### PROJECT ROVER

Project ROVER, which has as its objective the development of qualified nuclear rocket engines for the accomplishment of operational missions in space, is a joint program of the NASA and the AEC. Overall management responsibility for the program resides with the Space Nuclear Propulsion Office (SNPO) and its extensions in Albuquerque, Cleveland, and Las Vegas.

Among the major 1962 technical achievements of Project ROVER were the completion of facilities in which the KIWI-B reactors could be tested, and the successful operation of a liquid hydrogen pump and a regeneratively cooled nozzle. The first power operation of a reactor on liquid hydrogen feed was accomplished in a KIWI-B1B reactor test conducted on September 1. Preparatory to this test, a series of experimental runs were made with liquid hydrogen on a U-238 reactor which could not go critical. These "cold-flow" runs, which were completed in July, and the

KIWI-B1B test yielded much valuable information regarding the operation of rocket reactors on liquid hydrogen.

The KIWI-B series of experiments will continue until this program achieves its primary technical objectives of selecting an acceptable basic core design for use in the NERVA engine development project, and of demonstrating a restart capability for the KIWI core.

In February, the Jackass Flats area of the AEC's Nevada Test Site was designated as the Nuclear Rocket Development Station (NRDS). Additions and modifications to the NRDS facilities to permit the conduct of more complex, higher-power tests are progressing. The Nevada Extension of the SNPO at Las Vegas, which became fully operational in October, was established to manage the NRDS, where all phases of ROVER test operations are conducted.

Three other important steps taken during the year in the development of the nuclear rocket were the execution on June 28 of a contract between NASA and a private organization for the development and initial flight test of the RIFT stage, the first nuclear vehicle; the extension of the contract with the private corporation which performed the initial NERVA engine work to cover the entire engine development effort through September 30, 1966; and the selection of five companies to participate as candidate suppliers in a cooperative program aimed at providing industrial capability to produce nuclear rocket fuel elements.

#### PROJECT PLUTO

During 1962, plans were made to expand the objectives of Project PLUTO--a coordinated effort of the AEC and the Department of Defense (Air Force)--into the development of advanced-type nuclear reactors for ramjet systems for application in supersonic low-altitude missiles. These plans are being examined.

The initial engineering test reactor constructed to provide the engineering, thermodynamic, and nuclear experience basic to the development of a ramjet reactor--designated TORY 11A--was successfully tested in the Fall of 1961. This reactor demonstrated the feasibility of a reactor for nuclear ramjet propulsion.

The second reactor--TORY 11C--is designed to bridge the gap between the TORY 11A engineering test device and a flyable power plant. (TORY 11A tests were so satisfactory that TORY 11B tests were considered unnecessary and, consequently, were by-passed.) Construction of the TORY 11C is progressing satisfactorily, and its testing is expected to begin during the summer of 1963.

Work on modifying and expanding the PLUTO test facilities at the AEC's Nevada Test Site is on schedule.

Early in the year, the AEC, in response to a Navy request, initiated studies of nuclear ramjet engines for sea-based missile applications, including not only vehicles capable of being launched from existing POLARIS submarines but also from other seaborne launch configurations.

## PROJECT VELA HOTEL

The AEC is participating in the Department of Defense VELA HOTEL program, a research and development effort aimed at developing satellite-based instruments and systems to detect nuclear explosions in space. The AEC's instrument development work is being carried out jointly by the Los Alamos Scientific Laboratory and the Sandia Laboratory. Radiation detectors for neutrons, gamma rays, and X-rays will be employed.

# Chapter VI

## Department of State

### INTRODUCTION

In 1962 world interest in outer space activities was reflected with the beginning of implementation of the United Nations resolution on outer space, adopted in late 1961 at the initiative of the United States, and with the reactivation of the United Nations Committee on the Peaceful Uses of Outer Space.

The Department of State continued to direct United States efforts in the United Nations aimed at increased cooperation in outer space activities and definition of the legal and political aspects of outer space exploration. The Department also continued to effect new agreements and maintain old agreements for technical support for United States programs in other countries and programs of international cooperation in space science efforts. In addition, the Department continued its activities in the formulation of national policy in the legal and political aspects of outer space activity.

### ACTIVITIES WITHIN THE UNITED NATIONS

During the year the United States directed its efforts to the implementation of the provisions of General Assembly Resolution 1721 (XVI) adopted unanimously on December 20, 1961 on our initiative. The United Nations Committee on the Peaceful Uses of Outer Space, as reconstituted by that resolution, met twice in 1962 -- March 19-29 and September 10-14. The March meeting established two subcommittees, one charged with exploring practical means to advance international cooperation in the scientific and technical aspects of space activity, and the second to study and report on legal problems which may arise in the exploration and use of outer space. The Scientific and Technical Subcommittee, which met in Geneva on May 28, agreed upon a number of proposals for international cooperation through the United Nations. These recommended: (1) An exchange, on a voluntary basis, of information relating to national, regional, and international programs of peaceful space research, and of information on governmental and non-governmental international bodies active in space research; (2) That United Nations Specialized Agencies and Member States support the program of scientific cooperation during the International Year of the Quiet Sun (1964-1965) to be undertaken by the International Council of Scientific Unions, and the program sponsored by the same organization for a World Magnetic Survey; and (3) The establishment under U. N. auspices of a sounding rocket launch facility, or facilities, on the geomagnetic equator in time for the International Year of the Quiet Sun. The recommendations, in the main, stemmed from proposals made by the United States.

The Scientific and Technical Subcommittee also considered reports by the World Meteorological Organization and the International Telecommunication Union on those aspects of space meteorology and space communications in which international cooperation would be useful, but took no specific action with reference to recommendations included in either of these reports.



In the Legal Subcommittee, which also met in Geneva on May 28, the United States delegation presented a proposal on the liability of states for space vehicle accidents, and a draft General Assembly resolution on assistance to and return of space vehicles and personnel. Under the former, the Secretary General of the United Nations would have been requested to constitute an advisory panel of legal experts charged with the task of preparing an international agreement. The draft GA resolution recommended to States that they render assistance to personnel of space vehicles who might be the subject of accident or experience conditions of distress and that they return space vehicles and personnel that might land otherwise than as planned. The Soviet Union had earlier tabled a draft declaration of general principles and a draft international agreement, rather than a General Assembly resolution, on assistance to and return of space vehicles and personnel.

Significant elements of the Soviet draft proposals were unacceptable to a majority of the Subcommittee. Although the United States was prepared to modify its proposals in the interest of reaching agreement, the Soviet Union was unwilling to consider the questions of liability and of rescue and return in the absence of agreement by the Subcommittee to go forward with the Soviet draft declaration of principles. The Legal Subcommittee adjourned without reaching any agreements as to substance or procedure.

At the September meeting of the full Committee, the recommendations of the Scientific and Technical Subcommittee were adopted and forwarded in the Committee's report to the General Assembly. There was lengthy discussion on legal problems with, however, no agreement resulting. Five draft proposals on these legal questions were submitted to the General Assembly with the Committee's Report.

The Political Committee of the General Assembly began consideration of the Report of the U. N. Space Committee on December 3. The United States Representative led off the debate with a major address outlining United States space policy and reviewing the history of our leadership in sponsoring international cooperation in outer space.

The United States presented a resolution which called for General Assembly approval of the recommendations endorsed by the Space Committee on technical and scientific cooperation. The United States subsequently agreed to the inclusion in its resolution of a section which would recommit legal questions to the Space Committee. The resolution, as adopted unanimously by the Political Committee on December 11 and the General Assembly in Plenary on December 14, requested the Space Committee to continue its work on legal questions including the elaboration of legal principles to govern the activities of states in the exploration and use of outer space, liability for space vehicle accidents, assistance to and return of astronauts and space vehicles, and other legal problems. Those sections of the resolution approving the scientific and technical recommendations of the U. N. Space Committee were retained as originally presented by the United States Delegation.

During the debate the United States also introduced a draft declaration of legal principles to guide states in their outer space activities. Since agreement was reached on remanding legal questions to the Outer Space Committee, neither this proposal nor draft proposals presented by other delegations were put to a vote.

In response to General Assembly Resolution 1721 (XVI), paragraphs 1 and 2, the United States has registered with the U. N. Secretariat all United States objects in orbit since mid-February, 1962. Information provided gave the international serial designation of the objects launched into orbit or beyond, the launch vehicle, date of launch, satellite category, and orbital elements. After an initial report as of February 15, 1962, supplementary reports were submitted to the U. N. Secretariat on a twice-monthly basis.

#### OTHER INTERNATIONAL ACTIVITIES

In 1962, the United States continued to follow a policy of cooperation with other nations in space research. Among the more significant of these efforts was an agreement with the Soviet Union to cooperate on a limited number of space experiments. In March 1962, following the successful flight of John Glenn, Premier Khrushchev indicated to the President that the U. S. S. R. would be interested in undertaking a program of cooperation in outer space activities with the United States. With the support of the Department, Dr. Hugh L. Dryden of NASA met with Professor Blagonravov of the U. S. S. R. to have technical discussions on possible areas of cooperation. As a result of these conversations, technical arrangements for three specific cooperative programs were agreed ad referendum to the U. S. and Soviet Governments. The three projects involve (1) exchange of weather data from satellites, (2) a joint effort to map the magnetic field of the earth by means of coordinated launchings of geomagnetic satellites and related ground observations, and (3) cooperation in the experimental relay of communications via the ECHO satellite. In October, the President of the Academy of Sciences of the U. S. S. R. informed the Administrator of NASA that the proposed agreement was satisfactory to the U. S. S. R. The NASA Administrator replied with the concurrence of the United States. The technical agencies of the two nations will soon commence steps to implement the projects which have been agreed upon.

On December 5 the United States and Soviet Representatives to the United Nations in a joint letter informed the U. N. Secretary-General of the agreement.

In other significant developments in international cooperation, the Department of State concluded an agreement with Italy for a program of launching Italian satellites from Texas Tower-type launching platforms in the Indian Ocean using United States boosters. Agreements were also reached with India and Japan for cooperation in communications satellite experiments utilizing the RELAY and TELSTAR communications satellites.

In addition to these new cooperative programs, there was continuing support of NASA in the implementing and extending of cooperative programs with other countries including Sweden, Norway and Denmark, Pakistan, Japan, Italy, Canada and the United Kingdom. In this connection, the first two foreign satellites, the U. K. ARIEL and the Canadian ALLOUETTE, were launched by NASA in 1962.

The Western European nations continued to demonstrate a growing interest in space activities and the conventions for a European Space Research Organization (ESRO) and a European Launcher Development Organization (ELDO) were agreed, subject to ratification by the participating governments. The Department established general guidelines within the Executive Branch for responding to approaches from ELDO and ESRO for assistance.

The launch of the TELSTAR satellite and the passage of the Communications Satellite Act of 1962 stimulated world interest in communications satellites. In this field the Department assisted in the formulation of basic U.S. policy for the creation, with a minimum of delay, of a single global commercial communications satellite system, with broad and substantial international participation, yet identified with U.S. leadership and technological progress, based on the principle of non-discriminatory access and designed to realize the economic, technical and resulting political benefits of this new technology, both nationally and internationally.

The Department also continued to support NASA and the Department of Defense in gaining access in foreign countries for tracking and other support facilities for space programs. Preparations were made for the renegotiation of the agreements for the use of the Project MERCURY tracking stations to include follow-on manned space flight efforts of NASA. In addition, rights for new stations were obtained in Australia and Brazil for NASA and in a number of countries for the joint Service geodetic satellite program ANNA. Other arrangements in support of technical agency programs were also initiated.

# Chapter VII

## National Science Foundation

### INTRODUCTION

The principal efforts of the National Science Foundation are directed toward the stimulation and support of basic research and education in the sciences. Most of this activity is conducted at universities and non-profit institutions.

Significant research is also carried out at three National Research Centers, federally owned and supported by the National Science Foundation. They have been established to provide essential research facilities, so large and expensive that it is impractical to attempt to duplicate them at individual universities. The Centers also constitute nuclei for planning and executing research endeavors so broad in scope that the cooperative efforts of a number of institutions are required to execute them. Research at the Centers is carried out both by the resident staff and by visiting university scientists.

### THE NATIONAL RADIO ASTRONOMY OBSERVATORY (WEST VIRGINIA)

A new 300-foot radio telescope has been completed and placed in operation on the Green Bank site. It will, for some time to come, be the largest movable telescope in the world. This instrument is tiltable in altitude but does not rotate in azimuth. It is being used to study the distribution of hydrogen gas in our own galaxy and in some of the nearby external galaxies.

In addition, construction of a 140-foot telescope is planned for completion during the Calendar Year 1964. It will be the largest completely steerable parabolic dish-type antenna capable of efficient performance at a wave length of 3 centimeters.

At this Center, observations have been made of radio radiation from planets at a wavelength of 10cm. This has provided the following new values for planetary temperatures: Venus,  $610^{\circ}\text{K} \neq 50^{\circ}\text{K}$ ; Saturn,  $196^{\circ}\text{K} \neq 60^{\circ}\text{K}$ .

Observations have been made with the 85-foot telescope of four extended radio sources in the galaxy which are thought to be remnants of prehistoric supernovae. Two of the sources appear to be shell sources, i. e., they have a bright ring at some distance from the central condensation. Shell phenomena are caused by shock fronts which travel outward from the center and compress the magnetic field surrounding the galaxy.

### THE KITT PEAK NATIONAL OBSERVATORY (ARIZONA)

The program of the Space Division has been broadened to encompass a series of experiments from space probes and satellites. Development of a general purpose remotely-operated space telescope has continued, particularly with regard to the very large optical elements which would be required.

Excellent progress has been made on the 60-inch solar telescope and the 84-inch stellar telescope. Both of these instruments have been completed and are under-going initial testing.

### CHILEAN ASTRONOMICAL STATION

A site survey in Chile has been under way for three years to locate in that country the most valuable site for an astronomical observatory. Final selection of a mountain top has been made. It is planned that a 60-inch telescope be installed on the site and put in operation in 1965. The purpose of this effort is to provide a first-rate modern observatory for which U.S. astronomers can study astronomical objects in the southern sky.

### THE NATIONAL CENTER FOR ATMOSPHERIC RESEARCH (COLORADO)

An existing organization, the High Altitude Observatory, has been incorporated into this Center's structure. Observations made at an altitude of 80,000 feet with the aid of balloon-borne instrumentation has revealed the existence of a surprisingly large number of very small dust particles at the maximum balloon height.

Spectroscopic observations have been made of the chromosphere, a layer of the sun's atmosphere lying above the bright photosphere. Definite evidence now exists that the hydrogen and helium gases in this hot and tenuous region do not obey the ordinary laws of thermodynamics as a result of the intense outward flux of solar energy which pours through it.

### ACTIVITIES AT SELECTED UNIVERSITIES

#### Stratoscope II

This project sponsored by NSF, NASA, and the Office of Naval Research, is concerned with a balloon-borne 36-inch telescope which will be lifted to an altitude of 80,000 feet. At this height it will be remotely controlled from the ground in a program of direct photography and spectrography of planets and other celestial objects. The telescope itself is now essentially finished and assembled. A very accurate 36-inch quartz mirror has been completed.

#### Effects of Cosmic Radiation on the Earth's Atmosphere

Studies show that precipitation of energetic electrons from the outer Van Allen belt accounts for many of the X-ray phenomena observed in the earth's upper atmosphere. The precipitation appears to result from disturbances of solar origin. The energy spectra and the time variations for many of the larger solar cosmic ray events are being measured at ground stations and with balloon, satellite and space probe instrumentation in an attempt to understand the geomagnetic and inter-planetary effects. Research in the area is being supported at the University of Minnesota.

#### High Temperature Gas Dynamics

A major investigation of the properties of gases at high temperatures is being supported at Harvard University. Particular attention is being given to highly ionized

gases. The information derived from these studies has bearing on the technology of ion propulsion and the dissipation of heat during re-entry. In the latter case the use of a magnetic field to help dissipate the hot plasma is under investigation.

The design of liquid containers for operation in very low gravity environments is an important current problem, and is being studied under an NSF grant at Stanford University.

# Chapter VIII

## Department of Commerce

### INTRODUCTION

Space program activities of the Department of Commerce are carried out by the Weather Bureau, the National Bureau of Standards, and the Coast and Geodetic Survey. The Maritime Administration, recognizing the potential value of meteorological, navigational, and communications satellites to ships at sea, has such spacecraft applications under review.

### WEATHER BUREAU

During 1962, the space activities of the Weather Bureau centered upon (1) the use of TIROS data for operational weather analyses and forecasting, (2) the development of the National Operational Meteorological Satellite System, (3) the research programs of the Meteorological Satellite Laboratory, (4) the meteorological support given to the MERCURY and GEMINI manned space programs, (5) the operation of the Meteorological Rocket Network, and (6) the pursuit of potential non-meteorological by-products from weather satellites.

### Use of TIROS Data for Operational Weather Analyses and Forecasting

During the year, three NASA TIROS satellites were successfully orbited -- February 8th, June 19th, and September 18th -- and their cloud pictures relayed, via the Command and Data Acquisition stations, to the Weather Bureau's National Weather Satellite Center for processing and incorporation into analyses and forecasts.

Each month saw these TIROS pictures usefully applied to the improvement of the accuracy and coverage provided by the Weather Bureau's services. Operations for 1962 included:

- a. receipt from TIROS satellites of 3,583 usable sequences of pictures;
- b. receipt of 87,479 usable individual pictures;
- c. instigation of 203 adjustments to the weather analyses of the National Meteorological Center;
- d. issuance of 149 Satellite Storm Advisories to foreign countries;
- e. issuance of 152 Satellite Storm Advisories to Weather Bureau activities in the Continental United States, 261 to U.S. Air Force Weather Detachments overseas, and 37 to U.S. Navy Weather Centrals;
- f. location and positioning of 13 of 25 named tropical storms which occurred during the year;

- g. obtaining of important information on 12 other such storms; and
- h. programming of picture sequences specifically intended to support the following:
  - (1) Project TIREC (February 8-15 and April 6-17)
  - (2) Project BRIGHT CLOUD (March 24-29)
  - (3) University of Miami research project investigating radarscope photography
  - (4) Project MERCURY
  - (5) Antarctic Re-supply Mission
  - (6) Joint Task Force 8
  - (7) Project RANGER
  - (8) University of Wisconsin project studying ice-covered lakes of north central North America
  - (9) California water survey (U.S. Weather Bureau)
  - (10) DISCOVERER launch and horizon sensor check
  - (11) USAF requirements
  - (12) Australian Rocket Firing (LONG TOM Meteorological Rockets)
  - (13) Illinois State Water Survey
  - (14) MARINER launch (Venus probe)
  - (15) SCOUT launch from Wallops Island
  - (16) International Indian Ocean Expedition

The launch of TIROS VI on September 18th, while TIROS V was still operating, considerably increased the numbers of pictures and the global coverage obtained. This increase can be expected to be maintained as the projected TOSS program (see later description) becomes implemented.

#### International Facsimile Transmission of Cloud Maps

Because the operational usefulness of the cloud data obtained by TIROS satellites depends largely upon how rapidly and adequately they are disseminated to the community of meteorological information users, much attention was given to this aspect of weather satellite activities by NWSC. From April 15 to June 30, 1962, an experimental program was conducted consisting of the international radiofacsimile transmission of cloud maps (nephanalyses) to potential users in Europe, Africa,



South America, the Far East, and the Southwest Pacific. Transmission of the maps in this manner was expected to complement the coded analyses of satellite cloud cover observations routinely sent on international radio teletypewriter networks, a tedious and time-consuming process during which considerable detail is inevitably lost. This facsimile transmission was resumed on October 1st on an operational basis to Europe, Central America, the Far East, and, on an occasional service basis, to the Southwest Pacific.

Facsimile transmission of the cloud pictures themselves, individually and as photo mosaics, was also instituted. The first transmissions were made in May to Idlewild Airport, New York, then extended in July to Miami, San Juan, and New Orleans. By the year's end, other points were receiving TIROS pictures by this method, including Kansas City, Honolulu, San Francisco, Anchorage, and selected Air Force bases.

#### TELSTAR Transmissions

In late summer, TIROS V pictures and some nephanalyses were experimentally transmitted to France and England via the TELSTAR satellite. These tests proved moderately successful and demonstrated a technical potential for using communications satellites as a means of rapidly transmitting perishable weather information.

#### National Operational Meteorological Satellite System (NOMSS)

The Supplemental Appropriations Act, 1962 (Public Law 87-332), enacted in September 1961, provided funds to the Weather Bureau for the establishment and operation of a system for the continuous observation of worldwide meteorological conditions from space satellites. This resulted in the definition of a National Operational Meteorological Satellite System (short name NOMSS), requiring the joint efforts of the Weather Bureau and the National Aeronautics and Space Administration (NASA).

As a necessary first step in bringing NOMSS into being, the Department of Commerce, representing the Weather Bureau, entered into an interagency agreement with NASA on January 18, 1962. Under the terms of this agreement, the Weather Bureau's responsibilities consist of:

- a. determining the meteorological requirements of the system;
- b. specifying the meteorological quantities to be sensed and measured;
- c. processing and disseminating the resultant data for operational meteorological use; and
- d. archiving the data for weather research and climatological use.

NASA's role in NOMSS was agreed to be:

- a. supplying the spacecraft, launch vehicle, and Command and Data Acquisition (CDA) stations;
- b. conducting the launch operation;

- c. tracking, programming, and commanding the spacecraft; and
- d. recovering and communicating the meteorological data from the spacecraft to the Weather Bureau.

This division of Weather Bureau and NASA duties was intended to be consistent with the former's traditional role as supplier of the national weather service and the latter's statutory responsibility as the nation's civilian space agency.

With the execution of this interagency agreement, the Weather Bureau established the Meteorological Satellite Activities at Suitland, Maryland, in close proximity to the National Meteorological Center. Intended to provide an organizational framework within which the Bureau could perform its technical, managerial, and operational NOMSS function, it was redesignated in mid-1962 as the National Weather Satellite Center (NWSC).

### NIMBUS Development

Because NOMSS was originally based upon the initial use of the NIMBUS spacecraft as the System's first operational vehicle, NWSC and NASA collaboration during most of 1962 was directed towards this goal. Throughout the year, NIMBUS, an earth-oriented, polar-orbiting, second-generation weather satellite, continued in its development phase at NASA's Goddard Space Flight Center. NWSC personnel were detailed to the NIMBUS Project Office at Goddard to assist such development and provide on-the-spot Weather Bureau representation in problems and decisions affecting the meteorological data to be obtained from the vehicle.

One NWSC representative was assigned the responsibility of Data Utilization Manager as NWSC engaged in a continuing program to determine how best to handle the expected data. Systems studies concerning data flow and computerized processing in as close to real time as possible resulted in the ordering of advanced digital computation equipment scheduled for installation at NWSC in early 1963.

The first NIMBUS flight model will be a NASA research and development spacecraft intended to prove out and evaluate the vehicle, its subsystems, and their performance. When NIMBUS satellites have proven themselves to have adequate reliability for operational usage, NOMSS versions of NIMBUS, funded for and under the operational control of NWSC, will be flown. The weather data obtained by both the NASA research and development and the Weather Bureau operational versions of NIMBUS will be put to operational analysis and forecasting usage to the maximum extent that the nature of the data and the data-handling capabilities of NWSC permit.

### TIROS Operational Satellite System

To advance the date for the operational beginning of NOMSS, the Weather Bureau (NWSC) and NASA began discussions in October 1962 on the use of TIROS as an interim substitute for NIMBUS. TIROS, with two and one-half years of successful operations and a record of six placed in orbit out of six attempts, was considered adequate for routine operational use, although all six had been research and development in nature. The joint plan under discussion at the year's end called for one operating TIROS spacecraft maintained in orbit at all times until NIMBUS becomes operationally acceptable. Known as TOSS (Tiros Operational Satellite System), this

first operating phase of NOMSS held promise of hardware and flight implementation by mid-1963.

### Research Programs

From the TIROS weather satellites, the National Weather Satellite Center has obtained tens of thousands of cloud cover pictures and substantial infrared data relating to earth surface and cloud temperatures. The newness of this type of information has imposed problems of analysis and understanding and has led to an active research effort, conducted in-house and under-contract, by the NWS Meteorological Satellite Laboratory.

Using cloud picture information, this Laboratory during 1962 concentrated its attention upon hurricane origin, growth, and dynamics; tornadoes and similar short-lived severe storms; the information and movement of fronts and cyclones; vertical motion of the atmosphere; and jet streams and clear air turbulence.

Because TIROS pictures, taken in cloud-free areas, offered views of the earth's surface itself, they provided the means for studying, in addition, snow and ice cover and sea state (as indicated by the reflection of the sun by the water).

Research activity using available infrared data was carried out in planetary circulation and energetics and earth-atmosphere heat exchange.

From this research performed by the Meteorological Satellite Laboratory, the following useful end-results were sought:

- a. improved operational Numerical Weather Prediction (NWP) -- the basis for much of the Weather Bureau's current forecasting activity and techniques;
- b. improved cloud and precipitation prediction for agricultural and aviation purposes;
- c. earlier and more accurate warnings of severe storms;
- d. better long-range prediction methods; and
- e. more complete knowledge of the factors underlying climatic change and weather modification.

In addition to these meteorological and atmospheric research programs, an experimental study was initiated to determine the frequency range, signal strength, atmospheric attenuation, and noise interference for a high-frequency sferics sensor. Sferics are natural electrical discharges which occur in a storm and produce static. The study is intended to contribute towards the design of a sensor or sferics detection device which, when flown on a weather satellite, would locate lightning and electrical storm activity below.

Work continued during the year on the development of a satellite infrared spectrometer to determine the temperature structure of the atmosphere.

## Support of the MERCURY and GEMINI Programs

During 1962, three MERCURY manned orbital flights were successfully achieved by NASA. To each of these, the Weather Bureau made a significant contribution by providing detailed and specialized meteorological support services.

To provide such services, the Bureau operated a MERCURY Support Group, headquartered at the National Meteorological Center, Suitland, Maryland, with field offices and activities at Cape Canaveral and Miami. Reflecting the transfer of NASA manned space flight functions to Houston, a Weather Bureau office was also established there in the latter half of the year.

The MERCURY Support Group provided forecasting information for the orbital flight paths, with particular emphasis upon the launch and landing areas and upon emergency-or-contingency-landing areas. Weather briefings were given to the astronauts and to MERCURY officials and a special weather map was prepared and delivered to the astronauts immediately prior to flight.

The MERCURY Support group, in addition, debriefed the astronauts in an attempt to uncover any new meteorological information that might have resulted from the flight. These Weather Bureau personnel, further, provided climatological background studies not only for MERCURY orbits but for potential landing areas for the upcoming GEMINI series of flights. They acted as advisors to MERCURY operational personnel on general meteorological subjects and made analytical comparisons of the cloud pictures obtained by the astronauts with those obtained by TIROS satellites.

One particularly significant MERCURY flight experiment was instigated by the Weather Bureau's interest in the effects of various type camera filters upon cloud photography from satellite altitudes. This took the form of a hand-held camera which viewed the earth's appearance through blue, green, neutral, yellow, red, and dark red areas of the spectrum. The results of this experiment are expected to have value in designing camera systems for future unmanned weather satellites.

Plans were under way at the end of the year to provide a course of instruction in meteorology to the newly-selected astronauts. This training was expected to begin at Houston in January 1963. In 1963, we expect, also, to see the increased use of the Support Group for forecasting the weather for unmanned NASA spacecraft launches as well as continuation of the manned flight services.

## Meteorological Rocket Network

Satellites have provided spectacular new coverage and increased understanding of the extent, nature, and movement of clouds and their associated weather systems. However, they have been unable, thus far, to provide anything but deduced or indirect information about the conditions within the cross-section of the atmosphere which lies beneath them.

Information on the structure, motions, and dynamics of the atmosphere is still very much needed and vertical probing devices still the primary means of obtaining it. To probe or sound the upper air in the zone above balloon heights and below satellite levels, the continued use of meteorological rockets is required.

In recognition of this, planning had begun in 1961 for the establishment of a National Meteorological Rocket Network (NMRN), for which overall management responsibility would be assigned to the Weather Bureau. In April 1962, an office was established within the Bureau's National Weather Satellite Center to be responsible for the funding data acquisition, communications, and information processing, analysis, and dissemination aspects of this operational network.

Plans were accordingly formulated during 1962 by the Weather Bureau to begin operational functioning of the network with two synoptic observations per week from each of the six stations (White Sands, Point Mugu, Wallops Island, Fort Greely, Churchill, and the Atlantic Missile Range). These firings would begin in Fiscal Year 1964. Their observations would be disseminated over domestic and international weather circuits. At White Sands, the data would be collected and archived.

Summarized, the Weather Bureau's fulfillment of its MRN responsibility in 1962 took the form of planning activity expected to result in an operational status in 1963.

### Potential Non-Meteorological By-Products

The year's activities saw the Weather Bureau through its National Weather Satellite Center carefully examine the potential useful by-products that might accompany meteorological spacecraft activity. These include ice reconnaissance and iceberg tracking; satellite collection of weather and oceanographic buoy information; forest fire detection; snow surveys; and locust cloud detection and tracking.

### Ice Reconnaissance

The narrow-angle (12.7°) camera of TIROS I and II had given evidence of its ability to provide very detailed and high-resolution pictures of ice in the St. Lawrence River. Pursuit of the possibility of applying such pictures to ice reconnaissance problems took place in February following the launching of TIROS IV. It consisted of a joint U.S.-Canadian effort involving the photographing of ice from aircraft to compare with similar photographs of the same regions by satellite. This joint exercise confirmed the potential of satellite pictures for this purpose. It was handicapped, however, by the fact that TIROS IV carried only wide-angle and medium-angle lenses and thus the detailed resolution was sacrificed to the obtaining of broader geographical coverage. In September 1962, the U.S. Naval Oceanographic Office affirmed its interest in seeing the ice reconnaissance potential of TIROS further investigated. This potential is of interest to all agencies, naval or civilian, concerned with the movement of forces or shipping through waters affected by ice and its drift.

### Iceberg Tracking

Related to ice reconnaissance is the possibility of using weather satellites to track icebergs. If the bergs are large enough, it is anticipated that they can be detected using the television camera techniques employed in TIROS and NIMBUS. If they are too small for optical resolution and identification, then the emplanting of small radio transponders on the bergs themselves is a possibility. Using this technique, the passing satellite would interrogate the berg which would reply. Several interrogations may enable a navigational "fix" to be obtained and the position of this menace to shipping determined. Discussions were held with the U.S. Coast Guard on this

matter during the year.

### Weather Data Collection

Also examined during 1962 was the possibility of using satellites as weather data collection vehicles. In many areas of the world supporting data sources are few or non-existent, particularly in remote oceanic regions. To provide conventional or non-satellite weather observations in these data-sparse regions, consideration is being given to the use of buoys which, instrumented for such observations, will automatically sense and record the weather conditions in their area. The information which they obtain would, according to this concept, be stored and radioed to passing satellites upon command. These spacecraft would, in turn, store the information and read it out together with the cloud pictures and infrared or other data which they were intended or instructed to collect.

Because these automatic weather buoys could make underwater observations as well, the data collected from them by satellites could be oceanographic in addition to meteorological. Thus, the practical value of such buoys would be enhanced and the cost of a buoy network even more justified.

### Forest Fire Detection

About mid-year, the Forest Service of the Department of Agriculture began discussions with NWSC to determine the feasibility of using the sensing capabilities of weather satellites to detect incipient or early-stage forest fires. The value of being able to find these fires by satellite would be particularly high in remote areas, notably Alaska, where forest fire spotters and other detection means are few in number. Owing to the smoke and clouds often associated with forest fires, conventional meteorological satellite sensors -- television cameras and infrared devices -- appear inadequate for the task. As a possible answer, NWSC began to investigate the technical feasibility of using microwave radiometers, passive devices which would detect the radiation emitted by a fire in the microwave (popularly called the radar) region. These might be carried as another type of weather satellite sensor, a possibility offered by the flexibility inherent in the large size and modular construction of the NIMBUS spacecraft.

### Snow Cover Surveys

Another by-product investigated involved the measurement of snow cover. TIROS photos have long demonstrated their ability to depict the extent of snow coverage. One mosaic, made from pictures taken by TIROS IV on April 11, 1962, showed in some detail the mantle of white stretching from Lake Superior westward across ice-covered Lake Winnipeg, the Rocky Mountains and the Cascade Range, to Puget Sound. If satellites could also develop an ability to measure snow depth and water content, as well as photograph the extent of coverage, this would prove of very great hydrological importance. It would enable the spring runoff perhaps to be more accurately predicted and play an important role in the conservation and optimum use of the Nation's water resources. In the western part of the United States, where there is extensive irrigation, these resources have been valued at \$10 to \$15 per acre-foot.

## Locust-Cloud Tracking

The considerations that (a) sixty nations annually spend \$15 million on the spotting and control of locusts, (b) these insects move and appear as a cloud, and (c) their migrations are difficult to track in areas where communications and observation facilities are poor, caused the Weather Bureau and NWSC to investigate the possibility of detecting and tracking them as an incidental function of weather satellites. Information was gathered and solicited from those areas of the earth where locust plagues are severe threats to the agriculture and economy. Such data were being studied at the year's end. If they show the adaptability of United States meteorological satellites for photographing such "clouds," experiments will be proposed. If successfully carried out, a new means of generating international good will and cooperation should result and America's overseas image accordingly strengthened.

## International Aspects

The global observing capability of meteorological satellites offer unique opportunities for international participation and cooperation. The Weather Bureau, in conjunction with the NASA and Department of State, has been active in several international programs resulting from the advent of U.S. meteorological satellites. The United States introduced a resolution in the United Nations calling for strengthening the peaceful uses of outer space on an international basis. Subsequently approved as UN Resolution 1721 (XVI), it calls for extensive international activity in meteorology with major emphasis on the use of meteorological satellites. The United States has been working closely with the World Meteorological Organization, a specialized agency of the UN, in developing plans for the implementation of this resolution. Since the United States is the first and still the only country operating meteorological satellites, the United States will continue to play an important role in these expanding international meteorological programs.

As indicated earlier in this report, the Weather Bureau is making available to other countries data from meteorological satellites for immediate operational use. This has been accomplished by establishing special radio facsimile circuits beamed abroad as well as placing satellite analyses on existing international meteorological telecommunications circuits. The Weather Bureau is working with the WMO and other countries to improve these communications. The data also are made available for research through the National Weather Records Center.

Technical material on the meteorological satellite program and future plans are provided to the World Meteorological Organization, COSPAR, and other international bodies to assist these agencies and their members in using the satellite data, conducting their own research programs, and planning for the use of future meteorological satellite data in their own program.

## NATIONAL BUREAU OF STANDARDS

The National Bureau of Standards (NBS) has three major responsibilities:

- a. to provide national leadership in the development and use of accurate and uniform techniques of physical measurement;
- b. to develop and apply measurement techniques for determining the intrinsic properties of matter and materials; and

- c. to operate central research and technical service programs for the Federal Government in specialized fields.

These first two responsibilities are fundamental to progress in all areas of science and technology. Because the national space effort is a type of program which is pushing the state-of-the-art in many fields, the Bureau's measurement and materials work contributes substantially to the space program. Of the central technical services provided by NBS as its third responsibility, those of the Cryogenic Engineering Laboratory and the Central Radio Propagation Laboratory are most directly applicable to space technology and operations.

### Standards and Techniques of Measurement

A typical space vehicle requires many parts whose electrical, mechanical, and chemical characteristics must be carefully controlled for successful operation. As more complex spacecraft and space systems are developed, the production tolerances for individual components are continually reduced. Thus progress in space technology increasingly depends upon an ability to make measurements with extremely high accuracy and reliability.

The Bureau is responsible for providing the standards and techniques required for hundreds of types and ranges of measurements and for assuring that these measurements are consistent with one another and with the physical constants of nature. During 1962, NBS measurement programs advanced on many fronts of importance to space scientists. Examples are given in the following two sections:

### Temperature and Distance Measurements

During the year, improved methods were developed for temperature measurements up to 36,000° F by spectroscopic means, and capabilities for measurement at the extremely low end of the temperature scale were extended through development of a new ultrasonic thermometer. Laser techniques, employed for extremely accurate measurements of distances up to a meter or more, indicated the feasibility of making measurements over a distance of 100 kilometers with a precision of a part per million. Plans were developed to use these techniques to redetermine the speed of light with an accuracy that will meet the anticipated requirements of space technology.

### Gear Measurements

Because modern technology imposes increasingly severe dimensional requirements on gear elements and gear teeth, the Bureau established a gear metrology laboratory -- believed to be the first of its kind in the country -- for measuring gear elements under closely controlled conditions and for the development of highly accurate master standards.

### Clock Synchronization

The U. S. Frequency Standard, which plays a vital part in synchronizing the clocks of satellite tracking stations, was improved to the point where its present accuracy is better than one second in 3000 years.



The Bureau also has worked in close cooperation with the newly-formed National Conference of Standards Laboratories. A meeting of this organization at the NBS Laboratories in Boulder, Colorado, during 1962 attracted 643 representatives of industry and government who were interested in exchanging information and seeking solutions to measurement problems facing standards laboratories. The aerospace industry was heavily represented.

### Properties of Matter and Materials

Programs of the Bureau in the area of materials research ranged from basic determination of fundamental constants to applied projects aimed at solving problems originating from the space effort.

### Heat Radiation

The design problems of space vehicles have brought about a greatly increased demand for data on the heat radiation properties of materials. Although many laboratories have been established to perform the required measurements, widely divergent values have been reported by different laboratories on supposedly identical materials. To help correct this discrepancy, the Bureau was requested by the Air Force to establish standard equipment and procedures for measurement of normal spectral emittance, to prepare and calibrate working standards of normal spectral emittance for use in verifying equipment and procedures used by aerospace contractors, and to provide technical information in this area to interested laboratories. Equipment has now been developed for direct measurement of normal thermal emittance, and working standards, representing low, intermediate, and high emittance, have been prepared and calibrated.

### Metal Fatigue

Fatigue failures in metal parts are progressive and occur in two phases: (1) crack initiation, extending from the start of the stress application to the appearance of the first crack, and (2) a period of crack propagation, which terminates with abrupt fracture of the piece. In a study sponsored by the National Aeronautics and Space Administration (NASA), it was found that the rate of fatigue crack propagation through a metal specimen is significantly reduced by the presence of an organic liquid on the test section. By limiting the access of molecules of oxygen or water to the metal surface, this coating reduces the rate of detrimental surface reactions that normally occur when specimens are stressed in air.

### Plasma Physics

The Bureau's program in astrophysics and plasma physics were intended to provide the measurement standards and basic atomic data needed to determine the fundamental properties of plasmas (extremely hot gases occurring in thermonuclear devices and space) and to solve important problems in astrophysics. The national space effort now provides much spectroscopic data on the sun and stars from equipment carried on rockets and satellites above the earth's atmosphere. The value of these data will be greatly enhanced if they can be accurately described in measurement units based on precise laboratory standards.

In April 1962, the National Bureau of Standards and the University of Colorado announced the collaborative establishment of the Joint Institute for Laboratory

Astrophysics (JILA) on the campus of the University at Boulder, Colorado. This unique organization will provide a center for both research and advanced training in areas of physics and astrophysics important to the space program. It will bring together scholars in many specialties for exchange of ideas and data. It will also train graduate and post doctoral students in atomic physics and astrophysics, fields in which there is an acute shortage of qualified workers. Through laboratory and theoretical studies, it will endeavor to provide better understanding of the basic physical phenomena and properties of gaseous matter, like the atmospheres of stars, such understanding being essential if astronomical and geophysical observations are to be correctly interpreted.

### Radio Propagation and Space Telecommunications

The NBS Central Radio Propagation Laboratory has the central responsibility within the Federal Government for collecting and disseminating information on radio wave propagation. Its technical program includes research on upper atmospheric and solar phenomena, studies of radio wave propagation, advance predictions of radio propagation, advance predictions of radio propagation conditions, and issuance of warnings of solar and ionospheric disturbances, all of which are important to space scientists.

An installation for ground-based explorations of the upper atmosphere and outer space was constructed by CRPL and the Institute Geofisico de Huancayo (Peru) at a site 17 miles east of Lima. Known as Jicamarca Observatory, this installation makes use of an NBS-developed scatter radar technique. It employs a 6,000,000-watt pulse-transmitter and a 22-acre antenna to transmit to great heights a very-high-frequency radio wave lasting from 50 to 1500 millionths of a second. The antenna is also used to detect the faint-re-radiation of the pulsed radio wave by free electrons in the upper atmosphere. With this equipment, electron densities 4300 miles above the earth have been measured. In addition, radar observations of the planet Venus recently made with this equipment indicate that the planet has an extremely smooth surface -- smoother even than the moon which is now considered to be much smoother than the earth. The large antenna also proved to be a very valuable tool for measurement of the synchrotron radiation emitted by the belt of man-made high-energy electrons created by the high-altitude nuclear explosion of July 9, 1962. The installation will also be used in limited observations of radar echoes from the sun's corona and from solar gas clouds emitted by solar disturbances in studies of small-scale irregularities in the earth's outer atmosphere and in studies of the D-region of the ionosphere, particularly its turbulence and meteorology.

### Lunar Surface Communication

When man lands on the moon, one of his first needs will be reliable means of communication between points on the lunar surface. Under the sponsorship of the Jet Propulsion Laboratory, an analysis was made by NBS of the factors affecting point-to-point radio communication on the moon. In order to specify suitable radio frequencies for use, assumptions were made regarding lunar conditions that affect propagation but are not yet precisely known. The data obtained were used to determine the power required for sample transmission distances and bandwidths.

## Frequency Studies

Artificial earth satellites have opened up new horizons in long-distance communication possibilities. Optimum frequencies for satellite communication purposes lie generally in the 1 to 10 Gc/s portion of the radio-frequency spectrum. This portion of the spectrum, however, is now used by many communication services, and satellite communication systems using these frequencies would be expected to share them. NBS studies indicate that frequency assignments can be shared, with adequate geographical separation of terminals and proper consideration to antenna directivity. Theoretical studies and a continuing experimental program using 60-foot parabolic antennas were conducted to determine the minimum separation distance and antenna elevation angles for the space communication system, to keep the unwanted signals at the receiver input terminals below the interfering level.

## Cosmic Ray Studies

Bureau studies also provided new information relating to cosmic rays, information which will have influence upon the assessment of the radiation hazards of manned space flight and upon the shielding that long-endurance spacecraft may require.

## Cryogenic Engineering

The Bureau's activities in cryogenic engineering continued to provide information needed for practical applications of materials, systems, and techniques at very low temperatures. Demand for assistance in projects involving cryogenics has increased greatly as a result of missile and space programs which rely on cryogenic liquids as propellants. Among the means used by the Bureau in providing such assistance was the national Cryogenic Data Center where information on cryogenic engineering is collected and organized for use by other Government agencies, industry, and the public.

Many advanced rocket concepts and designs utilize hydrogen as fuel or propellant fluid. Data on the thermodynamic and transport properties of hydrogen now need to be known with higher accuracy and over wider ranges of temperature and pressures than have been necessary before.

With the support of NASA and the U.S. Air Force, the Bureau has been engaged in an extensive program to determine these properties. In the past year, provisional tables and charts of the thermodynamic functions of parahydrogen were prepared and published. These were based on pressure-volume-temperature measurements recently made by the Bureau.

The most promising method for achieving the low pressures found in outer space and for obtaining the pumping speeds required for space simulation is cryopumping, the freezing and absorption of gases on cold surfaces. Investigations oriented towards the evaluation of cryopumps as vacuum pumps have been undertaken by the Bureau and pumping speeds and capture coefficients of readily definable cryopump configurations measured.

## COAST AND GEODETIC SURVEY

The Survey's 1962 contributions to space projects and programs have been principally that of a support nature.

## Missile Range Measurements

At the Atlantic Missile Range, several super-precise base lines were measured for the scaling of missile tracking instrumentation. One of these lines, measured with an instrument which uses the speed of light as a basic reference, has an accuracy of one part in three million. Similar work has been done for the Pacific Missile Range and for launching facilities at Vandenberg Air Force Base. Geodetic positions and azimuths were provided for many of the United States launching sites and for facilities of some NASA civilian contractors.

## Satellite Observations

During the year, the Survey continued the development of its capability in precise time-position observations of earth satellites, in scaling satellite positions as photographed against star backgrounds, and in the computations of time-correlated orbit positions. Such efforts have been carried out primarily with passive satellites of the ECHO 1 type, but the Survey is also participating in the active geodetic satellite project ANNA. Special satellite tracking systems, as developed by the Survey, are in operation at Aberdeen, Maryland and Oahu, Hawaii. These are obtaining excellent results of the ANNA IB geodetic satellite against star backgrounds.

## Magnetic Field Studies

The Survey's Magnetic Laboratory, located near Fredericksburg, Virginia, continued to contribute to the space programs of the United States in various ways. NASA and NASA contractors have made use of the unique facilities there for duplicating the magnetic field intensities encountered by satellites and space probes. The magnetic instruments for EXPLORER XIV, EGO (Eccentric Geophysical Observatory), IMP (Interplanetary Magnetic Probe), and POGO (Polar Orbiting Geophysical Observatory) were tested during their development phases. The Laboratory has been involved in the development of improved methods for telemetering magnetic data, for the testing of equipment under extreme conditions of high vacuum, low temperature, and low magnetic field intensities, and for recording micro pulsations for correlation with results recorded by space instrumentation. Some theoretical studies have also been made relative to the behavior of electric current patterns in and above the ionosphere, and of the mathematical analysis of the earth's magnetic field and its description at satellite altitudes.

## Chapter IX

# Space Science Board

### INTRODUCTION

The activities of the Space Science Board of the National Academy of Sciences during the year involved both domestic and international aspects. In the former area recommendations were made to the Government on the national space science program; internationally, the Board was concerned with the Committee on Space Research (COSPAR) in encouraging cooperation with scientists in other countries in space research.

### SPACE SCIENCE SUMMER STUDY

The Board's attention during much of 1962 was directed toward the planning and conduct of an 8-week Space Science Summer Study. The Study, which reviewed the accomplishments of the past five years in space science and defined the future objectives of the program, was held at the State University of Iowa.

The desirability of conducting a review of the nation's scientific accomplishments and future plans in space research was recognized by the National Aeronautics and Space Administration and the Space Science Board in late 1961 and plans to accomplish this study were immediately formulated. The results of the study are twofold: first, a report of some 550 pages has been provided to the Government and is available to the general public; second, a larger segment of the scientific world has acquired an increased appreciation for the Government's plans for the future conduct of space research. In addition, the Government's scientists had an opportunity to gain an understanding of the attitudes and thoughts of university and industry specialists in many fields.

The Summer Study report itself consists of 16 chapters, most of which represent the report of an individual working group. During the course of the study these groups considered individually the scientific components of the NASA space sciences program, that is, astronomy, fields and particles in space, lunar and planetary programs, atmospheres of the solar system, meteorological rockets and satellites, and the biological sciences. In addition, specialized working groups considered such topics as bistatic radar astronomy, space probe sterilization, NASA/university relationships, international cooperative programs, and the scientific role of man in space exploration.

### FIFTH MEETING OF COSPAR AND THIRD INTERNATIONAL SPACE SCIENCE SYMPOSIUM

The Space Science Board, acting on behalf of the National Academy of Sciences, was host to the Fifth Meeting of COSPAR and the Third International Space Science Symposium in Washington, D. C. from April 30 to May 9, 1962. Nearly 600 scientists from 30 countries attended. Some 140 scientific papers were presented by scientists from the following countries: Argentina, Belgium, Canada, Czechoslovakia, France, Germany, Greece, Japan, Netherlands, Poland, Sweden, United Kingdom,

U. S. S. R. , and the U. S. A. The United States scientific presentation, organized by the Space Science Board, included 73 scientific papers. The Symposium Proceedings will be published and, like the volumes from the two previous COSPAR symposia, will represent a major compendium of space science research. The Symposium was divided into the following seven sessions: Upper Atmosphere and Exosphere of the Earth and Relationship to Solar Disturbances, The Sun and the Interplanetary Medium, The Moon and the Planets, Galactic and Extra-Galactic Astronomy, Life Sciences, and Technologies of Space Research.

The topics covered by the scientific papers are a measure of the progress in obtaining, with conventional research tools as well as with rockets and satellites, new results concerning the upper atmosphere of the earth and the physical processes operating in interplanetary space. Few scientific results were reported from deep space missions and in the field of extraterrestrial biology. Little progress was reported in the problem of avoiding contamination of the planets, but prerequisite ground work for the solution of this problem was begun. Successful manned space flight, as reported both by the U. S. A. and the U. S. S. R. , represents a milestone in space research.

The working sessions of COSPAR, conducted by national delegates, scientific union representatives and the Committee's officers, resulted in a number of actions, including the following major decisions: (1) proposal of a series of internationally coordinated space experiments for the International Year of the Quiet Sun (IQSY) and the World Magnetic Survey (WMS), including plans for satellites, synoptic rocket launchings, and polar cap experiments; (2) establishment of various procedures for the extension and clarification of exchange of information about experiments conducted in space; and (3) establishment of a Consultative Group on Potentially Harmful Effects of Space Experiments.

#### International Year of the Quiet Sun (IQSY) and the World Magnetic Survey (WMS).

This major international cooperative scientific undertaking, planned for the calendar years 1964-1965, is being organized to take advantage of the period of minimum solar activity predicted for 1964. The program is in some ways a sequel to that of the IGY, particularly as it relates to a comparison of sun-connected geophysical phenomena at the times of maximum to those at minimum solar activity. During IQSY, however, advantage will be taken of new techniques and insights gained during and since the IGY to increase still further the study of that portion of the terrestrial environment sensitive to solar control. The scientific disciplines of IQSY include: meteorology of the upper atmosphere, aurora, airglow, ionospheric physics, cosmic rays, solar activity, aeronomy, and the interplanetary medium. In all of these disciplines, programs have been planned that include measurements made by means of rockets, satellites, and space probes; there is no IQSY rocket and satellite program as such.

Because of the crucial role that rocket and satellite technology will play in the special observations and experiments planned for IQSY, COSPAR has been cooperating closely with the international IQSY Committee. Detailed discussion of the IQSY and WMS programs were held at two COSPAR General Assemblies, as well as at ad hoc sessions convened during other scientific meetings.

Three COSPAR representatives are members of the international IQSY Committee. National counterparts to the international Committee have been established. In the

United States, the Academy's Geophysics Research Board established the IQSY Panel for preliminary planning, and recently reconstituted the Panel into the U.S. Committee for IQSY. This Committee has maintained close and effective liaison with the Space Science Board, through joint membership, and through close staff coordination. The Board has considered some problems germane to the IQSY program, including the continuous monitoring of solar ultraviolet and X radiation, small satellites for specialized experiments, meteorological rocket network activities, the need for an aeronomy rocket for the altitude range 100-200 km, the importance of satellite magnetic measurements as contributions to both WMS and IQSY, and specific rocket programs that might be carried out on a coordinated basis at many locations around the world.

Under the COSPAR Working Group on IQSY, the possibility of stimulating coordinated rocket programs as direct contributions to IQSY is being investigated. These programs include meteorological rockets, determination of molecular oxygen concentration in the ionosphere, ionospheric electron density, upper-atmosphere winds using sodium ejection techniques, and upper-atmosphere winds and temperatures using grenades.

#### International Exchange of Rocket and Satellite Data.

At its Fifth Meeting, COSPAR formally adopted a new guide to the presentation and international exchange of rocket and satellite information. This guide, resulting from some two years of effort by the international scientific community, is a revision of the IGY Guide to Rocket and Satellite Data Centers prepared to take into account the changed requirements for dissemination of data that have occurred since the IGY-IGC period and to extend and clarify data-interchange agreements in the light of the experience of the first years of space research activities. It sets forth in detail procedures for announcements of rocket and satellite launchings, designation of satellites and space probes, distribution of acquisition and tracking data, exchange of scientific results, and presentation of reports and bibliographies of national space programs.

Publication of COSPAR's comprehensive worldwide list of optical tracking stations was announced and preparations were advanced for completion of a similar worldwide list of radio tracking stations. A new unified system of synoptic codes for the rapid worldwide transmission of satellite information was also issued at this meeting. A change was adopted in the scheme for scientific designation of satellites. A scheme based on the Greek alphabet was becoming too cumbersome in view of the large number of launchings each year, and a new scheme based on sequential numbering was adopted. It will go into effect on 1 January 1963.

#### Potentially Harmful Effects of Space Experiments.

In response to a request from its parent body, the International Council of Scientific Unions (ICSU), COSPAR established a Consultative Group on Potentially Harmful Effects of Space Experiments. This group will consist of six high-level scientists of broad competence including experts in astronomy, radiation physics, atmospheric physics and chemistry, communications, meteorite penetration, and microbiology. This international group will act as a focal point for developing quantitative scientific studies on potential problems which are raised by space experiments that may adversely affect research activity.

Domestically, the Space Science Board's ad hoc group on Project WEST FORD continued to represent the views of the scientific community and to ensure the availability of information on this project. In 1962, using the WEST FORD group as a nucleus, the Board decided to establish a committee of specialists to be responsive to the requirements of the COSPAR consultative group.

#### Symposia on Meteorology and Geodesy.

Two additional symposia were held in the week previous to the COSPAR meeting. The International Symposium on Rocket and Satellite Meteorology was a joint venture of the World Meteorological Organization (WMO), the International Union of Geodesy and Geophysics (IUGG), and COSPAR, and included 36 papers by scientists from Australia, Canada, France, German Federal Republic, Italy, Japan, The Netherlands, United Kingdom, United States and the Soviet Union.

The International Symposium on Use of Artificial Satellites for Geodesy was organized jointly by the International Association of Geodesy of the IUGG and COSPAR. A total of 47 scientific papers were presented by scientists from Czechoslovakia, France, Germany, Greece, The Netherlands, Poland, the United Kingdom, United States and the Soviet Union.

#### The U. S. National Report to COSPAR.

A comprehensive report on the U. S. space science program for the period March 1961 to March 1962 was prepared by the Space Science Board and was submitted to COSPAR. It included reports on the scientific programs and accomplishments of NASA, the Department of Defense, other U. S. government agencies, universities, research institutions of all types and U. S. industrial corporations. It also included a bibliography of the scientific literature related to space research.

### STUDIES RELATING TO MAN IN SPACE

In support of the U.S. man in space program, the Board established a number of working groups to study specific considerations of man's advance into space. These groups are considering radiation hazards, gaseous environment inside spacecraft, nutrition and feeding, weightlessness, temperature and acceleration.

### BIOLOGICAL RESEARCH

The scientist is interested in exploiting the space environment for the advancement of understanding fundamental biological processes. With this objective in mind, panels of specialists have been convened to consider the effects of diminished gravity, radiation effects, the effects of magnetic and electrical fields, the effects of the absence of the terrestrial environment on circadian rhythms, and the fundamental problems associated with closed ecological systems. Of these the panel on biological rhythms, the panel on magnetic and electric fields and the panel on radiation biology have all completed their studies.

### HIGH-ALTITUDE ROCKET AND BALLOON RESEARCH

A standing group of the Board, augmented early in the year to provide competence in the use of high-altitude balloons for the study of the earth's atmosphere, continued to be active during 1962. The group has given consideration to: the continuing need



for synoptic meteorological rocket observations and, in particular, support for an economical system of greater range not dependent on large radar installations; a COSPAR proposal for a series of simultaneous rocket measurements of winds in the ionosphere (to 200 km), which provides an ideal program for international cooperation; and the meteorological rocket network: distribution of stations, exchange of data and participation in IQSY -- the present network received a strong endorsement. In addition, the group secured the comment of a representative segment of the research community on proposed amendments to the Federal Aviation Agency regulations on rocket firings and balloon flights.

#### ALLOCATION OF RADIO FREQUENCIES FOR SCIENTIFIC RESEARCH

The National Academy of Sciences Committee on Radio Frequency Requirements for Scientific Research (formerly Radio Frequency Allocations for Scientific Research) has continued to assist the Space Science Board and the scientific community in their efforts to secure protected radio frequencies, especially in space research and radio astronomy. It has determined the consensus of interested segments of the scientific community, and has conveyed their findings to appropriate agencies of the U. S. Government for their use in drafting the U. S. position to be advanced at forthcoming international conferences. The Committee maintains a registry of U. S. radio astronomers and observatories to facilitate the coordination of their efforts, and undertakes to keep them informed concerning developments affecting their interests.

#### BOARD ORGANIZATION

In the fall, using the results of the Summer Study as the basis, the Board began a reorientation. The Board plans to operate in the future through a minimum number of standing committees augmented as necessary by small, highly specialized ad hoc groups. It is expected that this will increase the flexibility of the Board to react promptly to its changing responsibilities and to reduce the demands which committee service makes on scientists' time. In addition to major events of the year, the COSPAR sessions and symposium and the Summer Study, the Board, its committees, and working groups convened 33 meetings during 1962.

# Chapter X

## Smithsonian Astrophysical Observatory

### INTRODUCTION

The Smithsonian Institution Astrophysical Observatory, independently and under contracts and grants from other government agencies, is pursuing a broad program of fundamental scientific research in solar and stellar astrophysics and meteorites that is relevant, though not necessarily restricted, to immediate experimental space technology and navigation. Under grants by the National Aeronautics and Space Administration, the Observatory is engaged in four major projects: optical satellite tracking, the design and operation of two orbiting observatory experiments within the framework of NASA's Orbiting Observatory program, and the establishment and operation of a photographic meteorite recovery network of 16 stations.

Many distinguished scientists from all parts of the world visited the Observatory to work on important space problems. The data made available to them as a result of our satellite-tracking activities has resulted in the preparation of important scientific papers.

The number of scientific reports and papers materially increased during the year. The Observatory's Special Reports, Research in Space Science, now number more than 110, and staff scientists contributed more than 150 articles to leading scientific journals.

### OPTICAL SATELLITE TRACKING PROGRAM

The Satellite Tracking Program provides significant data on optical behavior atmospheric densities, and on geophysical and geodetical problems. It embraces 12 Precision Photographic Stations situated in Argentina, Peru, Curacao (NWI), Australia, Hawaii, India, Japan, Iran, South Africa, Spain, and the United States; and 94 volunteer Moonwatch teams, 49 in 18 foreign countries, and 45 in the United States. These photographic stations, equipped with Baker-Nunn cameras expressly developed for the purpose, provide the best optical means to date of observing and determining satellite positions. During the year new timing devices have been tested to achieve even greater accuracy, reliability, and ease of maintenance. To date, approximately 54,000 satellite passages have been photographed by the camera stations. Moonwatch observations this year have numbered approximately 8,000 passages of satellites and their orbiting components; those from October 1957 to the present have reached a total of nearly 48,000. The observations have resulted in data for correcting satellite predictions and for acquiring and re-acquiring nonbroadcasting satellites. An achievement to which a Wisconsin Moonwatch team contributed to an important degree, was the recovery in September 1962 of fragments of the Russian Sputnik IV.

Within the observatory establishment, staff scientists supervise and operate divisions of Research and Analysis, Computation, Photoreduction, Communication, and Publications. On the basis of information from the various tracking activities,

the Research and Analysis Division has derived a number of valuable conclusions on such problems as variations of atmospheric density as affected by solar activity, ultraviolet and corpuscular radiation, the earth's gravitational potential field, the effects of light pressure on satellites, and atmospheric drag, the data on which are now employed by nearly all other investigators of atmospheric problems. Refinements in station coordinates by means of a program of simultaneous satellite observations, for which Baker-Nunn installations are now well fitted, and a satisfactory prediction program have been achieved. Further geodetic applications of satellite observations are under study, particularly the possible adaptability of aerial reconnaissance cameras, used both independently and in conjunction with the fixed Baker-Nunn stations.

The Observatory also cooperated with the Department of Defense and NASA in setting up the international arrangements for the flashing-light geodetic satellite, Project ANNA. Eighteen series of flashes were photographed by the Baker-Nunn photographic tracking stations during the month of November, including the first operational flash over the United States. Simultaneous observations of flashes were made by the stations at Florida and New Mexico. This method will be used to determine distances between land masses.

#### ORBITING ASTRONOMICAL OBSERVATORY

Project CELESCOPE, its name derived from its pioneering use of a genuinely celestial telescope, is being developed as part of NASA's Orbiting Astronomical Observatory Program. When completed it will place in orbit four telescopes to extend stellar observations into the far ultraviolet regions of the spectrum. Its primary aim is to map and record the brightness of at least 50,000 stars and to prepare the path for further studies of objects and areas disclosed during the surveys. In 1962, under one subcontract, ultraviolet-sensitive television camera tubes have been successfully produced, and under a second subcontract the design has been completed for incorporating the tubes into the orbiting astronomical observatory's system. Completion of the prototype Telescope experiment based on this design is near. The satellite should be in orbit in 1964.

#### ORBITING SOLAR OBSERVATORY

The second Orbiting Observatory on which the Smithsonian has undertaken experiments in the NASA program, in cooperation with Harvard College Observatory, involves the design and construction of ultraviolet scanning spectrometers for solar studies. The instruments are now undergoing tests. Rocket flights are scheduled for 1963, to be followed thereafter by actual incorporation of the spectrometers aboard the S-17 satellite. Laboratory research on the vacuum ultraviolet radiation of atoms and molecules of astrophysical importance is also being pursued.

Preliminary reduction of data from the first Orbiting Solar Observatory is being done at the Observatory in order to provide a first view of solar flares in the high-energy gamma-ray region of the spectrum. In attempts to view solar flares in this energy region, no significant radiation was detected.

#### METEORITICAL STUDIES

An important development in the meteoritic program is the establishment, with

NASA support, of a new network of 16 camera stations in the Midwest, to trace and recover as quickly as possible freshly fallen meteorites for data on the intensity of cosmic rays near the earth and throughout the orbits of the meteorites. The cameras have been field tested and the first photographing station should be operating in January 1963, and the entire program by the summer of 1963.

With the Harvard College Observatory, the Smithsonian Astrophysical Observatory has undertaken the study of very small meteors through a Radio-Meteor Project. Utilizing radar techniques, this program records information concerning the speed and trajectory of the particles; ion distribution; the physics of meteor processes; and solar system dust. Radar also provides information of meteor distribution. The transmitter and receiver for this project cover a 35-mile area near Havana, Illinois.

The Observatory is continuing to develop its unique facilities for measuring radioactivity in meteorites and satellites that have returned to earth. In addition to the equipment used to measure radioactive isotopes of hydrogen and argon through destructive tests, a gamma-ray spectrometer has been constructed to make non-destructive measurements of certain isotopes. This equipment is used to determine the age of meteorites and their place of origin, and to furnish information on cosmic-ray distribution in the solar system. It is also the most definite test to determine if an object like the fragment of Sputnik IV found in Wisconsin was in space.

Among the other problems under investigation by this division of the Observatory are: the chemical and mineralogical analysis of other meteorites for information on their age, early history, and geochemical environment at time of formation; further delineations and effects of the Van Allen belts; design and construction of instruments (e. g. a high sensitivity mass spectrometer for analysis of noble gases and irons, and an electron microbe analyzer for meteorites); the chemical composition of chondrules for light on the birth and history of the planets; computation programs for testing current perturbation theories on the motion of comets; the dynamical history of meteor streams, of importance for further knowledge of interplanetary space; space and velocity distribution of interplanetary dust particles and the rate of accretion of meteoritic matter by the earth, especially that in the form of particles collected at very high altitudes; and the erosion and puncturing of bodies in free space, of significance for knowledge of the interplanetary medium and space engineering problems.

### BASIC SPACE STUDIES

In addition to problems associated with the orbiting observatories, the Observatory is concentrating on the stabilization of satellites and exploration of a possible high-sensitivity device for detecting displacement, the achievement of which would significantly affect techniques of space navigation and communication; the theoretical possibility of interchange of earth-moon orbits and moon-earth orbits of satellites; lunar orbital eccentricities, lunar dust particles; effects of the ionosphere, Van Allen belts, and the earth's magnetic field on radio-astronomical observations in MF and HF bands; the construction of a precise theory of critical inclination of satellite motion; study of the dynamics and structure of the upper atmosphere from observations of artificial satellites for, among other purposes, short and long range weather forecasting; exploration of possible use of radiation pressure on balloon satellites to achieve orbits around the moon; and the construction of computer programs for this

and other major orbital problems. Related research includes problems of gas dynamics stellar atmospheres and pulsation, lunar surfaces, solar granulation, molecular composition of interstellar space, possible optical cosmic-ray detection, and cosmology.

# Chapter XI

## Federal Aviation Agency

### INTRODUCTION

The Federal Aviation Agency moved ahead in 1962 with major programs designed to modernize the air traffic control system and to contribute to the development of future aircraft. At the same time, improvements were made in the nation's present aviation system to assure safe air operations and to provide services and facilities capable of meeting the increasing demands of the U.S. civil air fleet. The Agency was reorganized and brought in new management talent to provide more efficiently for both the present and the future.

During 1961, new directions were charted for many FAA policies and programs. These new goals were recommended by a series of Presidential and Agency task forces which reviewed FAA's operations and its plans for the future. In 1962, work was well under way to meet the new goals.

### RESEARCH AND DEVELOPMENT

A modernization plan for the nation's air traffic control system was developed by the FAA's System Design Team during 1962, and work is now proceeding on an experimental prototype of the future system. The plan was based on the general recommendations of the Project BEACON task force, which was established by the President to review the nation's air traffic control and navigation system.

When the Project BEACON group reported late in 1961, the President directed the Administrator to develop a modern system, based on the BEACON principles, to serve U.S. civil and military aircraft. A System Design Team, composed of 13 top FAA technical experts in the fields concerned, was organized to draw up an implementation plan for a National Airspace Utilization System which could meet aviation's needs through 1975.

The System Design Team plan calls for increased segregation of Visual Flight Rules (VFR) and Instrument Flight Rules (IFR) traffic along densely traveled airways and in terminal areas. It would rely increasingly on radar for controlling and separating traffic and would depend more and more on the Air Traffic Control Radar Beacon System rather than primary radar. These beacons provide identification now, and models under development also will give altitude information.

The plan also involves expansion of the geographical areas in which all aircraft will be under positive control, and it calls for segregating landing aircraft by speed category through use of terminal area corridors as a means of eliminating delays and making such operations safer.

The Air Traffic Controller would remain the key link in the National Airspace Utilization System, but the plan calls for provision of better aids to help him do his job. This includes extensive improvement of information processing and display techniques and increased use of computers.

An evolutionary modernization of the system is envisioned in the plan. Use will be made of existing and presently planned equipment, and continuing efforts will be made to improve the current system while the BEACON modernization plan is being tested and implemented. In addition, the System Design Team will update and modify its plan periodically to take advantage of technological advances.

With completion of the first edition of the System Design Team plan, FAA moved forward with development, procurement and installation at the Agency's National Aviation Facilities Experimental Center, Atlantic City, N. J. , of model and test equipment for the National Airspace Utilization System. The first generation of equipment new or improved in line with the plan is to be tested and proven by January 1, 1964. This and successively developed equipment will be phased into the current system on a progressive schedule.

The FAA also devoted major efforts to aircraft research during 1962. The supersonic transport research program moved into the contract stage as the Administrator and his advisors prepared to make a recommendation to the President on the technical and economic feasibility and advisability of launching a national development effort.

The FAA is engaged in an intensive supersonic transport aircraft research program in conjunction with the Department of Defense and the National Aeronautics and Space Administration. FAA provides program leadership and fiscal support. Defense is charged with administrative and technical support of the program, NASA with basic research and technical support.

Congress appropriated \$11 million to FAA for the program in fiscal 1962 and \$20 million for fiscal 1963. Under contracts let from these funds, industrial concerns and research organizations have conducted and are conducting technical research in the fields of aerodynamics, propulsion, structures, materials, and operating problems. Under concurrent study, have been broad economic and market analyses to determine initial, maintenance and operating costs for a commercial supersonic transport and the international demand for such an airplane.

A vital part of this research program has been joint FAA-NASA-Defense work in the field of noise and sonic boom. A supersonic airliner, it is felt, would have to provide minimal problems in these areas to be practical in operation. Factors involved in minimizing these problems would be design of airframe and power plant, and careful programming of aircraft operations.

In the future, helicopters and other vertical and short takeoff and landing (V/STOL) aircraft may provide increasingly economical, efficient shorthaul and inter-city operations. FAA is working with the military services to assure that aircraft in these categories being developed by the services are able to meet criteria for civil operation as well as military requirements wherever possible. Excellent cooperation is being received from the Army, Navy and Air Force in this area. Cooperative efforts are being pursued in fourteen rotary and other V/STOL aircraft projects. In four cases, FAA personnel are performing the evaluation engineering function for the military.

During 1962, the FAA began type certification tests on three different helicopters competing for a contract under the Army's light observation helicopter program.

Although tailored to military requirements, the program may fulfill one of civil aviation's needs -- a relatively low-cost, low-maintenance, high-performance helicopter which would reduce airport congestion and provide transportation for residential and business districts. Under the program the helicopters must be approved by the FAA for civil use to qualify for acceptance by the Army.

A significant helicopter flight test program in late 1962 examined helicopter performance in normal and emergency landing situations at various airfield elevations. Evaluation of data gathered will help engineers in the design of safer-landing helicopters and provide FAA with further guidelines for certification of helicopters.

Work also is under way to establish helicopter requirements for facilities to meet navigation, communication, air traffic control, and terminal operations needs.

In another area, FAA is participating in the Air Force's C-141 jet cargo transport development program to insure civil certification. The Air Force plane is scheduled for its first flight late in 1963. FAA has participated in the C-141 program from its inception in 1959 to see that it is compatible to the fullest extent possible with civil needs so that a new, efficient jet cargo transport can be available to the airlines at an early date. The civil version of the plane will be designated the Model 300.

Project LITTLE GUY was established in 1962 as an active program aimed at developing a simplified, more efficient cockpit layout for the lightplane aviator. The purpose is to make flying easier and safer for such flyers and greatly enhance the utility of this type of airplane for the general public. Under study in the program are flight controls to make cockpit operations easier and simpler, pictorial displays to provide navigational and other information in more easily read and easily usable form, and communications and other electronics equipment compatible with the needs of both general aviation and general aviation pilot.

First mockup of a simplified Project LITTLE GUY cockpit will be completed by the end of 1962. Equipment developed in the program will be made available to the aviation industry for future aircraft. Project objective is to have prototype equipment available for demonstration purposes after two years of effort.

Extensive consultations and studies have been conducted in cooperation with airlines and aviation manufacturers to establish preliminary design requirements for a short-to-medium range passenger and cargo airplane suitable for operation by "feeder" airlines. Such an airplane might also suit a military mission requirement; the armed forces have, therefore, taken part in this work. This effort has been termed the "DC-3 replacement program" in view of the fact that in its capabilities the plane would be a modern successor to the aging, multi-purpose DC-3 aircraft.

The reaction of turboprop engines to bird and radar chaff ingestion and of turbojet engines to runway marker ingestion was experimentally determined in wind tunnel tests in the first phase of a continuing program. Further work will include evaluation of bird ingestion effects on turbojet engines and development and evaluation of protective devices to minimize ingestion hazards to jet aircraft.

A major effort has been underway to develop operationally and economically feasible methods to combat bombing and other sabotage of airliners. A wide variety of scientific approaches are being explored with the cooperation of governmental agen-



cies directly concerned with the multiple aspects of such crimes.

Research continued with runway arresting gear, and a series of successful tests was concluded in November. In these tests, experimental arresting equipment halted a Convair 340 and a Boeing 720 jet airliner 45 times. After evaluating test data, researchers will report in April, 1963. Further determination of the course of the program awaits this evaluation.

Tests also continued with automatic landing systems which would permit aircraft to land in zero visibility conditions. Five systems are under study and evaluation.

Extensive research and development work in the field of lighting produced new technical standards for runway centerline and touchdown zone lighting. FAA specified a new configuration which is designed to provide an extra margin of safety during low visibility landings and takeoffs by giving pilots a better attitude reference and by eliminating the so-called black hole encountered when a pilot shifts from instruments to visual reference in the final landing phase.

The degrading effect of runway slush and standing water on jet transport takeoff and landing performance was determined in an extensive series of tests in which a large volume of artificial slush was created on test center runways. Important conclusions for aircraft operating under these conditions were reached.

Other important safety programs concern post-crash fire prevention, aircraft structural crashworthiness, and seat belt evaluation under varying conditions of age and environment.

Civil aviation human factors research took a major step forward during the year with the opening of the FAA's Civil Aeromedical Research Institute in Oklahoma City, Oklahoma. It is the only major civil Aviation Medical Research facility in the country, and it will contribute to greater flight safety through studies of man's relationship to aircraft and to the ground systems which serve them. Research results will be used to establish medical certification standards for airmen and in management of the air traffic control system.

In a related program, research continued during the year on man's aging process and its effect on his performance. This work is aimed at developing specific criteria that would be useful in judging the proper retirement age for a pilot based on his individual aging rate. This would replace the present blanket retirement age for all pilots.

#### AIR TRAFFIC CONTROL OPERATIONS

While provisions are being made for the future National Airspace Utilization System, improvements were made in the present system from which it will evolve.

The Agency program to consolidate control centers and realign center area boundaries gained momentum during the year with the completion of a long range area boundary study and the announcement of a reduction of the Agency's 29 control centers within the 48 contiguous states to 21. Purpose of the new center area configuration is to provide more efficient utilization of airspace, facilities, personnel and equipment. Technical and operational services will be improved, and more than

\$100 million will be saved over a 16-year period.

The high altitude area positive control program, in operation since October 1960 in the Chicago-Indianapolis control areas, was expanded vertically, from its original limits of 24,000 to 35,000 feet, to a new ceiling of 60,000 feet. In addition, the lateral dimensions were doubled in size eastward to include the long range radar coverage of the Detroit and Cleveland Centers. Area positive control service, which is limited to specially-equipped aircraft flying under instrument flight rules (IFR) regardless of actual weather conditions, is now available over an approximate 220,000 square-mile airspace area over much of the central and northeastern sections of the nation where some of the heaviest air traffic activities exist. Expansion plans covering the rest of the nation are being implemented as rapidly as the additional necessary radar and other equipment become available. Orders have been placed with manufacturers for all required electronics equipment. Target date for nation-wide coverage has been set for September 1963.

In November, the Agency put into force a program of expanded radar services in the Atlanta, Georgia terminal area to attack the problems of maintaining safe separation between controlled and uncontrolled aircraft and of providing expeditious service to all aircraft operating in high density terminals. Pilot participation in the program is voluntary. The operational experience gained will serve as the basis for the national plan to bring the service to other selected high activity terminals.

A plan is being developed by FAA and Defense to utilize the facilities of the SAGE Direction Centers at Great Falls, Montana, and Minot and Grand Forks, North Dakota, for air traffic control as well as air defense. After necessary modification of certain SAGE equipment has been completed, it is expected that the program will get under way by late Fall, 1963. The use of the SAGE Facilities will provide FAA a radar capability for covering the "Northern Tier" section of the nation, filling a gap in FAA radar coverage. It will also accelerate implementation of the high altitude area positive control program nationally.

During the year, FAA was designated as the single, central source for the collection, validation, and dissemination of aeronautical data. The new Flight Information Program will assure availability of current aeronautical information in usable, standardized form for all pilots using the air traffic control system and its services.

The FAA increased its efforts during the year to alleviate community aircraft noise problems. Air traffic control procedures have been issued for specific airports where problems are particularly acute. These concern traffic patterns, approach and take-off techniques, use of preferential runways and other procedures that would remove aircraft operations from the most congested areas, while at the same time consider safety requirements for the aircraft. The Agency also is working to encourage the development of safe and suitable engine noise suppression devices. And coupled with other programs, the Agency is working with other Federal agencies and with local airport authorities toward the development of a "land use compatibility" philosophy in airport vicinities.

During the year, the Agency continued to evaluate use being made of restricted areas by military and other national defense organizations for the purpose of expanding use of the navigable airspace for all pilots. Since the FAA assumed responsibility for airspace utilization and allocation in May 1959, almost 47,000 square miles of air -

space have been returned to the public domain, leaving approximately 97,000 square miles of airspace for restricted use. This contrasts with almost 144,000 square miles of restricted areas in effect May 1959.

To help create a more efficient environment for controllers, the Agency contracted with an architectural firm to design a standard, free-standing control tower. This design, accepted in November, will be used for all future airport control towers built with FAA funds. It offers a highly efficient interior layout, a distinctive design, and the flexibility of being built at the site where visibility is best in any airport design.

The FAA continued its regulatory efforts to assure that the nation's airmen and aircraft are properly qualified to fly safely, that regulations are fair and adequate, and that the rules are obeyed.

A concerted effort was made by the FAA and other government agencies in 1962 to improve the safety record of the supplemental airlines and to assure that they operate under the highest safety standards. FAA inspection teams conducted comprehensive evaluations of airlines with marginal safety records. Fourteen such inspections have been completed since 1961.

FAA also proposed a major overhaul of the regulations governing supplemental carriers to bring them closer in line with those for the scheduled airlines. In addition, a new rule was issued requiring aircraft operated by the supplementals to undergo a proving period before being placed in service. This rule previously applied only to scheduled carriers.

Other steps included the assignment of approximately 25 percent of the FAA's airline safety inspectors to check supplemental carriers and the establishment of "system worthiness inspection" procedures setting down comprehensive guides for original and periodic inspections.

Agreement was reached with Defense in August to transfer responsibility to FAA for flight checking the Air Force's worldwide system of air navigation aids. The agreement represents a major step toward creation of a common civil-military airspace utilization system and will foster greater economy and efficiency in flight checking United States-owned air navigation aids by entrusting this job to a single agency. The FAA already checks all civil, Army and Navy navigation aids.

In a move designed to permit airlines to improve schedule reliability, the FAA authorized new, lower ceiling and visibility landing minimums for jets at a limited number of airports meeting special requirements. Airlines may land their jets at these fields when the ceiling is as low as 200 feet and visibility is as low as a half mile if the planes are equipped with certain electronic systems and the pilots have demonstrated their ability in such a situation to an FAA inspector. Equipment required is a flight director system or an automatic approach coupling plus an improved instrument failure warning system. The 200 foot-half mile minimums have been standard for propeller aircraft, but higher minimums were set for jets to provide an extra margin of safety in their initial operating period.

Trans-Atlantic air navigation took a step forward in 1962 when the FAA approved airline use of Doppler navigation systems in conjunction with other aids, thus elim-

inating the requirement for a navigator in the crew. The first commercial flight using the system was made in October. The new system is based on Doppler radar, which uses the frequency shift in reflected radar signals to continually plot a position over land or water.

Data from flights using the Doppler system has contributed to Project ACCORDION, an FAA evaluation program aimed at the reduction of minimum separation standards for North Atlantic navigation. Planes must now be separated by 30 minutes laterally or 2,000 feet of altitude. In another project, the Agency collected and correlated monthly flight plan information on North Atlantic operations to provide data for simulation of air traffic control problems in the area.

Information from both projects contributed to a broader FAA study of North Atlantic control, navigation and communications problems. This study is concerned with long term goals and will be a basis for participation in International Civil Aviation Organization efforts to modernize the whole North Atlantic system.

The Flight Safety Foundation completed a year of collecting and evaluating near mid-air collision reports and delivered its final report to the FAA. This program, called Project SCAN, was instituted as an independent check on problems in this area. Working under FAA contract, the Flight Safety Foundation acted as an independent agent to which pilots could report, anonymously if they preferred, without fear of enforcement action.

The pattern of incident in the Project SCAN report confirmed findings on the near mid-air collision problem from FAA's own reporting system, although the number of incidents reported under Project SCAN was greater. The data was not directly comparable. Each incident reported to the FAA was thoroughly investigated and penalties leveled as appropriate, while the SCAN reports could not, by their nature be checked. Major FAA programs, including the System Design Team approach to air traffic control modernization, address themselves to the near mid-air collision problem.

The FAA's rules recodification program -- initiated in 1961 to simplify, reduce and consolidate the Agency's safety regulations into a single code called the Federal Aviation Regulations -- moved ahead on schedule in 1962 with six of ten subchapters recodified. Target for completion is August 1963.

In a parallel action, the FAA established a Regulatory Council of top officials, chaired by the Administrator, to serve as a central forum for the FAA rule-making process. Established, as well, was a formal hearing officer procedure for enforcement cases involving suspension or revocation of a certificate.

### AIRPORTS

The FAA allocated \$145 million in grants under the Federal Aid to Airports Program, \$70 million for Fiscal 1962 announced in January and \$75 million for Fiscal 1963 announced in July. This money matches local funds generally on a 50/50 basis and helps local communities improve existing airports and develop new airfields. Recent emphasis in the program has been on development of general aviation airports, especially in metropolitan areas where they could relieve congestion at major terminal airports. General aviation is all aviation other than commercial and military.

A project was also launched to revise airport criteria to make them more flexible and permit smaller communities to tailor an airport more closely to their needs.

Dulles International Airport at Chantilly, Virginia, 27.5 miles from downtown Washington, was opened for business in November to serve as the jet gateway to the Nation's Capital. It is the first airport in the world specifically designed for jet airliners. Among new concepts incorporated is the mobile lounge, which carries passengers between terminal and airplane, thus eliminating long walks and exposure to bad weather and ramp hazards.

Reorganization of the Agency was completed in 1962. Policy and program direction is handled at the Washington headquarters level, with responsibility for operations decentralized to the regional offices.

## Chapter XII

# Federal Communications Commission

### INTRODUCTION

The Commission's responsibilities and interest in the general field of telecommunication extend to the radio communication aspects of space satellite technology. It has a direct interest in many space programs, especially communications satellite programs (which are anticipated to be of future importance in greatly increasing the relatively limited capacity of present long distance terrestrial facilities and in enabling new services, such as simultaneous television, to be offered) and other programs which may eventually be developed for public use, such as radio-navigation via satellites.

The Commission's concern with these matters grows out of its statutory duty to "study new uses for radio, provide for the experimental uses of frequencies, and generally encourage the larger and more effective use of radio in the public interest" as well as to "make available, so far as possible, to all the people of the United States a rapid, efficient, nationwide, and world-wide wire and radio communication service."

In collaboration with representatives of industry and other government agencies, the Commission has contributed significantly to the work of Study Group IV of the International Radio Consultative Committee (CCIR) preparatory to the Xth Plenary Assembly of the CCIR, scheduled to convene in New Delhi, January 15, 1963. Study Group IV of the CCIR is responsible for the "study of technical questions regarding systems of telecommunication with and between locations in space."

Considerable progress has been made by the nation during the past year toward achieving a communication satellite system. The Commission has continued to cooperate with the National Aeronautics and Space Administration in its research and development programs in the field of communications satellites and in addition has issued experimental authorizations to private entities for work in this field.

The Commission's 1961 inquiry into the administrative and regulatory problems involved in the licensing of a commercial communications satellite system (docket 14024), was held in abeyance when it was made clear that the Executive Branch planned to submit proposed legislation to the Congress. The Commission participated in the drafting of such legislation. During Congressional deliberations, which resulted in the Communications Satellite Act of 1962, the Commission testified as to its views a number of times before the various Congressional committees concerned with the matter, and its staff cooperated closely with the staffs of the several Congressional committees in providing technical advice and assistance.

The Commission has been given substantial responsibilities under the recently enacted Communications Satellite Act of 1962 with respect to the establishment and regulation of a global communications system, and is presently engaged in carrying out these responsibilities. It also has been playing a major role in the

preparation of United States proposals for an Extraordinary Administrative Radio Conference to be held by the International Telecommunication Union at Geneva during 1963 for the allocation of radio frequencies for space communications. In addition, the Commission has been cooperating with other agencies on related matters of mutual concern in the field of space satellite telecommunications and technology.

### INTERNATIONAL DEVELOPMENTS

Through cooperative efforts on the part of the United Kingdom and France, ground station equipment was made ready for the first trans-Atlantic experimental transmissions, including TV, via TELSTAR, which received much publicity both here and abroad. For the first time, standard TV transmissions, including live program material, were sent over the Atlantic. The U. S. TV networks and the European Broadcasting Union (EBU) exchanged special programs on July 23, 1962, which demonstrated one of the uses which could be made of an operational space communication system when established. The transmission capacity of the TELSTAR satellite provides for one TV channel, or as many as 600 one-way telephone channels, or for the transmission of various other kinds of intelligence at a very rapid rate. Although these demonstrations proved spectacular, the long-range objective of the program is the development of a global space communication system which can provide adequate voice circuits, wide-band data transmission circuits, and record communications, the mounting demands for which are fast exceeding the capacity of existing cable and radio circuits, even allowing for reasonable future expansion.

In furtherance of this long range objective, the Commission is engaged with NASA and the Department of State in a series of discussions with foreign entities with the view toward developing their interest and cooperation in establishing overseas ground station installations, or encouraging such other means of participation in the experimental phase of the satellite communication program as appears appropriate. To date contacts have been made in Western Europe, Scandinavia, South America, and Japan. The results thus far have been favorable and hold promise of providing a sound basis for an eventually evolving global system.

### STATUTORY AND REGULATORY RESPONSIBILITIES

The Commission has been delegated major regulatory responsibilities by the Communications Satellite Act of 1962 over the activities of the communications satellite corporation as well as over those common carriers eventually authorized to utilize the satellite system through ground station ownership or otherwise. These activities will be subject to the Communications Act as well as to the Communications Satellite Act of 1962.

Thus, among other things, the Commission is responsible for the licensing of the satellites and ground stations, and regulating the terms and conditions for the use of such facilities. Congress has also delegated two new noteworthy regulatory responsibilities to the Commission. First, the Commission is to insure that effective competition is maintained by the corporation and ground station licensees in the procurement of apparatus, equipment, and services needed for the establishment and operation of these facilities. In carrying out this responsibility, the Satellite Act requires that the Commission consult with the Small Business

Administration and request its advice on how to ensure that small business concerns be given equitable opportunity to share in the procurement of equipment and services for the program. Second, the Commission is to approve all securities issued by the corporation subsequent to the initial stock offering. Thus, the corporation must be authorized by the Commission to issue any capital stock or borrow any monies other than the initial stock issue.

In view of the importance of space communications and the scope of the regulatory problems involved, many of which will be unprecedented, the Commission has created an Office of Satellite Communications directly under the Chief, Common Carrier Bureau. This Office will be responsible for the administration and implementation of those regulatory functions conferred on the Commission by the Communications Satellite Act of 1962. The Commission has also established a Space Systems Branch in the Office of the Chief Engineer to handle related space communication engineering problems. The General Counsel will continue to exercise his functions as chief legal advisor to the Commission on these matters.

To coordinate its work in connection with space communication and in anticipation of its relation to further developments, the Commission more than a year ago appointed a special space committee, headed by a Commissioner and consisting of representatives from legal, engineering, common carrier and other FCC units concerned with various aspects of space communication.

#### ALLOCATION OF FREQUENCIES FOR THE SPACE SERVICES

Even before the 1959 Administrative Radio Conference convened in Geneva by the International Telecommunication Union (ITU), plans were under way to have the International Table of Frequency Allocations provide frequencies for anticipated space communication. The likely mushrooming requirements for space frequencies was recognized by that Conference and an Extraordinary Administrative Radio Conference was tentatively scheduled for 1963 to deal with the subject. It has since been determined that sufficient information has been developed, or will be available, to warrant such a conference, and it now is scheduled to begin on October 7, 1963, at Geneva.

The U. S. is well advanced in its preparation for the 1963 International Telecommunication Union (ITU) space conference. The Commission, in cooperation with the Office of Emergency Planning, and other Government agencies and with industry advice, drafted a document setting forth the "Preliminary Views of the United States of America -- Frequency Allocations for Space Radiocommunication." This document was intended to serve as a basis for the formal U. S. proposals at the 1963 ITU space conference. It was circulated and discussed widely, both nationally and internationally, for the purpose of obtaining additional comments and views of interested parties here and telecommunication officials abroad. The results of studies by the International Radio Consultative Committee (CCIR) Study Group IV on preferred characteristics provided additional new material. The "Preliminary Views" document was revised to incorporate the changes considered necessary or desirable and issued to the public in the Commission's "Third Notice of Inquiry in Docket No. 13522." The revised document, entitled "Draft Proposals of the United States of America for the Extraordinary Administrative Radio Conference for Space Radiocommunication (Geneva, 1963)," dated October 22, 1962, was attached to this Third Notice of Inquiry which was adopted by the



Commission on October 24, 1962. Based on comments received, further modifications of the draft proposals may be made. It is expected that the document will then serve as a basis for further discussions with other countries prior to the submission of formal U. S. proposals to the 1963 ITU Space Conference.

The International Radio Consultative Committee (CCIR) is a permanent organ of the International Telecommunication Union (ITU) and is charged with the study of technical and operating questions relating specifically to radiocommunication, and with the issuance of recommendations pertaining to such questions. The Xth Plenary Assembly will convene at Geneva in January 1963 for one month to consider, among other things, technical matters relating to space systems. Since the results of that Assembly will affect decisions to be taken by the special space conference the following October, FCC representatives have been active, together with a great many U. S. scientists and engineers, in the work of the U. S. committee of the CCIR dealing with space matters. After the Xth Plenary Assembly of the CCIR the U. S. draft proposals will be further reviewed.

One additional major international "space" meeting is scheduled prior to the 1963 ITU space conference. In March, 1963, the 25 nation Administrative Council of the ITU will convene its annual session some two months early in order to adopt the final agenda for the space conference.

#### Radio Astronomy Developments

Although the 1959 Geneva conference provided for a radio astronomy service, it soon became apparent in the United States that the new service could not function efficiently if required to share most of its frequency bands with other radio services. To remedy this difficulty, the Commission has completed a document, "Preliminary Views of the United States of America -- Frequency Allocation for Radio Astronomy" in consultation with the President's Director of Telecommunication Management, as the basis for a United States proposal at a future radio conference.

The Commission instituted certain rule making actions concerning radio astronomy. It invited comments on possible changes in the International Table of Frequency Allocations to better accommodate radio astronomy's needs; proposed amending the domestic allocation to set aside bands for radio astronomy observations in the United States; and proposed that radio astronomy observatories in this country file annual reports of their activities for notification to the International Telecommunication Union (ITU).

#### AERONAUTIC DEVELOPMENTS

The Commission prescribes the manner and conditions under which frequencies may be assigned to non-Government licensees for aircraft communications (including telemetry), for aeronautical radionavigation, and for control and telemetry, for aeronautical radionavigation, and for control and telemetry in the development of missiles, rockets and satellites.

The higher speeds that result from the commercial use of jet aircraft have created increased demands on communications and aeronautical radionavigation facilities. Expansion of such facilities also has been necessary to meet the requirement for

better air traffic control. All of these demands have had to be accommodated within the limited frequency space available.

In a continuing effort to provide air traffic control frequencies consistent with expanding needs, the frequency band 135-136 Mc/s has been made available for this purpose by inter-governmental agreement. Aeronautical enroute stations within the United States have transferred the majority of their operations to VHF. The High Frequency (HF) portion of the spectrum will not be available for domestic operations after January 1, 1965.

The Commission is cooperating with the FAA and the Department of Commerce, which are evaluating a direct pilot-to-forecaster weather service test. Indications are that the results of the test may show a need for a permanent frequency assignment for this purpose. The frequency 122.9 Mc/s has been made available for a new class of station known as Aeronautical Multicom, which is to provide communications for general aviation activities not otherwise provided for in the Aviation Services. Preparation is in progress within the aviation industry for the use of space techniques in the aeronautical service.

The Commission is also involved in a limited way in a project of major scientific interest called STRATOSCOPE II. This project involves the use of a highly stabilized thirty-six inch optical telescope carriers to altitudes of around 80,000 feet by a large balloon for night observations of planets, stars and nebulosities. By going above all but a small portion of the earth's atmosphere to avoid the optical distortion it produces, observations of unprecedented quality are possible, as proved in an earlier less sophisticated program known as STRATOSCOPE I.

Although the high definition photographs are made at the telescope, an elaborate air-ground radiocommunication telemetry and command system is required. This includes an air-to-ground wide-band video circuit (TV) to permit ground observation of the telescope image in order to aim, focus and monitor the telescope's performance. The Commission has endeavored to assist in meeting the frequency requirements of this program and has granted an authorization in the Experimental Radio Service for the video link. Efforts to provide adequate frequencies on a regular basis for such projects are continuing.

# Chapter XIII

## United States Information Agency

### INTRODUCTION

World interest during 1962 focused as never before on the massive assault on space. As the United States stepped up its space effort to achieve our goal of a lunar landing within this decade, USIA increased its efforts to tell the world about America's peaceful objectives in space.

In portraying America's space effort to foreign audiences, USIA coordinated its efforts with those of other U.S. Government agencies and with American private enterprise. With their assistance and support USIA kept up a steady flow of information to overseas audiences through the Voice of America and its 223 posts around the world. U.S. Information Service officers and their staffs adapted these materials to local communications, ranging from scientific journals and network television programs to wall newspapers and minstrel singers.

### GUIDELINES

USIA used the following guidelines in its coverage of U.S. space programs during 1962:

- a. Emphasized the theme of space for peace. It was made clear that U.S. national policy favors the exploration, investigation and development of the peaceful uses of outer space. The benefits which have accrued and will accrue were specified. The extent to which the U.S. is already involved in international cooperation in the realm of space exploration was pointed out. Attention was drawn to U.S. efforts to forestall an arms race in outer space.
- b. Detailed space achievements as evidence of U.S. competence in science and technology. While it was admitted that the U.S.S.R. was ahead in booster capacity, the facts made it possible to point to U.S. primacy in orbiting a wide variety of sophisticated instruments.
- c. Explained that there is no incompatibility between the unequivocal stand for peace and a strong defensive capability.
- d. Publicized the openness of U.S. experimentation. This policy of openness contrasts with the secrecy which is characteristic of the closed society of communism.

### ASSETS

The Agency identified the following as favorable factors influencing the U.S. space image abroad:

### Openness of the U.S. Effort

The U.S. discloses its failures along with its successes and makes knowledge available to all mankind. On the other hand, the closed Soviet society conceals its failures, uses its successes for political objectives, and shares its acquired information only on a selective bases.

### Broad Scope and Volume of U.S. Space Activities

The U.S. space program serves human needs through weather, communications and navigational satellites, and makes a wide range of contributions to man's knowledge and understanding. Also, during five years of space exploration the U.S. has successfully launched a far greater number of satellites and space probes than the U.S.S.R.

### Miniaturization

The record of miniaturization of equipment and broad scope of experiments has been impressive.

### International Cooperation

By means of cooperative agreements and a free exchange of knowledge the U.S. makes it possible for many nations to participate in space research and exploration. Through the U.N. the U.S. seeks to establish open cooperation of all nations for the peaceful exploration of space and the benefit of mankind.

### LIABILITIES

The agency identified the following as adverse factors influencing the U.S. image:

- a. Soviet competence in booster power and size of payloads, which have enabled them to conduct more dramatic manned flights than the U.S.
- b. Soviet "firsts," which included: Sputnik I, launched four months before the first U.S. satellite; first man orbited in space; first lunar impact and first photographs of the dark side of the moon; and dual manned shots in near rendezvous posture.

### USIA TREATMENT OF U.S. SPACE ACHIEVEMENTS

#### Manned Space Flight

The manned orbital flights received major emphasis during the year because of its strong popular appeal, its importance in the U.S. space program, and its relative importance in establishing the U.S. space image. All USIA media gave continuing emphasis with peak activity centering around each of the three orbital flights during 1962.

#### Communications Satellites

Communications satellites were second only to manned space flight in public interest and extent of USIA coverage, which followed a pattern similar to that of manned space flight. USIA cooperated with other agencies and organizations in planning and producing the transatlantic TV demonstrations by TELSTAR. USIA also arranged telephony demonstrations between prominent individuals in 23 cities in Europe and the same number in the U.S. The USIS reported continuing widespread demand for informational materials on communications satellites not only in Europe but also in

Asia, Africa and Latin America, indicating popular interest in this new tool for international communications. Foreign editorial comment generally praised the American achievement and the use of space science for peaceful purposes. Because it can be seen regularly ECHO continued to hold mass interest. USIA capitalized on this by furnishing daily sighting schedules to foreign media.

### Weather Satellites

Predicting weather via space satellites received continuing coverage through all USIA media with particular emphasis on benefits to countries participating in the program. Typhoon and hurricane warnings resulting from TIROS observations proved especially effective in convincing foreign audiences of its value. Sample: USIS Athens reported that a leading paper in that city had changed its editorial policy from criticism to praise of TIROS when USIS furnished them evidence that TIROS weather information had been used to warn Africans of an approaching storm.

### Lunar and Planetary Experiments

Heavily covered by USIA media, the MARINER story was kept alive throughout its long voyage to Venus. The success of this space project, with release of its scientific findings, contributed to the rising status of the U.S. space image.

### Scientific Satellites

Earth satellites were given extensive coverage with emphasis on U.S. sophistication and instrumentation and dedication to the search for knowledge.

## ASSISTANCE TO NEWS MEDIA

### Press and Publications

Advance press packets of articles by recognized space authorities were despatched to all USIS posts for translation and release at time of flight. USIA's Wireless File supplemented these with detailed coverage of the flight itself. Followup included pamphlets, special articles and photo coverage for popular consumption plus NASA technical flight reports for selective distribution. USIS posts reported uniformly heavy usage of these materials in all areas.

### Television

USIA's TV branch sent out advance clips on all flights and followed up with coverage of the flight itself giving emphasis to areas not covered by commercial TV services. Sample: "Friendship 7" was distributed to TV stations in 74 countries in English, Spanish and international sound tracks. Numerous foreign TV networks carried the hour-long program in its entirety. In Italy it was viewed by a prime TV-time audience of 13 million. Rome's Fourth International Festival of Films for Television awarded it a Gold Plaque for the best news documentary program.

### Radio

Voice of America, through its worldwide English services, gave continuous on-the-spot coverage of all manned flights and extensive reportage through each of its 38

language services. These transmissions were picked up and rebroadcast in many countries throughout the world. There is reason to believe the Glenn flight was the most heavily covered ever in the history of radio broadcasting. During the Schirra flight VOA gave continuous coverage from Cape Canaveral for a 12-hour period -- from 6:30 a.m. to 6:30 p.m. USIS Tokyo reported usage by more than 200 radio and TV stations throughout Japan.

### Motion Pictures

USIA newsreel coverage of all manned flights reached mass audiences throughout the world. A special 10-minute theatrical documentary was distributed on the Glenn flight to 106 countries in 32 languages. More than 1,300 prints were needed to meet the demand.

This was followed by worldwide distribution of NASA's hour-long "Friendship 7" color documentary: 225 English-language prints to 71 countries with followup language versions in major world languages.

### Exhibits

In preparation for the first U.S. orbital flight USIA shipped to 101 overseas posts 2,000 copies of an eight-panel, four-color poster exhibit explaining graphically the techniques and objectives of Project MERCURY.

Immediately following the Glenn orbital flight USIA, NASA and the USAF joined forces to take the "Friendship 7" spacecraft on a fourth orbit, this time with stops in 23 countries. At every stop the public impact was impressive, particularly upon young people. Audiences included many chiefs of state who were given detailed explanations by accompanying NASA space scientists. Millions of people filed by to touch and examine the spacecraft. In Tokyo alone 500,000 viewed the capsule close up during its four-day stay; Japanese communications media gave prominent and favorable treatment to America's free and open information policy and the U.S. desire for cooperation in space.

### Books and Libraries

Official reports by NASA on each of the manned space flights were distributed to the 300 USIS libraries overseas. These were supplemented by Congressional and Senate hearings on the U.S. space program plus a continuing selection of the best U.S. commercial books and publications for use by USIS libraries and for USIS supported translated programs.

## INTERNATIONAL COOPERATION

USIA covered contributions by other countries to the tracking network operation, joint launchings, communications satellite experiments, bilateral agreements for space science research, and exchange of scientific and technical personnel. USIA stressed the benefits derived from cooperation between U.S. and foreign scientists.

### USIA - NASA COOPERATION

USIA maintains a full-time liaison officer at NASA to facilitate carrying out USIA's

statutory obligations for publicizing the space program. During the year the two agencies evolved a detailed space program of cooperation, now being put into effect, to utilize more fully the resources of both in the overseas information effort. One example of this cooperation is the joint programming and operation of "spacemobiles" -- a space science lecture demonstration. As of the year's end these units were operating in English-speaking Africa and Europe with others scheduled for Latin America, French-speaking Africa and the Near East during FY 1963.

## UNITED STATES LAUNCHING RECORD

Year	Earth Satellite Attempts		Escape Payload Attempts	
	Good	Failed	Good	Failed
1957	0	1	0	0
1958	5	8	0	4
1959	10	7	1	2
1960	16	12	1	2
1961	35	12	0	2*
1962	54	11	4	1
Total	120	51	6	11

**Notes:**

1. Information contained in this table is drawn from unclassified sources previously made public, and is believed to be complete and accurate in keeping with the definitions given below.
2. Numbers are given in terms of identified separate payloads placed in Earth orbit or sent to the Moon or into solar orbit. A few launchings have put up more than one payload. If these payloads were intended to separate from each other in flight, they are counted individually even though in a limited number of cases such separation failed to occur. A payload is defined as an object put into orbit or sent away from the Earth to accomplish some specific research or application purpose and to return data to Earth. Typically, a payload transmits telemetry, but not always (e. g. Echo which carried only a radio beacon). Some rocket casings may carry radio beacons, but limited data return incidental to putting up a payload does classify these as payloads in their own right.
3. The sole criterion of success and failure used for the purpose of this table is that of attaining Earth orbit, or escape to the Moon or solar orbit as appropriate to the column indicated. Some payloads reached orbit or escaped without returning as much data as planned; other payloads failed to reach orbit or escape, yet returned useful data at least briefly.
4. The corresponding data for number of launchings attempted (the count without reference to multiple payloads) are the same as given above except in the Earth orbital category for 1960 (11 failures), 1961 (29 successes) and 1962 (48 successes and 7 failures) making totals of 107 successes and 46 failures for the period 1957-62.

\*These failed to go to escape as intended, but did attain Earth orbit and are in those totals.

NASC Staff



## SUCCESSFUL U. S. LAUNCHES -- 1962

[ See explanation notes  
at end of table ]

Launch Date Name Designation Vehicle	Payload Data	Apogee and Perigee (in statute miles) Period (minutes) Inclination to Equator (degrees)	Remarks
Jan. 15 Echo II test Thor	Total weight: Not stated Objective: To test separation of cannister and inflation of the "balloon satellite." Payload: Improved, more rigid Echo-type balloon for passive communications; TV and movie monitors of separation, inflation.	Orbit not intended	Balloon ripped apart from too-rapid inflation at altitude of 250 miles.
Jan. 26 RANGER III 1962 Alpha 1 Atlas Agena B	Total weight: 727 pounds Objective: Impact Moon; TV photography and X-ray spectroscopy; rough-land survivable capsule containing seismometer; perform engineering experiments in attitude control and guidance. Payload: Vidicon camera, gamma-ray spectrometer, radar reflectivity experiment, and seismometer.	1.163 au * .9839 au 406.4 days .3988	Missed the Moon by 22,862 miles on Jan. 28, and entered heliocentric orbit. TV signal too weak to be useful. Gamma ray data received.
Feb. 8 TIROS IV 1962 Beta 1 Thor Delta	Total weight: 285 pounds Objective: Develop principles of a weather satellite system; obtain cloud and radiation data for use in meteorology. Payload: Two TV camera systems with clocks and recorders for remote pictures, infra-red sensors, heat budget sensors, magnetic orientation control, horizon sensor, and north indicator	520 441 100.3 48.25	In addition to research use, data from TV cameras are in use to prepare cloud analyses for current operational weather analysis and forecasting. Analyses are disseminated over domestic and international weather communications circuits.

Feb. 20 FRIENDSHIP 7 1962 Gamma 1 Mercury Atlas 6	Total weight: 2987 pounds. Objective: Orbit and recover manned spacecraft; evaluate man-spacecraft performance; investigate man's capabilities in space environment; obtain pilot's evaluation of operational suitability of spacecraft and supporting systems. Payload: Astronaut; two cameras, life support, aeromedical monitoring, and attitude control systems; telemetry.	163 100 88.5 32.5	Orbit achieved and all objectives of flight accomplished. Successfully recovered after 3 orbits. (John H. Glenn).
Feb. 21 AIR FORCE 1962 Delta 1 Thor Agena B	Total weight: Not stated. Objective: Development of space flight techniques and technology. Payload: Not stated	232 104 89.7 81.97	Decayed March 4, 1962
Feb. 27 DISCOVERER XXXVIII 1962 Epsilon 1 Thor Agena B	Total weight: Not stated. Objective: Development of space flight techniques and technology. Payload: Not stated	377 207 90.4 82.23	Decayed March 21, 1962. The capsule was ejected on the 65th orbit and recovered in the air.
Mar. 1 Reentry test Scout	Total weight: 155 pounds Objective: Intended to reenter at 19,000 mph. Payload: Heat shield experiment.	Orbit not intended	Did not attain speed expected.
Mar. 7 OSO I 1962 Zeta 1 Thor Delta	Total weight: 458 pounds Objective: Place satellite in Earth orbit to measure solar electromagnetic radiation in the ultraviolet, X-ray, and gamma-ray regions, investigate dust particles in space, and improve future spacecraft design. Payload: Devices to conduct 13 different experiments to study solar electromagnetic radiations and investigate dust particles in space and thermal radiation characteristics of spacecraft surface materials.	358 345 95.8 32.92	Orbit achieved. Experiments transmitted as programmed, continuously for three months and thereafter intermittently for several weeks.

Mar 7. AIR FORCE 1962 Eta 1 Atlas Agena B	Total weight: Not stated. Objective: Development of space flight technique and technology. Payload: Not stated.	427 146 93.9 90.93 **	
Mar. 29 P-21A Probe Scout	Total weight: Not stated. Objective: Scientific geoprobe of ionospheric electron density profiles, ion density, ion types, to gather data to improve communications. Payload: Not stated.		Orbit not intended Climbed 3910 miles, traveled 4370 miles downrange.
Apr. 9 AIR FORCE 1962 Kappa 1 Atlas Agena B	Total weight: Not stated. Objective: Space research and exploration. Payload: Not stated.	2111 1727 152.97 86.65	
Apr. 18 AIR FORCE 1962 Lambda 1 Thor Agena B	Total weight: Not stated. Objective: Development of space flight techniques and technology. Payload: Not stated.	332 98 91.5 73.53	Decayed May 28, 1962.
Apr. 23 RANGER IV 1962 Mu 1 Atlas Agena B	Total weight: 730 pounds Objective: Impact Moon; TV photography and X-ray spectroscopy of lunar surface; rough-land survivable seismometer on lunar surface; perform engineering experiments in attitude control and guidance. Payload: Vidicon camera, gamma-ray spectrometer, radar reflectivity experiment and seismometer.	Lunar probe --- --- 6.18 *	Impacted backside of Moon on April 26. No scientific data obtained.
Apr. 25 SA-2 Vehicle test Saturn C-1	Total weight: Not stated. Objective: To test S-I stage Payload: Diagnostic instruments and water ballast (95 tons).		Orbit not intended Generated 1.3 million pounds thrust; dumped water ballast in 2nd and 3rd dummy stages at 65 miles altitude.

<p>Apr. 26 ARIEL I 1962 Omicron 1 Thor Delta</p>	<p>Total weight: 132 pounds Objective: Place satellite in Earth orbit to investigate the ionosphere and its relationships with the Sun. Payload: Electron density sensor, electron temperature gage, solar aspect sensor, cosmic ray detector, ion mass sphere, Lyman-Alpha gages, tape recorder, X-ray sensors.</p>	<p>755 241 100.9 53.87</p>	<p>First international satellite. Contains six British experiments; launched by American Delta vehicle. Orbit achieved. All experiments except Lyman-Alpha gages transmitted for three months as programed. Continuing to provide useful data.</p>
<p>Apr. 26 AIR FORCE 1962 Pi 1 Atlas Agena B</p>	<p>Total weight: Not stated. Objective Space research and exploration Payload: Not stated.</p>	<p>Elements not stated</p>	<p>Decayed April 28, 1962.</p>
<p>Apr. 29 AIR FORCE 1962 Rho 1 Thor Agena B</p>	<p>Total weight: Not stated. Objective: Development of space flight techniques and technology. Payload: Not stated.</p>	<p>306 97 91.1 73.23</p>	<p>Decayed May 26, 1962.</p>
<p>May 8 Vehicle test Atlas Centaur</p>	<p>Total weight: Not stated. Objective: To start liquid hydrogen engine at 300 mile altitude. Payload: Diagnostic instruments.</p>	<p>Orbit not intended</p>	<p>Exploded before separation of Centaur stage.</p>
<p>May 15 AIR FORCE 1962 Sigma 1 Thor Agena B</p>	<p>Total weight: Not stated. Objective: Development of space flight techniques and technology Payload: Not stated</p>	<p>394 184 94.0 82.32</p>	

May 24 AURORA 7 1962 Tau 1 Mercury Atlas 7	Total weight: 2975 pounds Objective: Orbit and recover manned spacecraft to (1) evaluate man-spacecraft system performance, (2) investigate man's capabilities in space; and (3) obtain pilot's opinion on the suitability of the spacecraft and allied systems. Payload: Astronaut; cameras, life support and aeromedical monitoring and attitude control systems, telemetry, experiment to study effects of weightlessness on liquid, tethered balloon to study drag and visibility in space.	167 100 88.3 32.5	Orbit and all other objectives achieved. After three orbits, spacecraft and pilot (M. Scott Carpenter) recovered 135 miles east of Puerto Rico.
May 30 AIR FORCE 1962 Phi 1 Thor Agena B	Total weight: Not stated. Objective: Development of space flight techniques and technology. Payload: Not stated.	211 121 89.9 74.10	Decayed June 11, 1962.
May 31 Probe Blue Scout	Total weight: Not stated. Objective: Not stated. Payload: Not stated.		Orbit not intended
Jun. 2 AIR FORCE 1962 Chi 1 Thor Agena B	Total weight: Not stated. Objective: Development of space flight techniques and technology. Payload: Not stated.	217 117 90.0 74.25	Decayed June 28, 1962.
June 2 OSCAR II 1962 Chi 2 Thor Agena B	Total weight: 10 pounds. Objective: Development of space flight techniques and technology. Payload: Radio on 144.993 mc broadcasting "Hi" in Morse code.	177 119 89.3 74.27	Decayed June 21, 1962.
June 17 AIR FORCE 1962 Psi 1 Atlas Agena B	Total weight: Not stated. Objective: Development of space flight techniques and technology Payload: Not stated.		Elements not stated Decayed June 18, 1962

June 18	Total weight: Not stated,	253	
AIR FORCE	Objective: Development of space flight tech-	227	
1962 Omega 1	niques and technology.	92.4	
Thor Agena B	Payload: Not stated.	82.11	
Jun. 19	Total weight: 286 pounds.	605	Orbit achieved. Cam-
TIROS V	Objective: Place satellite in Earth orbit to (1)	363	eras transmitted excel-
1962 Alpha Alpha 1	provide weather data for operational weather anal-	100.5	lent photos. During
Thor Delta	ysis and research study, especially during 1962	58.08	pre-flight checks on
	hurricane season; and (2) develop principles for the		launch pad, infrared
	operational weather satellite system.		sensory subsystem
	Payload: Two TV camera-tape recorder-trans-		(similar to that in
	mitter circuits (one with wide-, one with medium-		TIROS III and IV) failed
	angle lens), two electronic clocks, magnetic orient-		to pass required checks;
	ation control, coil horizon sensor, north indicator.		subsystem was discon-
			nected and satellite
			launched with it inact-
			ive in order to meet
			launch period required
			for minimum coverage
			of August-September
			hurricane season.
Jun. 23	Total weight: Not stated.	149	Decayed July 7, 1962.
AIR FORCE	Objective: Development of space flight tech-	130	
1962 Alpha Beta 1	niques and technology.	89.0	
Thor Agena B	Payload: Not stated.	75.09	
Jun. 28	Total weight: Not stated.	397	Decayed September 14,
AIR FORCE	Objective Development of space flight tech-	130	1962.
1962 Alpha Gamma 1	niques and technology.	93.6	
Thor Agena D	Payload: Not stated.	76.04	

Jul. 10 TELSTAR I 1962 Alpha Epsilon 1 Thor Delta	Total weight: 170 pounds. Objective: Orbit satellite provided by AT&T to test broadband microwave communications in space, study radiation effects, and test satellite tracking techniques.	3494. 588 157.6 44.78	Orbit achieved. Satellite used successfully in communications tests until Nov. 23, when it became inoperative because of a malfunction in the command decoder. (Early in 1963 usefulness was restored and communications experiments were resumed.)
Jul. 18 AIR FORCE 1962 Alpha Zeta 1 Atlas Agena B	Total weight: Not stated. Objective: Development of space flight techniques and technology. Payload: Not stated.	Elements not stated	Decayed July 25, 1962.
Jul. 18 Echo II test Thor	Total weight: Not stated. Objective: To test separation of cannister and inflation of "balloon satellite." Payload: Improved, more rigid Echo-type balloon for passive communications; TV and movie monitors of separation, inflation.	Orbit not intended	Carried Echo II-type balloon to 922 miles in successful inflation test, but surface not as smooth as hoped for.
Jul. 21 AIR FORCE 1962 Alpha Eta 1 Thor Agena B	Total weight: Not stated. Objective: Development of space flight techniques and technology. Payload: Not stated.	217 122 90.0 70.29	Decayed August 14, 1962
Jul. 24 Probe Blue Scout, Jr.	Total weight: Not stated. Objective: Not stated. Payload: Not stated.	Orbit not intended	
Jul. 28 AIR FORCE 1962 Alpha Theta 1 Thor Agena B	Total weight: Not stated. Objective: Development of space flight techniques and technology. Payload: Not stated.	250 129 90.7 71.06	Decayed August 24, 1962

Aug. 2	Total weight: Not stated.	218	Decayed August 26, 1962
AIR FORCE	Objective: Development of space flight tech-	120	
1962 Alpha Kappa 1	niques and technology.	90.0	
Thor Agena D	Payload: Not stated	82.25	
Aug. 5	Total weight: Not stated.	Elements not	Decayed August 6, 1962
AIR FORCE	Objective: Development of space flight tech-	stated	
1962 Alpha Lambda 1	niques and technology.		
Atlas Agena B	Payload: Not stated.		
Aug. 23	Total weight: Not stated.	524	
AIR FORCE	Objective: Development of space flight tech-	388	
1962 Alpha Omicron 1	niques and technology.	99.6	
Blue Scout	Payload: Not stated.	98.62 **	
Aug. 27	Total weight: 447 pounds	1.013 au *	After 109 days, during
MARINER II	Objective: To fly by Venus and (1) scrutinize	.684 au	which it traveled over
1962 Alpha Rho 1	the planet for signs of water vapor, oxygen, and	285.6 days	180 million miles,
Atlas Agena B	other atmospheric constituents and attempt to	1.85	Mariner R-2 flew by
	determine the planet's temperature; (2) gather		Venus (at a distance of
	information on magnetic fields, radiation, and		21,594 miles) and
	cosmic dust in the space environment of Venus		transmitted to Earth,
	and in interplanetary space between Earth and		data concerning Venus,
	Venus; and (3) test basic elements of space tech-		as well as engineering
	nology required for advanced interplanetary		data (pressures, tem-
	missions of the future.		peratures, voltages)
	Payload: Microwave radiometer, infrared		on the status of the
	radiometer, ionization chamber and Geiger-		spacecraft's various
	Mueller tubes, solar plasma detector, and		systems. The probe
	cosmic dust detector. (40 pounds of instruments.)		continued beyond Venus
			in heliocentric orbit.
Aug. 29	Total weight: Not stated.	250	Decayed September 10,
AIR FORCE	Objective: Development of space flight tech-	114	1962.
1962 Alpha Sigma 1	niques and technology.	90.4	
Thor Agena D	Payload: Not stated.	65.16	



Aug. 31 Reentry test Scout	Total weight: 160 pounds Objective: Intended to reenter at 19,000 mph. Payload: Heat shield experiment.	Orbit not intended	Upper stages mal- functioned.
Sep. 1 AIR FORCE 1962 Alpha Upsilon 1 Thor Agena B	Total weight: Not stated Objective: Development of space flight tech- niques and technology. Payload: Not stated.	417 188 94.4 82.81	
Sep. 17 AIR FORCE 1962 Alpha Chi 1 Thor Agena B	Total weight: Not stated. Objective: Development of space flight tech- niques and technology. Payload: Not stated.	382 123 92.8 81.85	Decayed November 19, 1962.
Sep. 18 TIROS VI 1962 Alpha Psi 1 Thor Delta	Total weight: 281 pounds Objective: Place satellite in Earth orbit to obtain photographic data of Earth's cloud cover Payload: Two TV camera-tape recorder-trans- mitter circuits, two electronic clocks, magnetic orientation control, coil horizon sensor, and north indicator.	444 422 98.7 58.28	Orbit achieved. Cam- eras transmitting as planned.
Sep. 29 ALOUETTE 1962 Beta Alpha 1 Thor Agena B	Total weight: 320 pounds Objective: Orbit Canadian satellite to study ionosphere's free electron distribution, measure galactic noise from outer space and in ionosphere, and observe cosmic rays. Payload: Transmitters, receiver, and particle detectors.	638 622 105.5 80.53	First satellite design- ed and built by a Nation other than U.S. or U.S.S.R.; first NASA near-polar orbital launch; first NASA satellite launched from West Coast. Orbit achieved. Experi- ments transmitting as programed.
Sep. 29 AIR FORCE 1962 Beta Beta 1 Thor Agena D	Total weight: Not stated. Objective: Development of space flight tech- niques and technology. Payload: Not stated.	240 118 90.3 65.41	Decayed October 14, 1962.

<p>Oct. 2 EXPLORER XIV 1962 Beta Gamma 1 Thor Delta</p>	<p>Total weight: 89 pounds Objective: Orbit satellite to measure energetic particles in magnetosphere and outer space and their relationships to magnetic fields of Earth and interplanetary space. Payload: Proton analyzer, magnetic field experiment, trapped particle radiation experiments, and cosmic ray detector-analyzer package, ion-electron detector group, and solar cell damage experiment.</p>	<p>61,090 174 2,185 32.95</p>	<p>Orbit achieved. Experiments transmitting as planned.</p>
<p>Oct. 3 SIGMA 7 1962 Beta Delta 1 Mercury Atlas 8</p>	<p>Total weight: 3000 pounds Objective: Orbit and recover manned spacecraft to evaluate performance of man-spacecraft system, investigate man's capabilities in space environment, and obtain pilot's evaluation of all systems. Payload: Astronaut; cameras; life support, aeromedical monitoring and attitude control systems; telemetry; experiment to study various types of heat shielding.</p>	<p>177 101 88.75 32.55</p>	<p>Orbit achieved. Astronaut and spacecraft successfully recovered after 6 orbits. (Walter M. Schirra)</p>
<p>Oct. 9 AIR FORCE 1962 Beta Epsilon 1 Thor Agena B</p>	<p>Total weight: Not stated. Objective: Development of space flight techniques and technology. Payload: Not stated.</p>	<p>262 131 90.9 81.99</p>	<p>Decayed November 16, 1962</p>

Oct. 18 RANGER V 1962 Beta Eta 1 Atlas Agena B	Total weight: 755 pounds Objective: To obtain closeup, medium-resolution pictures of the lunar surface, measurements of the gamma radiation emitted by the Moon, data on the radar reflectivity of the lunar surface, and to hard land on the lunar surface a survivable instrumentation capsule containing a seismometer for detecting lunar tremors originating from within or caused by meteoritic impacts. Payload: Vidicon camera system, single-axis seismometer, gamma ray spectrometer, radar reflectivity experiment. (Payload weight was 117 pounds.)	Not yet calculated *	Launched in a Moon-collision trajectory. Because of a spacecraft power system malfunction, forcing the use of battery rather than solar power, mid-course guidance corrections were not performed and the mission objective of lunar impact was not achieved. The spacecraft went into orbit around the Sun, after missing the Moon by 450 miles.
Oct. 26 AIR FORCE 1962 Beta Kappa 1 Thor Agena D	Total weight: Not stated. Objective: Development of space flight techniques and technology. Payload: Not stated	3,452 120 147.8 71.41	
Oct. 27 EXPLORER XV 1962 Beta Lambda 1 Thor Delta	Total weight: 98 pounds Objective: Study artificial radiation belt created by July 9 nuclear explosion. Payload: Experiments to survey electron energy distribution, omnidirectional intensity of electron flux, particle flux, solar cell damage, and magnetic field.	10,927 187 314.8 18.01	Orbit achieved. Experiments transmitting as planned.
Oct. 31 ANNA I B 1962 Beta Mu 1 Thor Able Star	Total weight: 355 pounds Objective: Space research and exploration to establish geodetic parameters. Payload: Four flashing lights of 8 million candlepower, radio-ranging, and Doppler equipment.	732 669 107.8 50.13	Achieved orbit; experiments working as planned.

Nov. 5 AIR FORCE 1962 Beta Omicron 1 Thor Agena B	Total weight: Not stated. Objective: Development of space flight techniques and technology. Payload: Not stated.	251 122 90.6 75.02	Decayed December 3, 1962.
Nov. 11 AIR FORCE 1962 Beta Pi 1 Atlas Agena B	Total weight: Not stated. Objective: Development of space flight techniques and technology. Payload: Not stated.	Elements not stated	Decayed November 12, 1962.
Nov. 16 SA-3 Vehicle test Saturn C-1	Total weight: Not stated. Objective: To test S-1 stage. Payload: Diagnostic instruments and water ballast (95 tons).	Orbit not intended	Generated 1.3 million pounds of thrust; dumped water ballast in 2nd and 3rd dummy stages at 104 miles altitude.
Nov. 21 Probe Blue Scout	Total weight: Not stated. Objective: Not stated. Payload: Not stated.	Orbit not intended	
Nov. 24 AIR FORCE 1962 Beta Rho 1 Thor Agena B	Total weight: Not stated. Objective: Development of space flight techniques and technology. Payload: Not stated.	202 128 89.8 65.15	Decayed December 13, 1962.
Dec. 4 AIR FORCE 1962 Beta Sigma 1 Thor Agena	Total weight: Not stated. Objective: Development of space flight techniques and technology. Payload: Not stated.	174 119 89.16 65.00	Decayed December 8, 1962.
Dec. 13 AIR FORCE 1962 Beta Tau 1 Thor Agena	Total weight: Not stated. Objective: Development of space flight techniques and technology. Payload: Not stated.	1,720 152 116.2 70.37	

Dec. 13	Total weight: Not stated.	1,725	
INJUN III	Objective: Development of space flight techniques and technology.	153	
1962 Beta Tau 2		116.3	
Thor Agena	Payload: Not stated.	70.34	
Dec. 13	Total weight: Not stated.	1,696	
AIR FORCE	Objective: Development of space flight techniques and technology.	139	
1962 Beta Tau 3		115.6	
Thor Agena	Payload: Not stated.	70.29	
Dec. 13	Total weight: Not stated.	1,725	
AIR FORCE	Objective: Development of space flight techniques and technology.	144	
1962 Beta Tau 4		116.2	
Thor Agena	Payload: Not stated.	70.35	
Dec. 13	Total weight: Not stated.	1,714	
AIR FORCE	Objective: Development of space flight techniques and technology.	145	
1962 Beta Tau 5		116.0	
Thor Agena	Payload: Not stated.	70.34	
Dec. 13	Total weight: 172 pounds	4,623	
RELAY I	Objective: Test intercontinental microwave communications by low-altitude active repeater satellite; measure energy levels of space radiation in the orbital path, and determine extent of radiation damage to solar cells and electronic components.	805	Launched successfully. Planned to be the first space communication experiment linking North America, Europe, and South America.
1962 Beta Upsilon 1		184.9	Information obtained will contribute to development of a future operational satellite system for worldwide communication. (Early in 1963 initial low power levels were sufficiently overcome to initiate communications experiments.)
Thor Delta	Payload: Designed to transmit one-way wide-band communications (TV, 300 one-way voice channels or high-speed data) or two-way narrow-band communications (12 two-way telephone conversations, or teletype, photofacsimile, and data).	47.77	

Dec. 14	Total weight: Not stated.	241	
AIR FORCE	Objective: Development of space flight tech-	126	
1962 Beta Phi 1	niques and technology	90.5	
Thor Agena	Payload: Not stated.	70.0	
Dec. 16	Total weight: 222 pounds	733	Successfully launched
EXPLORER XVI	Objective: Establish probability of meteoroid	463	into orbit.
1962 Beta Chi 1	penetration of thin metal surfaces in the near-	104.3	
Scout	Earth environment.	52.04	
	Payload: Designed to measure meteoroid punc-		
	ture hazards directly by sampling spacecraft		
	structural surfaces; to measure particles having		
	different momentums, and to compare performance		
	of protected and unprotected solar cells.		
Dec. 18	Total weight: Not stated.		Orbit not intended
Probe	Objective: Not stated.		
Blue Scout	Payload: Not stated.		
Dec. 19	Total weight: 135 pounds	450	Successfully placed
TRANSIT V A	Objective: Development of space flight tech-	437	in orbit, but radio
1962 Beta Psi 1	niques and technology.	99.2	receivers failed to
Blue Scout	Payload: Radio Doppler navigation aids.	90.62 **	respond to incoming
			information and com-
			mands.
Date not stated	Total weight: 1 pound		Elements not
TRS I	Objective: Development of space flight tech-		stated
Not stated	niques and technology.		
Thor Agena B	Payload: Radiation detector.		

ADDENDUM:

After the 1961 report was completed, data became available on the final successful orbital launch of calendar year 1961, which are included here to provide continuity to the record of successful launches reported each year:

Dec. 22	Total weight: Not stated.	466	Decayed August 14,
AIR FORCE	Objective: Payload remained inert	145	1962.
1961 Alpha Lambda 1	Payload: Not stated	94.5	
Atlas Agena B		89.59	

NOTES: Successful launches are judged solely by the criterion of whether orbit of Earth or escape from Earth was achieved when so intended. Additionally, the table includes listings of important probes and vehicle tests not intended to orbit or escape, but in these cases, no criterion of success has been applied; some achieved their purposes, others did not. Seven additional Earth-orbital and one Earth-escape launching attempts not in this table failed to achieve orbit or escape.

Launch date is based on Greenwich Mean Time.

Name is the payload identification.

Designation is the international COSPAR astronomical name of orbital objects.

Vehicle is the launch craft type.

Total weight refers to the orbital or escape weight of the object containing the payload; it does not include the weight of any separate miscellaneous burned-out rocket casings, protective coverings, etc.

Objective and Payload are self-explanatory.

Orbital elements are those filed with the United Nations as available; otherwise they are taken from the NASA Goddard Satellite Situation Report or other official public releases.

Apogee and Perigee refer to the greatest and least distances respectively from the Earth of geocentric orbiting objects. In the case of data marked with an asterisk (\*), the data refer to Aphelion and Perihelion, the farthest and closest distance between objects in heliocentric orbit and the Sun. These latter instead of being measured in statute miles are measured in astronomical units. (The mean distance between Earth and Sun is called 1 au.)

Period refers to the time in minutes required to complete one Earth orbit. (In the case of heliocentric orbits the period is measured in days.)

Inclination refers to the tilt of Earth orbits in relation to the Equator, measured in degrees. In the case of heliocentric or other escape flights, the inclination is measured in degrees of tilt to the Ecliptic (the plane of the Earth's orbit in relation to the Sun). Inclinations in excess of 90 degrees carry a double asterisks (\*\*), indicating some amount of retrograde flight, i. e. , slightly westerly instead of the normal easterly.

Remarks are self-explanatory.

NASC Staff

UNITED STATES SPACE LAUNCH VEHICLES

Vehicle	Stages	Propellant	Thrust (in thousands of pounds)	Max. Dia. (feet)	Height Less Spacecraft (feet)	Payload (pounds)			First Launch
						345 mile orbit	Escape	Planetary	
Scout and Blue Scout	1. Algol (IIA)	Solid	86	3.3	65	240	---	---	1963 (60)
	2. Castor (I-E5)	Solid	64						
	3. Antares (X-259)	Solid	23						
	4. Altair (X-248)	Solid	3						
Thor Delta	1. Thor (DM-21)	LOX/RP	170	8	87	700/800	80	---	1963 (60)
	2. AJ-10-118	WIFNA/UDMH	7.5						
	3. Altair (X-248)	Solid	3.0						
Thor Able Star	1. Thor (DM-21)	LOX/RP	170	8	79	900	---	---	1962 (60)
	2. AJ-10-104	IRFNA/UDMH	7.9						
Thor Agena D	1. Thor (DM-21)	LOX/RP	170	8	76	1600	---	---	1962 (59)
	2. Agena D	IRFNA/UDMH	16	5					
Atlas SL V-III	1. Atlas D (improved)	LOX/RP	400 +	10	75	2700	---	---	1963 (59)
Atlas Agena D	1. Atlas D (improved)	LOX/RP	400 +	10	91	5000 +	750	400	1963 (60)
	2. Atlas D sustainer	LOX/RP	60						
	3. Agena D	IRFNA/UDMH	16						
Titan II	1. LR-87	Storable liquid	430	10	90	6200/7000	---	---	1962
	2. LR-91	Storable liquid	100						
Centaur	1. Atlas D (improved)	LOX/RP	400 +	10	105	8500	2300	1300	1962
	2. Atlas D sustainer	LOX/RP	60						
	3. Centaur	LOX/H <sub>2</sub>	30						
Saturn C-1	1. S-1 (8 cluster H-1)	LOX/RP	1500	21.6	125	20,000	---	---	1963 (61)
	2. S-IV (6 cluster A-3)	LOX/H <sub>2</sub>	90						
Titan III	1. Two 5-segment	Solid	2300	10, 10		27,000	6000	---	1964/5
	2. LR-87	Storable liquid	500	10					
	3. LR-91	Storable liquid	100						
	4. Upper stage	Storable liquid	16						
Saturn C-1B	1. S-I (8 cluster H-1)	LOX/RP	1500	21.6	141	28,500	---	---	1964/5
	2. S-IVB (1 J-2)	LOX/H <sub>2</sub>	200						
Saturn C-5	1. S-IC (5 cluster F-1)	LOX/RP	7500	33	275	220,000	90,000	70,000	1965
	2. S-II (5 cluster J-2)	LOX/H <sub>2</sub>	1000						
	3. S-IVB (1 J-2)	LOX/H <sub>2</sub>	200						

NOTES: Definitive data are difficult to compile. Payload capacity data vary according to the place and direction of launch as well as intended orbital altitude. Vehicles still under development may fall short of or exceed their projected capacities, both in payload and in engine thrust. Modifications of existing vehicles have already raised their performance, and future modifications may be expected in several cases. In general, these data apply to the latest versions now under development. The data of first launch applies to this latest modification with a date in parentheses, for the earlier version.

Propellant abbreviations used are as follows: Liquid Oxygen and a modified Kerosene--LOX/RP; Solid propellant combining in a single mixture both fuel and oxidizer--Solid; White Fuming Nitric Acid and Unsymmetrical Dimethylhydrazine--WIFNA/UDMH; Inhibited Red Fuming Nitric Acid and Unsymmetrical Dimethylhydrazine--IRFNA/UDMH; Nitrogen Tetroxide and Aerozene 50--Storable liquid; Liquid Oxygen and Liquid Hydrogen--LOX/H<sub>2</sub>.

(NASA STAFF)



## HISTORICAL BACKGROUND AND COMMUNICATIONS SATELLITE ACT OF 1962

On August 31, 1962, the President signed H. R. 11040, and the Communications Satellite Act of 1962 became law. At the time of signing, the President congratulated the Congress for "a step of historic importance." He stated further: "It promises significant benefits to our own people and to the whole world. Its purpose is to establish a commercial communications system, utilizing space satellites which will serve our needs and those of other countries and contribute to world peace and understanding."

Major steps in the development of this legislation were as follows:

- a. June 15, 1961, the President asked the Chairman of the National Aeronautics and Space Council to have recommendations prepared for communications satellite policy. Under direction of the Council staff, interagency meetings were held; policy recommendations were drafted; and those recommendations were acted upon unanimously by the Council.
- b. July 14, 1961, the President approved and released the policy statement, which stressed the public interest objectives in obtaining a global system as soon as technically feasible. This policy stated that private ownership and operation of the U.S. portion of the system is favored, provided that the public interest is adequately protected through opportunities for foreign participation, non-discriminatory use of and equitable access to the system, and effective competition in the acquisition of equipment and in the structure of ownership and control.
- c. In the fall of 1961, the President requested the staff of the Council to draft recommendations in order that the communications satellite policy could be effectively implemented. Under the direction of the Council staff, interagency drafting sessions were held, and the proposed bill was prepared and transmitted to the President.
- d. February 7, 1962, the President sent the proposed legislation to the Congress and, in his accompanying message, urged that it be given prompt and favorable consideration.
- e. Extensive hearings were held in the Congress. Six different committees called witnesses and participated in a thorough examination of the communications satellite policy and proposed legislation. After such committee actions, explanation and debate took place prior to votes in both the House and the Senate. The House passed a bill by a 354 to 9 vote on May 3; the Senate passed its corresponding version of a bill by a 66 to 11 vote on August 11; and the House acted to accept the Senate bill by a 377 to 10 vote on August 27.

- f. August 31, 1962, the bill was signed by the President and became law.
- g. October 4, 1962, the President nominated 13 distinguished citizens to be Incorporators, with the statutory responsibility for taking the necessary actions to establish a Communications Satellite Corporation.

The Incorporators, under interim appointments, have held a number of meetings to consider and initiate the steps required to organize the corporation and to apply for a charter under the District of Columbia Business Incorporation Act, as provided under the terms of the Communications Satellite Act.

The Communications Satellite Act of 1962 incorporates the major objectives of the President's policy statement of July 24, 1961. It provides authority for the creation of a private corporation to serve as the United States portion of any global system. It will be privately financed and the essential business management will be in the hands of 12 directors elected by the stockholders and 3 directors appointed by the President and confirmed by the Senate. At the same time that the benefits of profit-making incentives and private management are obtained, the Act is most careful to identify national policy objectives in relation to the use of commercial communications satellites and to provide the machinery within Government for the regulation of and assistance to the corporation. In such a framework, it is expected that the services the corporation provides and the way it conducts its business will be wholly responsive to the several objectives of the Act.



Public Law 87-624  
87th Congress, H. R. 11040  
August 31, 1962

**An Act**

76 STAT. 419.

To provide for the establishment, ownership, operation, and regulation of a commercial communications satellite system, and for other purposes.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,*

**TITLE I—SHORT TITLE, DECLARATION OF POLICY AND DEFINITIONS**

**SHORT TITLE**

SEC. 101. This Act may be cited as the "Communications Satellite Act of 1962".

**DECLARATION OF POLICY AND PURPOSE**

SEC. 102. (a) The Congress hereby declares that it is the policy of the United States to establish, in conjunction and in cooperation with other countries, as expeditiously as practicable a commercial communications satellite system, as part of an improved global communications network, which will be responsive to public needs and national objectives, which will serve the communication needs of the United States and other countries, and which will contribute to world peace and understanding.

(b) The new and expanded telecommunication services are to be made available as promptly as possible and are to be extended to provide global coverage at the earliest practicable date. In effectuating this program, care and attention will be directed toward providing such services to economically less developed countries and areas as well as those more highly developed, toward efficient and economical use of the electromagnetic frequency spectrum, and toward the reflection of the benefits of this new technology in both quality of services and charges for such services.

(c) In order to facilitate this development and to provide for the widest possible participation by private enterprise, United States participation in the global system shall be in the form of a private corporation, subject to appropriate governmental regulation. It is the intent of Congress that all authorized users shall have nondiscriminatory access to the system; that maximum competition be maintained in the provision of equipment and services utilized by the system; that the corporation created under this Act be so organized and operated as to maintain and strengthen competition in the provision of communications services to the public; and that the activities of the corporation created under this Act and of the persons or companies participating in the ownership of the corporation shall be consistent with the Federal antitrust laws.

(d) It is not the intent of Congress by this Act to preclude the use of the communications satellite system for domestic communication services where consistent with the provisions of this Act nor to preclude the creation of additional communications satellite systems, if required to meet unique governmental needs or if otherwise required in the national interest.

**DEFINITIONS**

SEC. 103. As used in this Act, and unless the context otherwise requires—

(1) the term "communications satellite system" refers to a system of communications satellites in space whose purpose is to relay telecommunication information between satellite terminal sta-

tions, together with such associated equipment and facilities for tracking, guidance, control, and command functions as are not part of the generalized launching, tracking, control, and command facilities for all space purposes;

(2) the term "satellite terminal station" refers to a complex of communication equipment located on the earth's surface, operationally connected with one or more terrestrial communication systems, and capable of transmitting telecommunications to or receiving telecommunications from a communications satellite system.

(3) the term "communications satellite" means an earth satellite which is intentionally used to relay telecommunication information;

(4) the term "associated equipment and facilities" refers to facilities other than satellite terminal stations and communications satellites, to be constructed and operated for the primary purpose of a communications satellite system, whether for administration and management, for research and development, or for direct support of space operations;

(5) the term "research and development" refers to the conception, design, and first creation of experimental or prototype operational devices for the operation of a communications satellite system, including the assembly of separate components into a working whole, as distinguished from the term "production," which relates to the construction of such devices to fixed specifications compatible with repetitive duplication for operational applications; and

(6) the term "telecommunication" means any transmission, emission or reception of signs, signals, writings, images, and sounds or intelligence of any nature by wire, radio, optical, or other electromagnetic systems.

(7) the term "communications common carrier" has the same meaning as the term "common carrier" has when used in the Communications Act of 1934, as amended, and in addition includes, but only for purposes of sections 303 and 304, any individual, partnership, association, joint-stock company, trust, corporation, or other entity which owns or controls, directly or indirectly, or is under direct or indirect common control with, any such carrier; and the term "authorized carrier", except as otherwise provided for purposes of section 304 by section 304(b)(1), means a communications common carrier which has been authorized by the Federal Communications Commission under the Communications Act of 1934, as amended, to provide services by means of communications satellites;

(8) the term "corporation" means the corporation authorized by title III of this Act.

(9) the term "Administration" means the National Aeronautics and Space Administration; and

(10) the term "Commission" means the Federal Communications Commission.

TITLE II—FEDERAL COORDINATION, PLANNING, AND  
REGULATION

IMPLEMENTATION OF POLICY

SEC. 201. In order to achieve the objectives and to carry out the purposes of this Act—

(a) the President shall—

(1) aid in the planning and development and foster the execution of a national program for the establishment and operation, as expeditiously as possible, of a commercial communications satellite system;

(2) provide for continuous review of all phases of the development and operation of such a system, including the activities of a communications satellite corporation authorized under title III of this Act;

(3) coordinate the activities of governmental agencies with responsibilities in the field of telecommunication, so as to insure that there is full and effective compliance at all times with the policies set forth in this Act;

(4) exercise such supervision over relationships of the corporation with foreign governments or entities or with international bodies as may be appropriate to assure that such relationships shall be consistent with the national interest and foreign policy of the United States;

(5) insure that timely arrangements are made under which there can be foreign participation in the establishment and use of a communications satellite system;

(6) take all necessary steps to insure the availability and appropriate utilization of the communications satellite system for general governmental purposes except where a separate communications satellite system is required to meet unique governmental needs, or is otherwise required in the national interest; and

(7) so exercise his authority as to help attain coordinated and efficient use of the electromagnetic spectrum and the technical compatibility of the system with existing communications facilities both in the United States and abroad.

(b) the National Aeronautics and Space Administration shall—

(1) advise the Commission on technical characteristics of the communications satellite system;

(2) cooperate with the corporation in research and development to the extent deemed appropriate by the Administration in the public interest;

(3) assist the corporation in the conduct of its research and development program by furnishing to the corporation, when requested, on a reimbursable basis, such satellite launching and associated services as the Administration deems necessary for the most expeditious and economical development of the communications satellite system;

(4) consult with the corporation with respect to the technical characteristics of the communications satellite system;

(5) furnish to the corporation, on request and on a reimbursable basis, satellite launching and associated services required for the establishment, operation, and maintenance of the communications satellite system approved by the Commission; and

(6) to the extent feasible, furnish other services, on a reimbursable basis, to the corporation in connection with the establishment and operation of the system.

(c) the Federal Communications Commission, in its administration of the provisions of the Communications Act of 1934, as amended, and as supplemented by this Act, shall—

(1) insure effective competition, including the use of competitive bidding where appropriate, in the procurement by the corporation and communications common carriers of apparatus, equipment, and services required for the establishment and operation of the communications satellite system and satellite terminal stations; and the Commission shall consult with the Small Business Administration and solicit its recommendations on measures and procedures which will insure that small business concerns are given an equitable opportunity to share in the procurement program of the corporation for property and services, including but not limited to research, development, construction, maintenance, and repair.

(2) insure that all present and future authorized carriers shall have nondiscriminatory use of, and equitable access to, the communications satellite system and satellite terminal stations under just and reasonable charges, classifications, practices, regulations, and other terms and conditions and regulate the manner in which available facilities of the system and stations are allocated among such users thereof;

(3) in any case where the Secretary of State, after obtaining the advice of the Administration as to technical feasibility, has advised that commercial communication to a particular foreign point by means of the communications satellite system and satellite terminal stations should be established in the national interest, institute forthwith appropriate proceedings under section 214(d) of the Communications Act of 1934, as amended, to require the establishment of such communication by the corporation and the appropriate common carrier or carriers;

(4) insure that facilities of the communications satellite system and satellite terminal stations are technically compatible and interconnected operationally with each other and with existing communications facilities;

(5) prescribe such accounting regulations and systems and engage in such ratemaking procedures as will insure that any economies made possible by a communications satellite system are appropriately reflected in rates for public communication services;

(6) approve technical characteristics of the operational communications satellite system to be employed by the corporation and of the satellite terminal stations; and

(7) grant appropriate authorizations for the construction and operation of each satellite terminal station, either to the corporation or to one or more authorized carriers or to the corporation and one or more such carriers jointly, as will best serve the public interest, convenience, and necessity. In determining the public interest, convenience, and necessity the Commission shall authorize the construction and operation of such stations by communications common carriers or the corporation, without preference to either;

(8) authorize the corporation to issue any shares of capital stock, except the initial issue of capital stock referred to in section 304(a), or to borrow any moneys, or to assume any

obligation in respect of the securities of any other person, upon a finding that such issuance, borrowing, or assumption is compatible with the public interest, convenience, and necessity and is necessary or appropriate for or consistent with carrying out the purposes and objectives of this Act by the corporation;

(9) insure that no substantial additions are made by the corporation or carriers with respect to facilities of the system or satellite terminal stations unless such additions are required by the public interest, convenience, and necessity;

(10) require, in accordance with the procedural requirements of section 214 of the Communications Act of 1934, as amended, that additions be made by the corporation or carriers with respect to facilities of the system or satellite terminal stations where such additions would serve the public interest, convenience, and necessity; and

(11) make rules and regulations to carry out the provisions of this Act.

### TITLE III—CREATION OF A COMMUNICATIONS SATELLITE CORPORATION

#### CREATION OF CORPORATION

SEC. 301. There is hereby authorized to be created a communications satellite corporation for profit which will not be an agency or establishment of the United States Government. The corporation shall be subject to the provisions of this Act and, to the extent consistent with this Act, to the District of Columbia Business Corporation Act. The right to repeal, alter, or amend this Act at any time is expressly reserved.

#### PROCESS OF ORGANIZATION

SEC. 302. The President of the United States shall appoint incorporators, by and with the advice and consent of the Senate, who shall serve as the initial board of directors until the first annual meeting of stockholders or until their successors are elected and qualified. Such incorporators shall arrange for an initial stock offering and take whatever other actions are necessary to establish the corporation, including the filing of articles of incorporation, as approved by the President.

#### DIRECTORS AND OFFICERS

SEC. 303. (a) The corporation shall have a board of directors consisting of individuals who are citizens of the United States, of whom one shall be elected annually by the board to serve as chairman. Three members of the board shall be appointed by the President of the United States, by and with the advice and consent of the Senate, effective the date on which the other members are elected, and for terms of three years or until their successors have been appointed and qualified, except that the first three members of the board so appointed shall continue in office for terms of one, two, and three years, respectively, and any member so appointed to fill a vacancy shall be appointed only for the unexpired term of the director whom he succeeds. Six members of the board shall be elected annually by those stockholders who are communications common carriers and six shall be elected annually by the other stockholders of the corporation. No stockholder who is a communications common carrier and no trustee for such a stockholder shall vote, either directly or indirectly, through the votes of subsidiaries or affiliated companies, nominees, or any persons subject to

his direction or control, for more than three candidates for membership on the board. Subject to such limitation, the articles of incorporation to be filed by the incorporators designated under section 302 shall provide for cumulative voting under section 27(d) of the District of Columbia Business Corporation Act (D.C. Code, sec. 29-911(d)).

(b) The corporation shall have a president, and such other officers as may be named and appointed by the board, at rates of compensation fixed by the board, and serving at the pleasure of the board. No individual other than a citizen of the United States may be an officer of the corporation. No officer of the corporation shall receive any salary from any source other than the corporation during the period of his employment by the corporation.

#### FINANCING OF THE CORPORATION

SEC. 304. (a) The corporation is authorized to issue and have outstanding, in such amounts as it shall determine, shares of capital stock, without par value, which shall carry voting rights and be eligible for dividends. The shares of such stock initially offered shall be sold at a price not in excess of \$100 for each share and in a manner to encourage the widest distribution to the American public. Subject to the provisions of subsections (b) and (d) of this section, shares of stock offered under this subsection may be issued to and held by any person.

(b) (1) For the purposes of this section the term "authorized carrier" shall mean a communications common carrier which is specifically authorized or which is a member of a class of carriers authorized by the Commission to own shares of stock in the corporation upon a finding that such ownership will be consistent with the public interest, convenience, and necessity.

(2) Only those communications common carriers which are authorized carriers shall own shares of stock in the corporation at any time, and no other communications common carrier shall own shares either directly or indirectly through subsidiaries or affiliated companies, nominees, or any persons subject to its direction or control. Fifty per centum of the shares of stock authorized for issuance at any time by the corporation shall be reserved for purchase by authorized carriers and such carriers shall in the aggregate be entitled to make purchases of the reserved shares in a total number not exceeding the total number of the nonreserved shares of any issue purchased by other persons. At no time after the initial issue is completed shall the aggregate of the shares of voting stock of the corporation owned by authorized carriers directly or indirectly through subsidiaries or affiliated companies, nominees, or any persons subject to their direction or control exceed 50 per centum of such shares issued and outstanding.

(3) At no time shall any stockholder who is not an authorized carrier, or any syndicate or affiliated group of such stockholders, own more than 10 per centum of the shares of voting stock of the corporation issued and outstanding.

(c) The corporation is authorized to issue, in addition to the stock authorized by subsection (a) of this section, nonvoting securities, bonds, debentures, and other certificates of indebtedness as it may determine. Such nonvoting securities, bonds, debentures, or other certificates of indebtedness of the corporation as a communications common carrier may own shall be eligible for inclusion in the rate base of the carrier to the extent allowed by the Commission. The vot-



ing stock of the corporation shall not be eligible for inclusion in the rate base of the carrier.

(d) Not more than an aggregate of 20 per centum of the shares of stock of the corporation authorized by subsection (a) of this section which are held by holders other than authorized carriers may be held by persons of the classes described in paragraphs (1), (2), (3), (4), and (5) of section 310(a) of the Communications Act of 1934, as amended (47 U.S.C. 310).

(e) The requirement of section 45(b) of the District of Columbia Business Corporation Act (D.C. Code, sec. 29-920(b)) as to the percentage of stock which a stockholder must hold in order to have the rights of inspection and copying set forth in that subsection shall not be applicable in the case of holders of the stock of the corporation, and they may exercise such rights without regard to the percentage of stock they hold.

(f) Upon application to the Commission by any authorized carrier and after notice and hearing, the Commission may compel any other authorized carrier which owns shares of stock in the corporation to transfer to the applicant, for a fair and reasonable consideration, a number of such shares as the Commission determines will advance the public interest and the purposes of this Act. In its determination with respect to ownership of shares of stock in the corporation, the Commission, whenever consistent with the public interest, shall promote the widest possible distribution of stock among the authorized carriers.

PURPOSES AND POWERS OF THE CORPORATION

SEC. 305. (a) In order to achieve the objectives and to carry out the purposes of this Act, the corporation is authorized to—

(1) plan, initiate, construct, own, manage, and operate itself or in conjunction with foreign governments or business entities a commercial communications satellite system;

(2) furnish, for hire, channels of communication to United States communications common carriers and to other authorized entities, foreign and domestic; and

(3) own and operate satellite terminal stations when licensed by the Commission under section 201(c)(7).

(b) Included in the activities authorized to the corporation for accomplishment of the purposes indicated in subsection (a) of this section, are, among others not specifically named—

(1) to conduct or contract for research and development related to its mission;

(2) to acquire the physical facilities, equipment and devices necessary to its operations, including communications satellites and associated equipment and facilities, whether by construction, purchase, or gift;

(3) to purchase satellite launching and related services from the United States Government;

(4) to contract with authorized users, including the United States Government, for the services of the communications satellite system; and

(5) to develop plans for the technical specifications of all elements of the communications satellite system.

(c) To carry out the foregoing purposes, the corporation shall have the usual powers conferred upon a stock corporation by the District of Columbia Business Corporation Act.

TITLE IV—MISCELLANEOUS

APPLICABILITY OF COMMUNICATIONS ACT OF 1934

SEC. 401. The corporation shall be deemed to be a common carrier within the meaning of section 3(h) of the Communications Act of 1934, as amended, and as such shall be fully subject to the provisions of title II and title III of that Act. The provision of satellite terminal station facilities by one communication common carrier to one or more other communications common carriers shall be deemed to be a common carrier activity fully subject to the Communications Act. Whenever the application of the provisions of this Act shall be inconsistent with the application of the provisions of the Communications Act, the provisions of this Act shall govern.

NOTICE OF FOREIGN BUSINESS NEGOTIATIONS

SEC. 402. Whenever the corporation shall enter into business negotiations with respect to facilities, operations, or services authorized by this Act with any international or foreign entity, it shall notify the Department of State of the negotiations, and the Department of State shall advise the corporation of relevant foreign policy considerations. Throughout such negotiations the corporation shall keep the Department of State informed with respect to such considerations. The corporation may request the Department of State to assist in the negotiations, and that Department shall render such assistance as may be appropriate.

SANCTIONS

SEC. 403. (a) If the corporation created pursuant to this Act shall engage in or adhere to any action, practices, or policies inconsistent with the policy and purposes declared in section 102 of this Act, or if the corporation or any other person shall violate any provision of this Act, or shall obstruct or interfere with any activities authorized by this Act, or shall refuse, fail, or neglect to discharge his duties and responsibilities under this Act, or shall threaten any such violation, obstruction, interference, refusal, failure, or neglect, the district court of the United States for any district in which such corporation or other person resides or may be found shall have jurisdiction, except as otherwise prohibited by law, upon petition of the Attorney General of the United States, to grant such equitable relief as may be necessary or appropriate to prevent or terminate such conduct or threat.

(b) Nothing contained in this section shall be construed as relieving any person of any punishment, liability, or sanction which may be imposed otherwise than under this Act.

(c) It shall be the duty of the corporation and all communications common carriers to comply, insofar as applicable, with all provisions of this Act and all rules and regulations promulgated thereunder.

REPORTS TO THE CONGRESS

SEC. 404. (a) The President shall transmit to the Congress in January of each year a report which shall include a comprehensive description of the activities and accomplishments during the preceding calendar year under the national program referred to in section 201(a)(1), together with an evaluation of such activities and accomplishments in terms of the attainment of the objectives of this Act and any recommendations for additional legislative or other action which the President may consider necessary or desirable for the attainment of such objectives.

(b) The corporation shall transmit to the President and the Congress, annually and at such other times as it deems desirable, a comprehensive and detailed report of its operations, activities, and accomplishments under this Act.

(c) The Commission shall transmit to the Congress, annually and at such other times as it deems desirable, (i) a report of its activities and actions on anticompetitive practices as they apply to the communications satellite programs; (ii) an evaluation of such activities and actions taken by it within the scope of its authority with a view to recommending such additional legislation which the Commission may consider necessary in the public interest; and (iii) an evaluation of the capital structure of the corporation so as to assure the Congress that such structure is consistent with the most efficient and economical operation of the corporation.

**Approved August 31, 1962, 9:51 a.m.**

SPACE ACTIVITIES OF THE UNITED STATES GOVERNMENT  
Historical Summary and 1964 Budget Recommendations  
 January 17, 1963

(In millions of dollars)

	<u>NASA</u> <sup>1/</sup>	<u>Dept of Defense</u>	<u>AEC</u>	<u>Weather Bureau</u>	<u>NSF</u>	<u>Total Space</u>
<u>New Obligational Authority</u>						
<u>Historical</u>						
1955	56.9	3.0	-	-	-	59.9
1956	72.7	30.3	7.0	-	7.3	117.3
1957	78.2	71.0	21.3	-	8.4	178.9
1958	117.3	205.6	21.3	-	3.3	347.5
1959	338.9	489.5	34.3	-	-	862.7
1960	523.6	560.9	43.3	-	.1	1127.9
1961	926.2	793.8	67.7	-	.6	1788.3
1962	1796.0	1284.3	147.8	50.7	1.3	3280.1
<u>1964 Budget</u>						
1963	3622.6	1617.6	228.9	43.2	1.5	5513.8
1964	5663.6	1667.6	254.3	26.2	2.3	7614.0
<u>Expenditures</u>						
<u>Historical</u>						
1955	73.8	1.5	-	-	-	75.3
1956	71.1	16.5	6.3	-	6.2	100.1
1957	76.1	47.5	19.2	-	7.3	150.1
1958	89.2	135.5	20.2	-	4.0	248.9
1959	145.5	341.0	32.6	-	1.5	520.6
1960	401.0	518.1	41.1	-	-	960.2
1961	694.0	710.0	64.3	-	-	1468.3
1962	1229.0	1028.8	130.0	1.0	.9	2389.7
<u>1964 Budget</u>						
1963	2358.0	1421.0	190.6	19.3	1.1	3990.0
1964	4154.0	1622.0	247.1	44.7	1.5	6069.3

<sup>1/</sup> Excludes amounts for aircraft technology in 1961 and succeeding years.  
 Amounts for NASA-NACA aircraft and space activities not separately identifiable  
 prior to 1961.

Note - Historical amounts are estimates based on best data available.

Source: Bureau of Budget

SPACE ACTIVITIES

1964 Budget Document

January 17, 1963

(In millions of dollars)

<u>NASA</u>	New obligational authority			Expenditures		
	1962 <u>actual</u>	1963 <u>est.</u>	1964 <u>est.</u>	1962 <u>actual</u>	1963 <u>est.</u>	1964 <u>est.</u>
<u>Space Research &amp; Technology</u> <sup>1/</sup>						
Manned space flight .....	923.2	2242.1	3758.2	547.4	1376.0	2713.0
Space applications.....	76.2	118.1	140.7	60.6	82.0	124.0
Unmanned investigations in space.....	429.2	603.0	780.3	337.4	441.0	593.0
Space research & technology.	231.8	437.9	538.8	196.1	281.0	475.0
Aircraft technology.....	28.9	50.7	48.4	28.0	42.0	46.0
Supporting operations & other	132.4	235.9	445.6	87.5	178.0	249.0
Total, budget plan basis...	1821.7	3687.7	5712.0	1257.0	2400.0	4200.0
Adjustment to NOA basis..	+3.2	-14.4	-	-	-	-
 Total, Space Research & Technology (equals total NASA)	1824.9	3673.3	5712.0	1257.0	2400.0	4200.0
 <u>Federal Space Programs</u> <sup>2/</sup>						
NASA .....	1796.0	3622.6	5663.6	1229.0	2358.0	4154.0
Department of Defense.....	1284.3	1617.6	1667.6	1028.8	1421.0	1622.0
Atomic Energy Commission	147.8	228.9	254.3	130.0	190.6	247.1
Department of Commerce:						
Weather Bureau.....	50.7	43.2	26.2	1.0	19.3	44.7
National Science Foundation.	1.3	1.5	2.3	.9	1.1	1.5
 Total.....	3280.1	5513.8	7614.0	2389.7	3990.0	6069.3

<sup>1/</sup> The budget function "Space Research and Technology" consists by definition of the NASA agency totals only. See discussion and tables on pages 18, 75, 284, and 393-4 in the Budget and pages 781-7 in the Appendix.

<sup>2/</sup> See summary of Federal Space Programs on pages 403-04 in the Budget.

Source: Bureau of the Budget