Statement of

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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Committee on Science and Astronautics
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Mr. Chairman and members of the subcommittee:

We welcome this opportunity to report on NASA's continuing efforts to carry out a mandate imposed by the Congress in the National Aeronautics and Space Act of 1958. The Act, of course, directed NASA to conduct its aeronautical and space activities so as to contribute materially to cooperation with other nations and groups of nations. In particular, I welcome the opportunity to appear at the first hearings of this new subcommittee. We look forward to working with you in your area of interest and stand ready to help in any way we can.

For my report to you this morning:

-- First, I propose to review the basic guidelines which we have followed in our international activities. I do this because of the importance of the guidelines for both the character and value of our program.

-- Second, I will describe in general terms the extent of our programs.

-- Next, I would like to illustrate the programs in depth by treating three project areas in some depth.

-- I mean to say something of the tangible benefits of our program.

-- And finally, I should like to review two major, current areas in which we are seeking to extend international cooperation in space for the '70s.

I Program guidelines

Turning now to the first of these topics, our program guidelines:

(1) We have attempted to fashion as concrete a program as possible, with clearly defined objectives and responsibilities in each and every case. This has led us to proceed on a project-by-project basis. We do not enter into generalized agreements whose implementation and substance are uncertain.

(2) Each project is tested against its scientific or technical validity. While the intangible values of international cooperation are fully appreciated, we believe they may be achieved best, perhaps, through projects valid in themselves.

(3) Each project requires contributions by all the participants, not necessarily on an equal basis, but sufficient in each case to make the project more valuable to each participant than going it alone. Thus, responsibilities are shared in a literal, not merely in a notional sense.

(4) Each nation participating in a cooperative project funds its own responsibilities. We do not exchange funds. Thus, there is no giveaway element and both sides gain.

II General Program Description

Under these rigorous guidelines we have developed cooperative projects and associations over the past decade in most aspects of our national space program--in small and large satellite projects, in sounding rocket investigations, in ground-based participation in our flight programs, in the operation of our tracking and data acquisition network, in the collection and distribution of technical and scientific reports, and in our aeronautical programs.

We have, for example, launched 16 foreign contributed satellites and agreed to launch 15 more--conceived, built and funded abroad. We have selected, on their merits, nearly two dozen significant foreign experiments which have been contributed for flight on our own satellites. We have participated in more than 600 cooperative scientific rocket soundings from scientific vantage points in all quarters of the world. We have involved more than 250 foreign scientists in the analysis of lunar samples--on the merits of their proposals. We have provided for direct daily reception of data from our weather satellites by some 50 countries. We have stimulated the construction of major ground stations in a dozen countries in the experimental testing of communications satellites, contributing directly to the establishment of

Intelsat. Foreign nationals have participated in, and contributed importantly to, the operation of our overseas tracking and data acquisition facilities. On the aeronautics side, we have carried on cooperative projects with Canadian, French, German, and British agencies in the development and testing of a variety of V/STOL aircraft configurations.

These and other activities have produced some 250 agreements with 35 countries, engaged scientists and technicians in over 70 countries, and accounted for joint expenditures by us and our collaborators of over $300 million since 1961, over $500 million when current projects have been completed. Some two-thirds of this figure represents foreign expenditures.

III Examples of Cooperative Activities

Project Helios

Project Helios is a $100 million plus project with the German Ministry for Science and Education for the preparation and launching of two probes to within 45 million kilometers of the sun. The Helios probes are designed to fly closer to the sun than the planet Mercury--and thus to contribute importantly to an understanding of solar processes and solar-terrestrial relationships. It should also be possible to improve estimates of the mass and orbital elements of the planets--a task that will require the most precise spacecraft ranging.

Under our agreement, Germany will design, manufacture, and integrate the two spacecraft, provide the German experiments (which constitute the bulk of the payload), operate and control the spacecraft from a German control center, and provide data to all the experimenters. NASA will provide two advanced launch vehicles of the Atlas/Centaur or Titan/Centaur class, certain experiments, coordination with Italian and Australian co-experimenters, and the use of the NASA deep-space network to support the mission. The spacecraft will weigh about 205 kilograms each and will be launched into heliocentric orbits in the 1974-76 time frame. The Helios project is the German response to suggestions by a NASA team traveling in Europe in 1964 to propose more significant cooperative space projects than had yet been engineered. Agreement in principle was reached in 1966; a year later, a Joint Mission Definition Group began a two-year comprehensive study. The group's final report in April 1969 led to the signing of a memorandum of understanding in June.

The Helios spacecraft impose technical requirements of an advanced character on German industry, particularly for the development of the on-board power system and thermal controls, which must cope with radiation at the level of 11 solar constants. On-board data-processing systems must also be highly sophisticated. The scientific payloads themselves will be contributed by a large group of experimenters, who represent 12 universities and government laboratories in Germany, the United States, Italy and Australia.

As in all of NASA's cooperative satellite projects, Helios will be managed by a Joint Working Group, which will monitor technical implementation, focussing primarily on the interfaces between the spacecraft and the booster and between the spacecraft and its payload. The Joint Working Group is an important and tested mechanism for ensuring full and successful cooperation.

Direct Community Instructional TV Broadcasting

Helios illustrates a cooperative endeavor suited for advanced countries with established scientific and engineering communities and the resources to devote to the development of sophisticated flight hardware. The NASA international program is not limited to cooperation with such highly developed nations.

There is, for example, a most exciting program now under way with the Department of Atomic Energy (DAE), parent agency for space activities in India. This project involves an experiment in the broadcasting of instructional television via satellite to some 5000 remote Indian villages, nearly half of which will receive programs directly from space into the community TV-viewing sets.

The basis for India's urgent interest in such an experiment is apparent enough. India today possesses a single television transmitter, located in New Delhi. A

substantial proportion of her half-million villages are so isolated that the government has no effective means of communication with their largely illiterate inhabitants. Yet national programs to develop population controls and to increase agricultural productivity require immediate and effective assistance through local instruction and education.

The experiment is made possible by advances in NASA's series of Applications Technology Satellites (ATS). The ATS-F satellite, to be launched in 1973, will increase on-board power to 80 watts, will achieve high gain by means of a 9.1-meter parabolic antenna to be deployed in space, and will point the antenna with extreme precision. These features will make it feasible for the first time to broadcast television directly into the viewing set. The receiver must, however, be augmented by the addition of a preamplifier, a modulation converter, and a parabolic antenna with a diameter of about 3 meters. The total cost of such a receiver-viewer is expected to be a few hundred dollars.

The combination of ATS-F satellite and augmented receiver will bring television directly into the villages without a costly intermediary network of large ground terminals and microwave links. (Actually, the India experiment will be a hybrid one; where villages are densely clustered, ground-relay stations will distribute the satellite programs to conventional receivers.)

The ATS-F satellite will first be used for about a year in the Western Hemisphere by U.S. agencies for the primary purpose of performing about 18 experiments in communications development and environmental factors.

NASA will then make ATS-F available to India for a year of broadcasting, by India, devoted to family planning, agricultural improvements, national integration, and other educational programs. To make this possible, the satellite will be nudged farther east in its synchronous orbit until it comes into line of sight of an existing experimental ground station at Ahmedabad. That station and perhaps others will transmit television programs, formulated and controlled by India, to the satellite for rebroadcast to village receivers and to three relay stations. The programs will go out on one video and two audio channels. Thus, simultaneous broadcasting in two languages will be possible. If two or three regions use the service at different periods of the day, such time sharing can increase this to four or six languages.

Since the contributions of the United States to the Indian experiment will be made in the course of a program already in process for technological development purposes, it entails only modest incremental costs to NASA. The satellite transponder for the Indian experiment and the relocation of a small ground-control station together represent little more than 1 percent of the total cost of the ATS-F and ATS-G projects (which are combined in NASA's

programming). The cost to India for the development and conduct of the experiment may exceed $15 million--most of which can be met in rupees. Under the agreement, each side is responsible for its own costs.

India's programmatic responsibilities are clearly substantial. They include the operation of the Ahmedabad station; the construction and operation of relay stations; the design, production, distribution, and maintenance of receivers; the development, scheduling, and production of effective television programs; the organization of village audiences and provision for their access to the equipments and supplies whose availability is implied by instructional programs; and more. The effort can hardly avoid stimulating substantial industrial and managerial progress of broad value to India--in addition to attacking the immediate objectives stated in the cooperative agreement.

An important element in the extended history of the India project was a year-long joint study to assess the relevance of the experiment to a national television system which India might later establish--based either on satellites or on conventional ground-distribution links. This study convinced India that it might save two-thirds by selecting the satellite alternative. Thus, a fixed annual expenditure would give India a national communications system covering all its communities in 10 rather than the 30 years required for conventional television links.

The U.S.-India experiment in instructional television by satellite will be closely watched by other developing countries and by those Westerners who hope that advanced technology can be of some use in attacking larger social problems in the developing world. Brazil, for example, has also expressed interest in the use of community broadcast satellites to complement a larger national education program, and the responsible Indian agency has invited Brazilian observation and participation in the Indian experiment. A United Nations Working Group on Direct Broadcasting has encouraged experiments of this type and will undoubtedly follow this one carefully. The experiment may also establish a valuable precedent for the proper use of direct broadcasting capabilities and may help to direct present concerns over possible abuses into constructive channels.

Earth Resources Surveying

An example of international cooperation that holds special interest for developing and advanced countries alike is earth resources surveying by satellite. Many see earth resources surveying as a most promising means by which space technology can help nations accelerate their development and improve the management of their environment and resources. Others advocate caution in forecasting the ultimate economic gains. Until NASA has flown its Earth Resources Technology Satellites, some balance seems indicated. On the one hand, we wish to avoid stimulating

other countries to premature or excessive commitment of scarce funds and skills. On the other hand, it is important to give appropriate notice of a possible significant new aid to national development so that those who wish can begin to develop the expertise which will be necessary to utilize it.

The principal examples of ERS preparatory projects in the international area are NASA's arrangements with Brazil and Mexico in the aircraft phase of our ERS program. These arrangements are predicated on the inherent economic utility of aircraft sensing programs. Brazilian and Mexican managers, scientists, and engineers have been trained at the NASA Manned Spacecraft Center in Houston, in field work with user agencies, and at a special course organized at the University of Michigan. NASA instrumented aircraft have overflown test sites in both countries, and both countries have conducted their own domestic aircraft surveys. These activities should help to develop the skills and ground truth necessary for the use of satellite data when it becomes available. The data have been shared with us and we have learned something of ground characteristics quite different from our own. We believe also that we have made important contributions to an international climate favorable to ERS programs.

Indian agencies have undertaken a similar domestic aircraft program with advice and assistance from NASA.

An immediate practical application was identified at an early stage: a coconut palm blight of unknown extent had been detected in Kerala State. An Indian aircraft was instrumented and has already surveyed the region to map the spread of the blight by means of infrared or color film techniques. Indian reports indicate that the airborne sensors could detect diseased trees with no symptoms visible at all to the naked eye. Informed countermeasures can now be taken. Technical expertise developed through a NASA-supported university program in the United States is being made available.

In his September 1969 speech to the United Nations General Assembly, President Nixon made special mention of the prospects of benefits through earth resources survey techniques from space. He promised that the United States would make the data of its future program available to all and would work toward ways to provide for international participation "as this program proceeds and fulfills its promise." In coordination with other domestic agencies participating in the U.S. Earth Resources Survey Program, we have continued to inform the international community of the prospects for ERS coverage and to provide opportunities for orientation and training in the interim period before such coverage becomes a reality. The most recent example of this activity was the NASA-initiated International Workshop on Earth Resources Survey Systems which was

concluded last Friday in Ann Arbor. A measure of the world interest in the potential of ERS is the fact that representatives of 53 countries and international organizations attended at their own expense. Still another graphic illustration of world interest in the use of space techniques for earth resource surveys is the remarkable response which we have received to our invitation to investigators to propose experimental uses of the data to be gathered by ERTS-A. We have received some 80 proposals from would-be investigators in some 28 countries.

IV Program Benefits

I have dwelt at some length on just three examples of the NASA international program in order to give you a sense of their concrete and substantive character, their extensive division of responsibilities, and their broad values. I would like to say a word about their very real benefit to the United States and her cooperating partners:

There are significant cost savings, i.e., we get scientific and technical results at less cost to the United States. For example, when Canada assumes responsibility for a series of satellites in the NASA ionospheric research program, when Germany undertakes a major solar probe program with us, and when countries such as Brazil, India, and Norway provide extensive range support for sounding rocket projects which require their unique geographical locations, I have already noted that our partners have actually spent well over half the total cost of our joint projects.

There are rich scientific benefits when gifted foreign experimenters win opportunities to fly their instruments on NASA satellites after vigorous competitive selection. Scientific benefits have also come, for example, from wholly new data obtained from the cooperative Canadian topside sounder satellites and the Italian atmospheric density satellites, from such new techniques as the German barium cloud procedure for investigating the earth's magnetic field in space, and from the global observations which have been organized in support of radio propagation and geodetic satellite programs.

There are technological benefits when, in joint projects, Canadian engineers pioneered in swept-frequency ionospheric sounders and in extensible spacecraft booms and French engineers advanced the state of the art in balloon technology, remote sensors, spacecraft engineering, and aircraft hazard testing.

I am confident also that the nation and the world are deriving important intangible benefits--political benefits, if you will--from the open and peaceful U.S. space program. Certainly, the quantum jump which India can take toward a national communications system through space techniques can have the most profound and far-reaching effects not only in India but, through India, in the entire world.

Especially significant for the future, I believe, are the contributions that NASA cooperative space projects are

making to the development of institutions and expertise abroad. They have played a catalytic role in the establishment of national civilian space organizations throughout much of the free world and in the creation of effective new space science and technology centers.

V Major Objectives for the Seventies

It is apparent, in what I have so far reported regarding our international activities during the sixties, that joint projects did not materialize in connection with the development of major hardware items, as in the Apollo program for instance, nor was it possible to develop very significant cooperation with the Soviet Union.

These two "gaps" in cooperation area, of course, readily explained. The absence of international cost-sharing in the development of the expensive Saturn and Apollo systems relects our own fast start in these areas and also the limited level of expenditure for space activity in Europe, where we would naturally look first for cooperation in advanced research and development. All of the European countries together have been spending only about $300 million each year on space. This is an order of magnitude less than space expenditures by the United States, and presumably the same order of magnitude less than the space expenditures of the Soviet Union.

In the case of the Soviet Union, U.S. efforts to develop meaningful space cooperation date back to pre-Sputnik days.

A brief period of apparent progress began in 1962 with correspondence between President Kennedy and Chairman Khrushchev and led to four limited agreements in the fields of satellite meteorology, communications, magnetic survey, and space biology and medicine. It did not prove possible, however, despite continuing efforts on our part, to expand these agreements or, indeed, to implement them in the full sense. My own view is that Soviet policies in the sixties did not require direct and substantive engagement in international cooperation. In these years, for example, the Soviet Union did not engage in significant space cooperation with <u>any</u> country. Only recently have the Soviets flown experiments for nations of the Eastern Bloc and landed a French corner reflector for laser ranging on the moon.

Let me now describe very briefly our current efforts to expand international space cooperation in these two areas--major development programs and cooperation with the Soviet Union.

For almost two years, we have made unusual efforts to give the advanced free world countries every chance to become fully acquainted with our major post-Apollo projects, the space shuttle, and the space station. Our purpose has been to put these countries in a position to decide whether or not they would wish to commit their own resources to working with us.

Europe's initial response has been gratifying. The European Space Conference and its members are spending about six million dollars on studies of post-Apollo program possibilities. Half-a-dozen British, French, and West German firms, funded in Europe, are supporting our prime contractors in the space shuttle design studies.

The problem for our European friends is a serious one. They consider they cannot fund significant participation in the shuttle and, at the same time, fund an independent European booster program.

If Europe is to give up the development of an independent launch capability to work with us, it wants assurances that we will sell launch services for European satellite projects. Some of these could involve competitive commercial applications. Quite understandably, Europe wants to know what the other conditions of its participation might be; for instance, what sort of voice it might have in post-Apollo program management and what access it could expect to program technology.

The answers depend in some degree on the character and extent of European technical participation. This has not yet been defined. The management and political conditions must in the end be fitted to a specific technical program. Nevertheless, in meetings with the European Space Conference last September and February, we, with the other agencies concerned, have provided positive and generous

answers to the major questions troubling Europe.

We said that we would sell launch services for projects consistent with peaceful purposes and international agreements. We said that general technical access to the entire program would be available, but that technology at the level of commercial know-how would be transferred in either direction only where one side required it to complete its commitments to the other. We promised broad association in program management, but--since Europe is talking only of a 10 percent share--we said that we must retain decision-making responsibility. The only exception would come where European costs were directly affected, in which case decisions would be joint.

The urgent need now is for Europe to develop a preliminary expression of its technical interests in the Space Transportation System as quickly as possible. Second, we should sit down together to develop this preliminary concept into a joint technical proposition. Third, we should introduce into this technical package the appropriate management and political conditions. The total package would then be open for commitment by nations prepared to go ahead with it.

Whether such a procedure will begin and how far and fast it might then go remain to be seen. We are prepared to proceed on any basis consistent with our national program objectives and the requirements of good management. If Europe chooses that its interests lie elsewhere, we will

continue our programs on our own.

Sooner or later, we in the West must learn to work together on major technical projects so that, in President Nixon's words, we can share both the benefits and the costs of progress.

Let me turn now to current cooperation with the Soviet Union. A new phase in our relationship began in 1969, when President Keldysh of the Soviet Academy of Sciences accepted our suggestion to meet to discuss compatible rendezvous and docking arrangements as well as broader opportunities for cooperation. The rendezvous and docking talks took place in Moscow in October 1970. The more general discussions were held in Moscow last January 1971

The NASA group to discuss rendezvous and docking was headed by Dr. Robert Gilruth, Director of the Manned Spacecraft Center in Houston, and the Soviet side was headed by Academician Boris Petrov, Chairman of an Academy Council for International Cooperation.

The talks were substantive and businesslike. The Soviet side provided technical details as well as access to their simulators at Star City near Moscow. The resulting agreement sets up a procedure by which the two sides can, through a combination of independent and coordinated action, arrive at compatible docking systems. The procedure consists of these steps:

1. First we identified, in the agreement itself, a dozen specific technical elements of the rendezvous and docking process--such as the coordinate systems, visual and electronic aids for rendezvous, docking hardware, and so forth.

2. Next we were to exchange supplementary technical information on subjects not covered in the Moscow talks, for example, on the composition and characteristics of spacecraft atmospheres and voice communications systems. This exchange has been accomplished.

3. Third, each side was to prepare its own draft of the technical requirements for compatibility. These drafts were exchanged in March 1971.

4. Next, three Joint Working Groups will try to develop a single set of technical requirements for compatibility.

5. Finally, each side will design its own independent system to meet the agreed requirements.

6. NASA and the Soviet Academy will then consider what implementing action to take.

In January 1971, the two sides addressed a broader space science and applications agreement. Three days of detailed discussions began in Moscow on January 18. The Soviet delegation was headed by President Keldysh, and

included 15 top Soviet scientists. Dr. Low, then Acting Administrator of NASA, headed the US delegation and was accompanied by Dr. John Naugle and me of NASA, Mr. William Anders of the Space Council, Mr. Arthur Johnson of NOAA, and Mr. Robert Packard of the Department of State.

At the opening session of our talks, Dr. Low conveyed President Nixon's desire to expand international cooperation in space with the Soviet Union and other nations. Again, the discussions were frank and to the point. The document which was prepared jointly and initialed on January 21 summarizes the results of these discussions. An affirming exchange of correspondence was completed on March 26.

The main points of agreement are as follows:

-- We will exchange lunar samples already obtained in the Apollo and Luna programs and set up procedures for a continuing exchange.

-- NOAA and the Soviet Hydrometeorological Service will work directly to bring the current exchanges of weather satellite data up to operational levels. Joint working groups will consider ways of coordinating the weather satellite systems of both countries to achieve the economies and other advantages of complementary systems.

-- In the field of meteorological rocket soundings, a joint working group will develop recommendations for meridional networks in the Western and Eastern hemispheres.

-- In the field of the natural environment, we will try to develop a program for advancing earth resource surveys and analyses, beginning with the oceans and vegetation. To this end we will conduct coordinated surface, air and space research over an agreed international water area. We will also exchange results of coordinated measurements to be made by each country over similar land sites in its own territory.

-- For the scientific investigation of near-earth space, the Moon and the planets, joint working groups will identify the most important scientific objectives and exchange the results of programs in these areas. This will allow each side to take into account the objectives and work of the other in shaping its own program.

-- In the field of manned space activity, we agreed to exchange highly detailed medical information of man's reaction to the space environment.

The joint working groups which I have mentioned are to work out detailed procedures, and to discuss additional areas for further cooperation. They are supposed to report their recommendations to the principals within about six months from now.

The essential character of both the October and January agreements is that of coordination in the common interest. There is no strictly integrated program or project. The objectives are scientific rather than technical and there is no constraint upon independent. action by either side. To the extent that either side wishes, it can take into account the planning and results of the other side.

The performance of these agreements must be observed carefully before we can fully assess the level of interest of the Soviet Union. Certainly, the negotiations were more straightforward than in the past. Top levels of the Soviet Academy participated directly for the first time. Our negotiators were for the first time given meaningful access to Soviet facilities.

If a cautious optimism proves justified, we can expect definite benefits. Each side will gain access to lunar materials from sites additional to those it has explored on its own. We will nearly double the coverage of our operational meteorological satellites. We shall have created a global network for sounding rocket observations of basic importance to world meteorological research. We shall have demonstrated a mutual participation in earth resources survey work. We can greatly expand our knowledge

of the behavior of man in flight through data on Soviet missions in addition to our own. We shall make it possible to avoid any undesirable duplication of scientific work in space, to plan complementary missions, and to verify anomalous results--all helping us to develop opportunities for more rational and economic conduct of space science and exploration. Finally, successful performance of the rendezvous and docking agreement will give us greater flexibility in space emergencies and for joint activities in space which could go a long way toward reducing international tensions and demonstrating common human interest.

There are, then, very real advantages for us in this renewed and seemingly improved relationship. Dr. Low has observed that in pursuing this relationship we shall not lose sight of the role of competition, as well as that of cooperation, in our relationship with the Soviet Union.

In conclusion, I hope this review of international space activities within NASA's scope has been useful to you. I shall, of course, be happy to answer questions which the Subcommittee may have. Thank you, Mr. Chairman.