STUDY PERTAINING TO THE

NATIONAL LUNAR PROGRAM

VOLUME III

NATIONAL SECURITY IMPLICATIONS OF A US-USSR COOPERATIVE LUNAR VENTURE

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MAIN DCS/RESEARCH AND DEVELOPMENT
ABSTRACT CONTAINS INFORMATION ON NATIONAL SECURITY IMPLICATIONS OF UNITED STATES/UNION OF SOVIET SOCIALIST REPUBLICS COOPERATIVE LUNAR VENTURE. INCLUDES INFORMATION ON PAST COOPERATIVE VENTURES, USSR SPACE PROGRAMS, INTERNATIONAL GEOPHYSICAL YEAR (IGY), COMMITTEE ON SPACE RESEARCH (COSPAR), ANTARCTIC TREATY, PEACEFUL USES OF ATOMIC ENERGY, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION (NASA) AND SOVIET UNION ACADEMY OF SCIENCES AGREEMENT, SOVIET SPACE PROGRAM, SOVIET MILITARY CAPABILITIES AND GOALS, SOVIET LUNAR LANDING PROGRAM, SCIENTIFIC SATELLITES, COST OF OFFENSIVE SPACE SYSTEM PROGRAM, AND INTELLIGENCE AND SECURITY IMPLICATIONS OF NASA PROPOSED PROGRAM.
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REPORT STRUCTURE

FOR

STUDY PERTAINING TO THE NATIONAL LUNAR PROGRAM

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I N T R O D U C T I O N

I. INTRODUCTION

A. Purpose of Analysis

The reasons underlying why the United States wishes to cooperate with the Soviet Union in a lunar program are primarily political in nature. They are concerned with the hope that bilateral cooperation in the lunar program can lead to other cooperative ventures in larger areas of mutual concern. Thus, joint scientific programs may lay the groundwork for new and more significant agreements and may further serve as major steps leading to an improved international climate.

However, in almost all agreements to cooperate in scientific or technological endeavors, there will be aspects of potential military and national security concern. Recognizing this, it is the intent of this portion of the study to analyze the NASA Staff Paper, <u>US-USSR Cooperation in Space Research Programs</u>, in an attempt to determine and evaluate the military and national security implications of the proposed cooperative efforts described in the staff paper.

B. Scope of Analysis.

The NASA Staff Paper does not set forth a single, suggested program for US-USSR cooperation. Specific proposals are suggested, and numerous examples are given of possible modes of cooperation. The preliminary nature of these proposals and their broad nature preclude making a general conclusion concerning the relative military and national security benefits of the proposed cooperative ventures as a whole; specific conclusions can be drawn, however, concerning each suggested effort which may form a part of a future proposal to cooperate with the Russians.

In qualitatively analyzing the military operational and national security implications of cooperative US-USSR space efforts, only those projects were considered which NASA had described in their Staff Paper, US-USSR Cooperation in Space Research Programs. To aid in carrying out the analysis, however, the past experience of the United States in carrying out cooperative arrangements with Russia was examined in some depth; and the Russian Space Program was reviewed in detail in order that an understanding could be gained of its relative position with respect to the Space Program of the United States. This information, together with the results of Volume II, formed the basis for the conduct of the analysis. The extent and depth of each of these three analyses is indicated below.

1. Past US-USSR Cooperative Ventures

Past international scientific and technical cooperation was surveyed in all areas with a view toward identification of any factors which might be present and which would aid in the evaluation of present and future proposals for US-USSR cooperation. Although particular attention was paid to cooperation with the USSR, United States cooperation with other countries was also considered in order that a comparison could be drawn between the Russian approach and that of most other countries with which the United States has entered into cooperative agreements.

In assessing the character of past cooperation, emphasis was placed on agreements and proposals which required each cooperating party to undertake specific actions. The purpose in doing this was to concentrate on those proposals which more nearly reflect the nature of the substantive, cooperative proposals which the President has indicated to be most desirable.

2. USSR Space Program

The review of the USSR Space Program was performed by analyzing in considerable detail the space capabilities of the Soviet Union. In doing this, particular attention was devoted to the Soviet scientific and engineering state-of-the-art, the capabilities of USSR personnel involved with their space program, their facilities, their estimated expenditure of resources to date, and the estimated resources required to support their postulated space objectives through the 1970 period. Based upon this review and a review of the history of the USSR space program, the aims and achievements of Russian space explorations have been set forth. In essence, then the study attempted to collate all available documents, estimates, special reports and discussions with U.S. experts available into a best estimate of the USSR Space Program and objectives through 1970.

3. Operational, Intelligence, and Security Implications

Three general areas of cooperation were examined: data exchanges, operational cooperation, and joint integrated projects. Each of the proposed projects in these three areas was examined separately from the standpoints of what the possible military operational benefits might be; what intelligence gains and losses might accrue to the US and USSR; and, finally, what security implications would exist. After doing this, an over-all qualitative tradeoff was made between the value one project might have for the United States and the corresponding value it might have for Russia.

In making the analysis of the military operational benefits which might exist in any specific proposal, consideration was limited to those factors which appeared to bear on the capabilities of the United States and Russia to carry out military operations.

Because the proposals that were examined were concerned primarily with cooperation in lunar activities, the majority of these factors were influencing only on military space operations. However, some factors which were involved could modify capabilities to carry out military operations in areas other than just space. For example, proposals to establish a joint meteorological satellite system could provide the basis for improved weather prediction in remote areas of the world. Such improvements could contribute significantly to the capability for waging limited war in those regions. Therefore, those types of operations were also considered.

Analysis of intelligence implications involved: (1) the identification of critical gaps in our knowledge of the Soviet space program and a determination of the extent and degree to which data and results on U.S. programs are available to the Soviets; and (2) a gross comparison of known or estimated capabilities in the proposed cooperative areas so as to determine relative advantages and disadvantages, and to identify fruitful areas of exchange.

Security implications were assessed by reviewing current DOD and NASA security and disclosure policies, with a view to determining whether cooperation in the desired areas might result in conflict with existing policies or require changes in policy.

C. Summary of NASA Staff Paper

It is NASA's view that negotiations with the Soviet Union preferably would be based upon a four-step series of exchanges, where the early exchanges would be subject to verification and where each succeeding exchange would become progressively more meaningful. These steps are:

(1) Implementation of Existing Dryden-Blagonravov Agreement

(2) Exchange of Data on Past Manned Space Programs

(3) Exchange of Gross Descriptions of US and USSR Manned Lunar Programs

(4) Exchange of Precise Descriptions of US and USSR Manned Lunar Programs

Within these four steps, NASA visualizes that there may be three types of cooperative efforts undertaken: data exchanges, projects involving operational cooperation, and joint integrated programs. Thus, all of the suggested ventures which are included in the NASA paper fall within one of these three categories.

A more detailed description of the NASA Staff Paper, and an analysis of the proposed program approach is given in Section IV of this volume, while the operational and national security implications of the individual, proposed joint efforts are discussed at some length in sections V and VI.

II. REVIEW OF PAST US-USSR COOPERATIVE VENTURES

A. The Character of Past Cooperation

1. Categories of Cooperation

Past international cooperation in scientific and technical activities can be summarized in terms of the following general categories:

a. Simple Exchanges of Information and Contacts among Scientific Personnel. Substantial progress has been made in this category. During the past seven years there has been a noticeable trend toward increased participation by all countries, including the USSR, in scientific information and personnel exchange programs. This applies equally to space and non-space exchanges between Western nations but not to USSR participation in the space areas. Soviet concurrence in United Nations Resolution 1721(XVI) of December 20, 1961, appeared to have been the starting point of possibly a new era of Soviet cooperation with other nations in exploring outer space. Since that time the USSR has provided some data on its space science activities in limited areas such as launch and orbit registration, micrometeoroid flux, meteorology and communications frequencies.

b. Coordinated Observations, Experiments, and Operations Conducted by Various Countries. The trend in this category also has been toward increased participation and activity among the Western nations. The Western nations have engaged in many coordinated scientific and technical investigations in space and other environments. Among the cooperative achievements are activities such as satellite tracking, communications experiments and the world weather watch including the International Weather Central serving Antarctica. Soviet participation in coordinated programs has been extremely limited. In non-space areas they did conduct some coordinated observations during the International Geophysical Year (IGY) and have agreed to similar activities during the International Year of the Quiet Sun (IQSY). In the space area, there has been no Soviet activity, and it remains to be seen whether the Soviets will fulfill the Dryden-Blagonravov agreements to conduct coordinated experiments.

c. <u>Integrated International Program Involving Integration of Hardware or Other National Resources</u>. There have been no USSR activities in this category nor have there been serious negotiations to undertake integrated US-USSR programs. On the other hand, we have undertaken integrated programs with a number of Western nations. Probably the most notable are the joint sounding rocket and the integrated satellite payload endeavors, because they demonstrate potential areas of space cooperation with the USSR.

2. <u>Past Experience</u>

Of the few cooperative contacts between the US and USSR, most have been both non-governmental and in multilateral activities such as the Committee on Space Research (COSPAR) and the scientific Committee on Antarctic Research (SCAR) of the International Council of Scientific Unions; and the International Telecommunications Union (ITU) and World Meteorological Organization (WMO) of the United States. Multilateral forums usually prove more suitable for propaganda purposes; on the other hand, it is easier to submerge political antagonisms in such bodies than in direct bilateral engagements. Multilateral activities have been successful in negotiating and conducting cooperative programs; however, to be realistic, a complex <u>integrated</u> program must be negotiated and conducted by a few parties.

In proposing or opposing various cooperative efforts, the Sovient Union has been prone to apply stringent political and military criteria; for example, Soviet demands regarding the organization of COSPAR were essentially political in nature. The United States tends to give more weight to the manifest scientific purposes of cooperation and to believe that what is good for international science is usually good politics as well. To the Soviet Union, what is good for science is clearly subordinate to political and security considerations.

Characteristic of these relationships has been the tendency to restrict them to exchanges of scientific results and to shy away from revelations concerning the technology by means of which data are acquired. Many observers have detected the apparent isolation of Soviet representatives in international scientific forums from recent technological developments in their homeland. During the Dryden-Blagonravov negotiations NASA noted that Soviet delegates, drawn largely from the Academy of Sciences, were in several respects unfamiliar with details of the Soviet space program; for example, a principal Soviet authority on meteorology revealed his ignorance of the fact that some Russian satellites had been engaged in cloud photography. In most instances the Soviet Union has safeguarded the identity of those engaged in work on military and space technology. It appears that such individuals are normally not permitted to attend international scientific gatherings. Thus, while promoting the image of the Soviet Union as a motive force in scientific cooperation, Moscow has apparently taken measures to minimize the possibility of undesirable disclosures of present techniques and capabilities.

3. Comparison of US and USSR Cooperation

Even in the basic sciencies the flow of information tends to be one-sided, with the United States and other Western powers volunteering more data than the

Soviet Union. This may be partly a function of the greater investment made by Western nations in fundamental science, but there is ample reason to believe that the common Soviet practices of selective disclosure extends to this kind of information as well. Data and discoveries which enhance the prestige and influence of Russian science without divulging matters of immediate relevance or probable value to Soviet technology are preferred candidates for publication or presentation to international scientific bodies.

Important distinctions also exist in personnel exchanges and contacts under bilateral agreements. In the Soviet-American cultural exchange program, for instance, the United States often sends social scientists and students of the humanities to Russia while the USSR tends to send scientific and industrial experts to this country. A degree of non-comparability has, therefore, emerged in these exchanges, with the Soviets apparently most interested in gaining greater knowledge of American scientific and industrial techniques. Similarly, the activities pursuant to the bilateral understandings on cooperation in the peaceful use of atomic energy have disclosed considerable asymmetry. Unlike the U.S. Atomic Energy Commission which is responsible for both military and civilian developments of nuclear energy, the Soviet State Committee for the Utilization of Atomic Energy is separate from the Ministry which performs weapons design and manufacture in the USSR. Accordingly, Soviet visitors to American nuclear facilities often come in contact with persons knowledgeable in both the military and civilian applications of nuclear technology. By contrast, American personnel visiting Soviet atomic energy facilities under these arrangements generally encounter scientists with virtually no knowledge of the Russian nuclear weapons program. Again, the possibility of significant technical intelligence leaks seems to be minimal on the Soviet side.

As a general rule, Soviet contributions to planning and execution of cooperative endeavors do not appear comparable to those of the United States. For example, planned radio propagation experiments to be conducted cooperatively in the Antarctic during the IQSY involve American equipment installed at the Soviet Vostok station, together with U.S. facilities elsewhere in the region. The Soviet contribution to this program consists of permission to install U.S. equipment at the Russian site and some participation by Soviet personnel. The communication experiments under the Dryden-Blagonravov agreement require the U.S. to orbit a passive satellite, Echo II, while the Soviet input includes a number of radar and optical observations and some radio experiments. Similarly, the meteorological investigations contemplated in the latter understanding appear to be designed largely around U. S. plans for weather satellites. There is no indication that the Soviet Union has revealed detailed information on its own plans in this area.

There are exceptions, perhaps the most notable being Soviet contributions to the various Atoms for Peace conferences. Soviet research reported at the 1955 conference led to substantially improved understanding of the effective resonance integral, a major factor in nuclear reactor processes. The Soviet Union also provided valuable data bearing on the possibility of oceanic disposal of radioactive wastes by reporting oceanographic explorations which found significant water transfer even in some of the deepest oceanic trenches and caverns Characteristically, these contributions required little disclosure of the details of Soviet technology. Moreover, as NASA and other agencies have observed, Soviet data is sometimes virtually useless because of the Russian refusal to supply sufficient information concerning instrumentation and equipment used in its collection to permit analysis of the findings.

B. Specific Cooperative Agreements and Proposals

Some of the most significant agreements and proposals are summarized herein for reference. Although the list is not extensive, it is typical of the nature and scope of the technical and scientific cooperation, or lack thereof, between the US and USSR in recent years.

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1. International Geophysical Year (IGY)

a. Objective: The IGY, a non-governmental international enterprise which operated from 1 July 1957 to 31 December 1958, was established to study the planet Earth and its cosmic surroundings.

b. Agreed Action: Research activity in the IGY was conducted through national scientific organizations. Over-all planning was international. Rules were established for regulating the flow, processing, collection, safekeeping, and exchange of data. Additionally, three World Data Centers, including one each in the US and USSR were established to act as focal points for this data exchange activity.

c. Achievement and Problems: The IGY amassed a monumental body of data about the Earth and the surrounding space. Although it will take years to completely analyze this data, some specific and provocative discoveries have been disclosed. Altogether 20,000 to 30,000 scientists and engineers from 66 nations participated. Three world centers were established to receive the raw data from the participating countries. Particularly gratifying to Western scientists was the extensive flow of material from the Soviet Union. Solar data from remote Soviet observatories sometimes reached the Colorado data center before comparable observations from s[illegible] in the United States.

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The Soviets did withhold the exchange of data on rockets and satellites. The first Sputniks were launched during the IGY and their scientists were allowed to publish specific results of their space experiments but there were strict limitations on what they could say about the satellite-launching vehicle, including the final-stage rocket that went into orbit. They were not allowed to make public the orbital parameters which would have been most helpful to anyone who wished to conduct tracking operations. Possibly this was because the military thought these elements could be used to pinpoint the launching site. The Soviets failed to reveal anything comparable to American disclosures of satellite-launching techniques. The broad success which characterized the scientific effort in virtually all other fields did not really extend to the IGY program in space research where it is now clear, the Soviet Union had political rather than scientific objectives. Soviet intransigence greatly restricted the IGY agreements for exchange of information in this area. As a result, unanimous consent to broader agreements could not be obtained. Soviet compliance with even the modest IGY requirements in space science were largely pro forma. Attempts to improve the situation were entirely unavailing.

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2. Committee on Space Research (COSPAR)

a. Objective: COSPAR was established by the International Council of Scientific Unions (ICSU) and designed to carry on the work of the expiring IGY. The COSPAR constitution gave representation to those countries engaged in launching rockets or satellites, initially Australia, Canada, France, Japan, the Soviet Union, the United Kingdom, and the United States. COSPAR was established to provide the world scientific community with the means to exploit the possibilities of satellites and space probes of all kinds for scientific purposes, and exchange of resulting data on a cooperative basis. Normally the committee will not concern itself with such technological problems as propulsion, construction of rockets, guidance and control.

b. Agreed Action: A formal agreement does not exist between the US and USSR under COSPAR. However, the Soviets have at times agreed to provide orbital elements for their satellites and advance notice on some launchings.

c. Achievements and Problems: Three working groups were established: tracking and transmission of scientific information; scientific experiments; and data and publications. The Committee was to be composed of representatives from three of the countries listed in paragraph (1) with delegates from the nine international scientific unions concerned with space research. The

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initial representation was largely pro-western and the Soviets protested the unbalance of the membership. In 1959, the Soviets rejected the organizational structure, arguing that the committee did not accurately reflect the Soviet position as a leader in space research, while including in its membership nations which had never fired a rocket. Russia proposed admitting the entire Soviet bloc. A compromise plan resulted after a Soviet boycott. This gave the Soviets and the US equal control over budget and program matters. The Soviet Union approached the problem of international cooperation in COSPAR with much caution.

Soviet scientists have attended the meetings, however, they have generally been most reticent about agreeing to any specific or detailed cooperation. They have never provided details of their future rocket or satellite plans, only giving the numbers to be launched in a single year. At the scientific symposia, the Soviets' participation has been sporadic, and in Warsaw, their attendance hit a low mark. Prior to Warsaw, they withheld the list of presentations until long past the deadline, then inundated the program with a large number of second-rate presentations and papers to be read in absentia. This participation is typical of their past participation when it is on a voluntary basis. Nevertheless, the quality of the COSPAR space science symposia has on the whole been very high, and it is undoubtedly the best regularly scheduled scientific forum in the field.

3. Antarctic Treaty

a. Objective: The twelve nations that had active programs in the Antarctic during the IGY agreed that Antarctica should be set aside for peaceful purposes, with freedom of scientific inquiry throughout the area. Under terms of the Treaty, all territorial claims are to be held in abeyance for a period of not less than 30 years. There are no political fences to bar free exchange and free movement of research personnel and scientific data among national expeditions. The nations regularly inform one another of their expeditionary plans and are free to visit and inspect each other's stations and activities. The Treaty further states that the Antarctic may not be used for weapons testing or nuclear explosions, nor may it serve as a disposal area for radioactive waste material. Finally, the Treaty sets forth guidelines by which the signatory parties may implement this program of international cooperation.

b. Agreed Actions: In addition to the prohibitions such as military bases or fortifications and weapon testing it has been agreed that:

(1) Freedom of scientific investigation in Antarctica and cooperation toward that end, as applied during the International Geophysical Year, shall continue, subject to the provisions of the present treaty.

(2) Information regarding plans for a scientific program in Antarctica shall be exchanged to permit maximum economy and efficiency of operations.

(3) Scientific personnel shall be exchanged in Antarctica between expeditions and stations.

(4) Scientific observations and results from Antarctica shall be exchanged and made freely available.

(5) Each party shall give advance notice of all expeditions to and within Antarctica, and any military personnel or equipment intended to be introduced into Antarctica for other than scientific research.

(6) All areas of Antarctica, including all stations, installations and equipment, and all ships and aircraft at points of discharging or embarking cargoes or personnel in Antarctica, shall be open at all times to inspection by observers designated by the Contracting Parties.

c. Achievements and Problems: All signatories, including the USSR, actively participated in the scientist exchange programs since the beginning of the IGY in 1957. During six of the past seven years the US and USSR have exchanged scientists. There has been similar cooperation between other Western nations and the USSR. In the 1963-64 Antarctica program there will be 26 scientists from other countries participating in the American expeditions.

The countries, including the USSR, operating expeditions in Antarctica have been giving prior information to the other countries regarding the activities they will undertake. Additionally, inspections provided for under Article VII have been conducted by the US and other Western nations. The USSR has indicated it would not conduct inspections, but their stations were opened to the observers from the US and other countries. The results of these inspections are not available at this time.

The Scientific Committee on Antarctic Research (SCAR) was formed to further the coordination of scientific activity in Antarctica, with a view to framing a scientific program of circumpolar scope and significance. SCAR holds annual meetings and sponsors symposia. The seventh meeting was held in September 1963 and was preceded by a most successful international symposium on Antarctic Geology. SCAR requires that each National Committee prepare an annual report on its Antarctic research programs as well as its plans for the coming season. All countries have demonstrated compliance with this requirement. The reports submitted include not merely programs but also descriptions of the instruments in use at each station, the normal complement of personnel, the exchange scientists, their recent publications, and the responsible authors.

International scientific ventures in Antarctica have been uniquely successful and free of major problems. Based on past successes, it appears that the Consultative Meetings provided for under Article IX of the Treaty and SCAR operations will continue to develop effective solutions to problems of cooperation and coordination of Antarctic research and support.

4. Peaceful Uses of Atomic Energy

a. Objective: The objective of this agreement is to provide cooperation in the field of utilization of atomic energy for peaceful purposes.

b. Agreed Actions: The US and USSR have agreed to conduct exchanges of visits by groups of specialists in the following fields:

(1) Nuclear power reactors

(2) Plasma physics and controlled thermonuclear fusion

(3) Nuclear physics

(4) Solid state physics

(5) Purification and disposal of radio active waste products

(6) The use of tracer compounds in medicine

(7) Radioneurological research

(8) Design and utilization of charged particle accelerators.

Facilities to be visited as well as the specific field of activity contemplated by each side shall be agreed to between the US Atomic Energy Commission and the State Committee of the USSR for Utilization of Atomic

Energy. Each visit will be limited to ten persons and from 10 to 15 days in length. The agreement also calls for an exchange of 2 or 3 research scientists in the fields of thermonuclear fusion; reactor techniques and physics of high-energy particles; exchange of information; holding of joint conferences; and exchange of scientific instruments.

c. Achievements and Problems: The USSR and the US have exchanged visits and data on peaceful use of atomic energy. In May 1962, an American delegation toured some Soviet equivalents of our unclassified atomic energy facilities. A surprising note is the American group was shown more than had been anticipated. Late in 1963, a Soviet group made a reciprocal tour of installations in the United States. Early in 1964, two groups from each country are scheduled to be exchanged under the atomic energy agreement. Unlike the U.S. Atomic Energy Commission, which is responsible for both military and civilian developments of nuclear energy, the Soviet State Committee for the Utilization of Atomic Energy is separated from the ministry which performs weapons design and manufacture in the USSR. Accordingly, Soviet visitors to American nuclear facilities often come in contact with persons knowledgeable in both the military and civilian applications of nuclear technology. By contrast, American personnel visiting Soviet atomic energy facilities under these arrangements generally encounter scientists with virtually no knowledge of the

Russian nuclear weapons program. Again the possibility of significant technical intelligence leaks seem to be minimal on the Soviet side while the United States does run the risk. As in past ventures, we can expect the Soviets to carefully screen participants to ensure that individuals familiar with Soviet military programs do not make exchange visits.

5. <u>NASA-USSR Academy of Sciences Agreement (Dryden-Blagonravov</u>

a. <u>Objective</u>: On June 8, 1962, the US-USSR signed an agreement regarding cooperation in the exploration and use of space for peaceful purposes. This agreement established the basis for coordinated efforts in the areas of meteorology, world geomagnetic survey, and satellite telecommunications. In March 1963 both parties signed a memorandum of understanding which detailed the scope and nature of the cooperation in these areas.

b. <u>Agreed Actions</u>: The US and USSR agreed to participate jointly in passive communications satellite experiments. In essence, these experiments will consist of measurements of the quality of transmission between the USSR and the US using a passive reflector satellite (Echo II) for that portion of the communications link between the USSR and the U.K. NASA will provide the link between the U.K and the US. The following kinds of transmissions will be made:

(1) Unmodulated Carrier
(2) Single-frequency modulation
(3) Telegraphy
(4) Facsimile and voice, if feasible

The US and USSR will promptly exchange results of the experiments and observations and make this information available to the scientific and technical community. In addition, the agreement sets forth the technical details and arrangements for experiments at various frequencies, radar and optical observations of Echo II, and for negotiations on possible joint experiments with active communications satellites.

The agreement also calls for the US and USSR to contribute to the World Geomagnetic Survey by coordinated launching of two earth satellites during the period of the International Year of the Quiet Sun. The third part of this agreement calls for the coordinated launching of operational weather satellites and exchange of weather data within six hours of the observation time. A facsimile communications link between Washington and Moscow is to be established with occasional exchange of data beginning in the first half of 1964 and with full-time use beginning in the latter part of 1964. The US and USSR will each launch weather satellites and will equally share the cost of the link. Should other countries desire to bridge the line on a receiver only basis they may do so and will make a proportional contribution to the total expenses of the communications link.

c. Achievements and Problems: In general the Soviets are delinquent in most parts of this agreement. The meteorological program is far behind schedule, since the communications link has not been established and timely data cannot be exchanged. The passive communications satellite program is the only area in which cooperation has become even a partial reality.

The USSR was silent on any actions pertaining to the agreement until December 1963. At that time, the USSR indicated that substantive replies were being prepared and asked for the launch date for Echo II. Dr. Dryden provided the launch window and nominal orbital elements for the Echo II satellite and reiterated NASA's request for Soviet radar cross-section and optical observations of the satellite during the inflation stage. This occurs in part over the USSR during the first orbit. The Soviet Academy of Sciences replied that they intended to observe Echo II and participate in the communications tests via the satellite.

The Soviets did track Echo II using optics, however, they refused to conduct the radar cross section experiment. They reported that good photos were obtained from 5 tracking stations. The U.S. has requested the films; however, a month has elapsed and none have been received. As of 27 February, the U.S. had been transmitting unmodulated carrier, telegraphy, and single-frequency modulation from Jodrell Bank, England. The Soviets, after a strong request from NASA, admitted they were not going to participate in return transmissions to Jodrell Bank, England.

Similar to other agreements, the agreement on this program is open to interpretation. The agreement states that transmissions will be made between Jodrell Bank, U.K. and the USSR. Since the Soviets were not specifically required to make transmissions, they apparently will not do so. Again, the Soviets have shown that they will provide only those functions and data specifically detailed in an agreement.

6. Unsuccessful Proposals

On 7 March 1962, President Kennedy proposed to Mr. Khrushchev areas of desired cooperation between the United States and Russia. These were:

- A joint meteorological satellite system
- Exchange of satellite tracking service
- Coordinated mapping of the earth's magnetic field in space
- Coordinated demonstration of the feasibility of international communications via satellites
- Exchange and pooling of knowledge in space medicine.

Mr. Khrushchev's 20 March 1962 response to President Kennedy stated a desire to engage in cooperative activities for the peaceful uses of outer space and suggested the following potential areas of cooperation:

- Satellite communications system
- Satellite weather observation system
- Program for observation of Mars, Venus, Moon and other planets
- Program for mutual assistance in the search and recovery of satellites and space ships

- Satellite study of the earth's magnetic field and exchange of space biology knowledge

- Establishment of initial principles of space law.

Agreements have been made for conducting satellite communications experiments, exchanging of meteorological satellite information and mapping of the earth's magnetic field by satellites. The United Nations has adopted a resolution covering exploration and use of outer space and recovery of space vehicles and astronauts that make an emergency landing on the territory of a foreign state. However, a specific US/USSR bilateral agreement in this area has not been negotiated. Biology data is being exchanged under COSPAR. Agreements have not been reached on obtaining operational tracking services from each other's territories nor for a program for observing Mars, Venus, Moon, and other planets.

Chairman Khruschev's proposal was: "It seems to us that it would be profitable to reach agreement on the organization of a joint program for making observations by radio and by optical means on objects launched towards the moon, Mars, Venus and other planets in the solar system.

In the opinion of our scientists, it would undoubtedly be beneficial if States joined together to speed up scientific progress in the study of the physics of interplanetary space and celestial bodies".

The proposal made by President Kennedy for cooperation in space tracking was: "It would be of great interest to those responsible for the conduct of our respective space programs if they could obtain operational tracking services from each other's territories. Accordingly, I propose that each of our countries establish and operate a radio tracking station to provide tracking services to the other utilizing equipment which we would each provide to the other. Thus the United States would provide the technical equipment for a tracking station to be established in the Soviet Union and to be operated by Soviet technicians. The United States would in turn establish and operate a radio tracking station utilizing Soviet equipment. Each country would train the other's technicians in the operation of its equipment, would utilize the station located on its territory to provide tracking services to the other, and would afford such access as may be necessary to accomodate modifications and maintenance of equipment from time to time."

Past experiences indicate that the Soviets will refrain from entering into any agreement that would require their disclosing tracking capabilities, tracking site locations, or provide information that would assist us in more accurately locating their reference datum plane.

C. Summary: During this survey and appraisal of Soviet-American experience in cooperative scientific and technical ventures, a number of conclusions and generalizations were indicated. Those factors which could be applicable to assessments of future proposals for US and USSR cooperative space programs are summarized below:

1. The Soviet Union is willing to allow others to bear a disproportionate share of the burdens and tends to limit its contributions to modest exchanges of data and personnel, both of which are usually well removed from operational programs or current technology.

2. With rare exceptions, the US and the Western Nations have provided the initiative in gaining and implementing agreements for scientific and technical cooperation.

3. Specific short-term agreements that detail the obligations of each party seem most likely to be fulfilled. In such cases the Soviet Union seems to live up to the letter, if not always the spirit, of the undertaking.

4. Arrangements which permit independent observation, experimentation or operation by national facilities without actual integration of technology or other resources seem to be preferred by the Soviet Union.

5. There is no evidence to suggest that the Soviet Union will allow foreign observers intimate exposure to advanced Russian technology, although they may be willing to employ their personnel with the equipment of other nations.

6. A corollary to the previous point is that successful collaboration seems most probable in the areas of pure, rather than applied science. The Soviet Union firmly believes that all technology has military implications.

7. The long time required to negotiate and initiate even relatively simple cooperative programs argues against US proposals for integrated cooperation in areas which may be considered essential to orderly growth of the US civilian and military space capability.

8. To the USSR, political and security considerations are paramount in discussing, formulating or conducting cooperative scientific programs.

III. USSR SPACE PROGRAM

A. Aims and Achievements to Date

There is little doubt that the USSR has been engaged in a well-planned, long-term program emphasizing the development and support of manned flight in near-earth space. Although these activities seem consistent with their announced 1955 goals of interplanetary travel, they are also consistent with other objectives, including military.

Since October, 1957, the Soviets have displayed an impressive record of dramatic space accomplishments which has greatly increased their national prestige and has provided them with significant propaganda gains. Included are: orbiting the world's first earth satellite, impacting the moon, photographing the unseen side of the moon, launching the first vehicle to transfer from earth-orbit to an interplanetary trajectory, the first successful orbiting and recovery of a man, the first concurrent orbital flight and recovery of two manned satellites, and most recently, the first successful orbiting and recovery of a woman. These significant achievements were realized by exploiting the propulsion capacities achieved in their missile program.

The collection of scientific data by Soviet space vehicles was fairly limited and selective through 1961. Apparently there was a lack of systematic and comprehensive in-flight measurement of space environment data needed for future space ventures, but this need was at least partly met by US data available to the USSR, primarily through COSPAR. Beginning in late 1961, the Soviet program was apparently expanded to include a series of unmanned space launchings (the Cosmos series) in order that greater emphasis could be placed upon the collection of data covering the near-earth space environment. This program was initiated for the stated purpose of collecting astrophysical and geophysical data, studying cloud distribution and formation, and testing satellite structures and other elements of cosmic apparatus.

Cosmos launchings have been given little publicity by the Soviets and evidence establishes beyond doubt that at least two distinct programs are involved. Those Cosmos satellites consisting of small non-recoverable payloads and launched from Kapustin Yar have been carrying out the geophysical and astrophysical program announced by the Soviets in March of 1962, and can consequently be called scientific satellites. However, only a limited area of space is being explored. The significance of this lies in the fact that the area being explored is the area in which manned spacecraft are expected to operate, be they space stations of a research nature, or manned space weapons.

The evidence also suggests that the more obvious scientific aspects of this phase of the series are being used to cover the development of applications with military potential in the heavier, recoverable Cosmos satellites launched from Tyura Tam.

Certainly, the information and data being obtained from these larger Cosmos satellites would be useful in the development of military space systems, and the initial testing of such systems would probably be conducted under the guise of scientific experiments. Despite the absence of firm evidence to show that military systems are being developed by the USSR, it is believed that the Soviet program by its characteristics is the best indicator of Soviet military capabilities and intent, and that the USSR could be proceeding actively to develop space systems for reconnaissance, surveillance, and other military purposes.

B. Historical Summary of Soviet Space Programs

The major emphasis of the Soviet space program has been on manned space flight, although it has included vertical rocket firings, unmanned earth satellites and lunar and interplanetary probes. Through February 1964 at least 47 earth satellite vehicle (ESV) missions, nine lunar probes and ten interplanetary probes have been attempted. Of these, at least six ESV missions, five lunar probes and eight planetary probes were failures. The important highlights of the Soviet program are shown in chronological form below:

CHRONOLOGICAL SUMMARY

Date	Description
Oct 57 - May 58	Sputniks I, II, and III launched from Tyura Tam into 65° orbits to collect geophysical data on near-earth space, including deep-space radiation; to provide biological and capsule data, and to determine reliability of their 20-megacycle communications transmitter. The orbited payload of Sputnik III was 3,000 pounds.
Jan 59 - Oct 59	Lunik I, II and III (1,000-pound payloads) lunar probes launched. Lunik I was a near-miss, Lunik II impacted on Moon, and Lunik III obtained first photos of backside of Moon on a circumlunar trajectory. Lunik I and II believed to have carried instruments to collect data on magnetic fields in cislunar space, micrometeoroid impacts and other space environmental data. Both released sodium clouds at 70,000 or 80,000 miles.
May 60 - Dec 60	Sputniks IV, V, and VI orbited with payloads over 10,000 pounds using SS-6 booster as the first-stage launch vehicle. Objectives were to check further stabilization control, life support, and re-entry systems and to obtain data on the effects of space environment on living biological specimens.
Feb 61	Venus probe (1,420-pound payload) successfully injected into trajectory intended to approach Venus. Communications with probe were subsequently lost.
Mar - Apr 61	Sputniks IX and X launched and recovered after one orbit. These were prototype Vostoks, probably simulating in all respect their first man-in-space shot, except each carried a dog as passenger.

Apr 61

Gagarin completed single-orbit flight in Vostok I.

Aug 61

Titov completed 17 orbits in Vostok II.

Mar 62

Soviet initiated Cosmos series of unmanned launchings. By February 1964, they have had 25 successful launches; 12 from Kapustin Yar (KY) with no recoveries and 13 from Tyura Tam (TT) which, with one exception, were recovered in USSR.

KY launches placed payloads in orbit having inclinations (49°) suitable for mapping near-earth space and for near-maximum surface coverage of ConUS. Probable that KY Cosmos satellites not devoted exclusively to pure science.

TT satellites are orbited at 65° inclination. Evidence suggests some TT vehicles used to check out equipment and collect data for subsequent Vostok flights.

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Weight and recovery capabilities of TT system would permit also carrying other higher-resolution photographic systems. Reconnaissance photography a very real possibility.

Aug 62

Vostok III and IV launched 24 hours apart. Nikolayev in Vostok III recovered after four days; Popovich in Vostok IV recovered after three days. Soviets attempted nearly identical orbits and achieved a proximity of about 5 N.M. at one point.

Oct 62 - Nov 62	Mars I successfully launched on trajectory to Mars. Communications reportedly maintained with vehicle out to 66 million miles. Mid-course correction failure may have resulted in excessive miss-distance precluding accomplishment of mission objectives.
June 63	Mission similar to Vostok III and IV repeated in Vostok V and VI. Bykovsky in Vostok V recovered after five days. Tereskhova, first woman in orbit, launched in Vostok VI two days after Vostok V launching, and recovered after three days. Demonstrated launch precision represented first step toward development of rendezvous and docking capability. At this point, Soviets had accumulated 380 ≠ hours of manned space flight.
Nov 63	Polyot I launched and possessed per Soviet announcements initial capabilities for in-space re-start of engines, orbital plane changes, and altitude changes. Preliminary US analysis has only confirmed an engine start at zero-g. Evidence indicates standard SS-6 booster used to boost new or modified 3rd-stage engine. No evidence to support Soviet claims of significant changes in orbital plane or orbital elements.

In general, the Soviet space program has been characterized by a small number of failures in the early stages of system development with rapid progress in achieving of reliability.

Prior to the launching of Vostok I, the SS-6 booster had been used at least seventeen times as a space launch vehicle, This included seven earth-satellites, six lunar mission attempts, and four planetary mission attempts. A minimum of ten successive, successful SS-6 performances preceded Vostok I.

The re-entry system had a poorer reliability factor. It had been used only five times before the Vostok I, and its orientation control subsystem had failed twice. It had only two successive, successful performances before Gagarin was launched. Without knowledge of what corrective measures were taken between the failure of 1 December 1960 and the March 1961 launchings, the Soviet man-in-space program was, on a purely statistical basis, a high-risk affair.

C. Scientific and Technological Capabilities

The purpose of this section is to indicate succinctly the Soviet scientific and technological capabilities and limitations which appear most likely to be of concern in making an assessment of the potential gains or losses in a cooperative US-USSR space program.

1. Personnel

Since its inception, the USSR's space program has been closely linked to its military missile program. The two programs have used the same boosters and launching facilities, and are mutually supporting in other respects as well. It is believed that many of the scientists, engineers, and technicians who are working on space projects are also involved in the Soviet missile program. According to L. I. Sedov:

"There is one large team in Russia that handles all space projects. The same key men are in charge of guidance, tracking, and other segments for each of the projects. It is a very large team and it can well take care of several projects in parallel . . . We have no distinction between military and civilian projects."

The Soviet space effort appears to be well-programmed and coordinated. The group responsible for coordination at the national level has not been identified. It is thought that initially the Inter-Agency Commission for Inter-Planetary Communications, headed by L. I. Sedov, was charged with prime responsibility for Soviet space programs, including their coordination and control, but its functions have apparently been curtailed. More recently, there are indications that the Soviet space program may be directed by a State Commission, possibly chaired by D. F. Ustinov, reporting directly to the Council of Ministers. This commission is probably responsible for the selection and planning of specific missions, for budget allocation, and for evaluation of results. Below this level, responsibility for the design, development, and fabrication of space vehicles is probably assigned to the State Committee for Defense Technology. Scientific support for the program is centralized in the Academy of Sciences and the Academy of Medical Sciences, which are also probably responsible for the design and development of certain supporting systems such as life support apparatus.

Official secrecy has prevented the identification of more than a few of the key personalities in the Soviet space program, but their achievements leave little doubt that many men who occupy the first rank in Soviet science and technology are involved in the Soviet space effort. The announcement of awards to some 7,000 engineers, scientists, and technicians for developing the Vostok indicates that a very considerable number of personnel is involved directly in space projects. We have not been able to determine the total manpower employed in the space program or to identify all of the scientific and technical facilities involved.

2. Facilities

a. Ranges

The Soviets launch their space vehicles at the Tyura Tam and Kapustin Yar test ranges. Launch areas "A" and "B" at Tyura Tam, the primary facility, contain similar launch pads, each estimated to be capable of withstanding repeated launches of boosters in the multi-million pound thrust category. Space launches are known to have taken place only from Area "A," which has also been used for many ICBM launches dating back to 1957. All major space programs use this range-head and its associated downrange instrumentation. Only small payload satellites of the Cosmos program have been launched from Kapustin Yar.

The Soviet test philosophy of horizontal checkout for missiles and space boosters considerably increases the launch pad availability time. Thus, they are able to support more than one operation in a short time period with only one pad. Demonstrations of this capability occurred in 1960 when two Mars probe attempts were launched in a period of 96 hours, and in 1962 when Vostoks III and IV were launched 23 hours apart. Also, ICBM's have been launched within 72 hours of each other from Pad "A".

The satellites launched from Kapustin Yar use the launch facilities constructed for the MRBM. The launch complex has supported MRBM operations since 1957.

b. Tracking and Communications

The Soviets have at least 70 optical and 27 photographic stations, a number of meteor observation sites, and at least 25 radio telescopes which can be used for space vehicle tracking. These, when combined with their automated radars, interferometers, and radio direction finders provide an adequate tracking system within the geographical confines of their own borders.

The chief limitation on Soviet capabilities for tracking and communicating with space vehicles is the lack of a global tracking network capable of continuous observation and communications with satellites and space probes. Facilities in the USSR are adequate to determine the initial trajectory with a high degree of accuracy. To extend their monitoring capability, the Soviets rely on specially instrumented ships, relieving to some degree the problems arising from the the lack of land facilities. However, the value of these ships is limited, because of the difficulty of accurately determining their positions. Thus far, Soviet capabilities in this field have been generally adequate for the missions undertaken—indeed, they have probably to some extent shaped those missions.

For space probes the Soviets possess, in addition to the optical stations, a deep space tracking and communications facility located in the Crimea. This facility includes a massive antenna system composed of eight, 16-meter dishes integrally mounted on a large platform and capable of tracking in azimuth and elevation. This, however, provides coverage only when vehicles are within line-of-sight and therefore does not fulfill a requirement for 24 hours communications with extra-terrestrial space vehicles. The Soviets have demonstrated a capability for tracking and transmitting data over earth-to-lunar distances, but they have demonstrated less success in deep space communications. Although they have probably overcome their earlier communications difficulties, such as those experienced in the 1961 Venus probe, they have not yet demonstrated a tracking system with the sophistication necessary for deep space exploration.

Tracking stations in other hemispheres would be a major aid to mid-course guidance and to achieving better terminal accuracy. There is evidence that the USSR has been seeking to acquire sites for space tracking monitoring stations in Chile, Indonesia, Africa, Cuba, Afghanistan and Australia. It is of particular interest that locations in Chile and Indonesia are roughly 120 degrees apart from the Crimea and, if used for deep space tracking sites, would provide a 24-hour capability.

c. Data Processing

The rapid determination of orbits and trajectories of space vehicles from a large number of observations requires advanced data processing techniques. The ability of the Soviets to process data for such missions as re-entry and extra-terrestrial launches from parking orbit indicates that high-performance computers are being used. A propaganda film on the Titov flight revealed that an advanced Soviet digital computer, capable of 20,000 arithmetic operations per second, was employed in space-track computations and data handling. Computers of lesser performance are probably used for pre-launch calculations and other operations where speed is not so vital.

The Soviets will probably continue to seek increased computer reliability and speed of operation, and will seek to reduce size, weight, and power requirements. The Soviet have in operation at least one computer capable of 50,000 operations per second, and are probably developing computers capable of 100,000 operations per second. They have a thorough knowledge of contemporary foreign research in computer theory and design, but they are also competent in this area in their own right. In the past, Soviet computers have incorporated novel design features concurrent with the appearance of similar features in US models. However, the USSR lags behind the West in the development of peripheral equipment (magnetic tape units and input/output accessories) and in the general availability of digital computers. In spite of this, there is no evidence that any priority applications have been hampered by the lack of computers. Future progress in space research will require development and application of computers for onboard applications and of ground-based computers with increased capabilities. The Moscow Coordinating and Computing Center probably accomplishes this function at the present time. Based on Soviet accomplishments, it is estimated that they will be able to meet these needs.

3. Technology

a. Propulsion

A broad program is under way in the USSR directed at the improvement of existing Soviet liquid propellants, including storable propellants; and continued rocket engine development, including solid- and composite-propellant engines, is indicated by the recent expansion of testing facilities. In the 1960 period, work was initiated on liquid hydrogen for propellant applications.

A 1-to-2½-million-pound thrust, liquid rocket engine is believed under development, and is estimated to have been static tested in 1963.

It is estimated that Soviet engines existing now and anticipated for the near future are adequate to support a manned lunar mission.

b. Life Support

Whereas the Soviets have demonstrate the ability to control for ten to fifteen days the environment in a multi-manned space vehicle and have shown adequate biomonitoring capabilities, they have yet to demonstrate the regenerating of cabin air by electro-chemical means; design of an adequate space suit; and advanced techniques for crew protection against the effects of prolonged weightlessness.

c. Ballistic Control and Recovery

There are two aspects of past Soviet efforts in ballistic control and recovery techniques which may be applicable to future systems. These are (1) the modulation technique which was developed for the vertically fired rockets suitable for the lunar earth-return vehicle and (2) the shock mitigation equipment developed during the vertically fired rocket program, which is suitable for a lunar soft-landing vehicle. In all, the Soviet effort has been concerted, and the successes of their recovery system have resulted from a well-planned, long-range program which, from 1951 through 1961, included a comprehensive test program which checked every facet of the recovery operation. However, Soviet ballistic control and recovery technology has not progressed appreciably beyond that used in Sputnik V.

d. Space Flight Vehicle Power

The USSR has an active research and development program directed toward the development of power supplies involving the use of silver-zinc batteries, nickel-cadmium batteries, and solar cells. In addition, they are conducting research and development on thermo-electric and thermionic energy sources. In contrast, the Soviets have not made a substantial research and development effort in fuel cells although there is evidence that this effort will be significantly increased in the near future. As of late 1963, a fuel cell had been developed by the Soviets, but it was not being programmed for any mission because of unreliability.

While the Soviets have published nothing concerning electro-mechanical energy conversion methods for space power systems having high-power outputs, they do have a program to develop electric engines whose operation requires the use of such power.

e. Bio-Sciences Facilities and Instrumentation

Around 1957, the Soviets greatly expanded their facilities and efforts devoted to cosmonaut crew training. Centrifuges were acquired, and one of their aviation training and research facilities was converted to an extensive bioastronautics facility. This facility is being further expanded, and more environmental and test equipment is being obtained.

At the present time, the Soviets are able to gain only a meager amount of real-time monitoring of cosmonauts in flight when compared with world-wide coverage during US orbital flights and the extensive real-time assessment of American astronauts. The USSR will need to increase their monitoring and tracking capability considerably for future manned space missions, and thus it can be expected that more ships will be deployed and a broader selection of land sites will be used.

Soviet bio-sciences data collected in their Vostok manned **spaceflight** missions should have provided them with considerable insight into the quantitative and qualitative effects of the space environment on (1) sleep requirements and the degree to which variations occur with different individuals, (2) optimum programming of work-rest-sleep cycles and (3) the design of sleep facilities for future space crews.

f. Lunar Environmental Data and Instrumentation

In their Lunik I and Lunik II flights, the Soviets had instruments aboard to make magnetic field measurements in the vicinity of the moon, as well as radiation fields in cislunar space.

The Soviets have shown interest in instrumentation suitable for use in soft lunar landings, and in soil analyzers, seismometers, gravity meters, temperature sensors, gas composition sensors and micrometeorite detectors.

Cosmic and corpuscular radiation measurements will continue to be of interest for some time to come. Measurement of pressures as low as 10^{-14} mm of Hg will also be important, until it is established whether or not the moon has any atmosphere. This requires a capability that the Soviets probably do not now possess.

g. Range Instrumentation

Due to geographical limitation, Soviet land-based, downrange instrumentation is supplemented by instrumented ships and aircraft. The ships have been closely associated with Soviet long-range ballistic-missile launchings into the Pacific Ocean and in earth-orbital and space vehicle efforts. Aircraft are also employed for downrange instrumentation functions during space exploration missions.

The Soviets have already announced that they will attempt to rendezvous two spacecraft in an earth orbit very soon. The tracking of two space vehicles for this purpose must rely upon the use of highly accurate radio and optical tracking systems. It is believed that the Soviets now have ground stations suitable for a rendezvous mission in space, and the VOSTOK space mission have indicated that they might be working on vehicle-borne rendezvous tracking systems. Thus, they could make a successful rendezvous during 1964.

The Soviets have claimed that they need an angular accuracy of 1-second-of-arc for tracking of their space vehicles. This accuracy appears to be beyond the capability of their single-station, radar-tracking systems;

but it appears that they have achieved this accuracy by the combination of radio and optical systems in redundant data-triangulation processing techniques.

The Soviets have frequently described techniques of automated data handling which indicates automatic insertion of information obtained by downrange stations into a common data-handling network for transmission to a coordination-computation center, in addition to automated disconnection of an element in the system, if it loses synchronization.

The Soviets are presently installing optical tracking equipments in Chile. One of the devices is a meridian telescope which uses earth rotation as a scan mechanism and can determine the meridional location of a star to extreme accuracy in the order of 1 second or less. This device could also be used to determine the meridional location of space vehicles in the same manner as the Soviet large, 8-dish, deep-space Doppler interferometer radio telescope.

This telescope, which uses a crossed baseline 3,200 feet long, is located at the Lebedev Physics Institute near Moscow, and is a part of the Distant Space Radio Communication Center (DSRCC). It will probably be involved in tracking of future lunar exploration vehicles, and should provide an angle-tracking accuracy of on the order of 15- to 20-seconds of arc. It is possible that the Soviets will install at least two other long-baseline devices of this type, so that they may use triangulation techniques to track lunar and deep-space vehicles. If frequency stability can be sufficiently increased, future Doppler tracking systems will not need to maintain a closed-loop, phase-coherent system. The Soviets have indicated that they are performing experimental work in the development of highly stable oscillators, using atomic clocks. Such stable frequency sources are being used at present in the 8-dish, DSRCC deep-space Doppler interferometer system, where they are buried underground in a rigidly controlled environment.

No significant advantage in the operation of such devices will be gained until stabilities are improved to a point where they could be used in space vehicles without seriously affecting their accuracies. Based upon Soviet design trends in tracking systems, it appears that they are working toward the achievement of these stabilities, and can be expected to achieve workable systems prior to, or by, 1967.

Laser devices may be used in the future for deep-space optical tracking, as well as for rendezvous guidance and communications. Soviet capabilities in this former area were indicated on November 5, 1963, when TASS reported that a concentrated beam of light (infrared) had been bounced off the moon and detected on earth by a Soviet observatory in the Crimea. The announcement said that a laser had been installed at the focal point of the 100-inch reflector telescope at the Crimean Astrophysical Observatory. The reflected light beam was detected back on earth by a special electronic receiver at the focal point of the telescope.

h. Communications

Most of the military communications circuits, including those used in the Soviet missile and space R&D program, and all circuits carrying civil traffic are, and probably will continue to be, a part of the existing,and to be expanded, facilities of the Soviet Unified Communications System. The present program to expand the Unified Communications System, which will extend over several years, is concentrated on the installation of primary and tributary microwave radio and buried cable systems. Future expansion programs are expected to include the application of scatter, waveguide, and satellite communications systems.

An area of most persistent research and exploitation has been in the use of high-frequency (HF) radio for space communications. Development of this rather conventional means of space communications has alleviated the Soviet problems resulting from the lack of a contiguous, global network of ground stations and offers the possibility for command and control of future space vehicles directly from the Soviet Union.

Although it is expected that they will continue to use the lower frequencies in the HF band, evidence indicates the Soviets will use line-of-sight communications frequencies in their manned capsules and in their space station program.

D. Future Objectives and Capabilities

1. Soviet Military Capabilities and Goals

On the basis of evidence presently available, it is not possible to determine the existence of Soviet plans or programs for the military use of space. The limitations of this evidence, however, are such that the chances of identifying military programs, even if they existed, are poor. It appears that the USSR is developing space systems for military support and is almost certainly investigating the feasibility of space systems for offensive and defensive weapons. Moreover, it is possible that space exploration, which is totally new to human experience, will offer unforeseen opportunities for military application. Soviet decisions to develop military space systems will depend on their expected cost and effectiveness as compared with alternative systems, the political and military advantages which could be gained, and the Soviet estimate of US intentions and capabilities in comparable fields. The USSR will produce and deploy those military space systems which it finds to be feasible and advantageous in comparison with other types of weapons and military equipment.

a. Offensive Space Systems

Although Soviet space activities have demonstrated that they have a capability to develop an orbital bombardment satellite, we believe that the weapons which the Soviets could orbit in the 1965 to 1970 period would compare unfavorably with ICBM's in terms of reaction times, average life, reliability, vulnerability, accuracy, and targeting flexibility, and would not, therefore, add significantly to their military capability.

Nevertheless, various political motives such as a desire to bolster international prestige by a demonstration of technical/military prowess; an attempt to gain political concessions by stimulating respect for Soviet science, awe of Soviet power, and fear of Soviet intentions; or, if convinced of U.S. military intentions in space, a desire to delay U.S. efforts by arousing world pressure against the militarization of space, might impel the Soviets to orbit a weapon for demonstration purposes. Conversely, the Soviets would have to risk strong U.S. countermoves, a general intensification of the cold war, acceleration of the arms race, and the sparking of an ambitious U.S. military space program. Thus, the specific factors likely to be involved in a Soviet decision to orbit nuclear weapons tend either to conflict with one or another or to rest on such imponderables as the Soviet estimate as to the likelihood of a U.S. program to develop offensive weapon systems for use in space. Further, these factors depend, in part, on the over-all U.S. posture, the international climate as a whole, and the tactical line of Soviet policy at any given time. It is possible that the Soviets are deferring a decision while awaiting more information on their own technical progress and on U.S. capabilities and intentions with respect to military space programs. A firm estimate as to whether the Soviets will deploy an orbital bombardment system within the 1965 to 1970 period cannot be made at this time.

On balance, however, it seems to us that the disadvantages would outweigh the advantages; and we believe, therefore, that the changes are less than even that the USSR will make such a move. Even so, the Soviets may weigh the balance differently than we do, and they may exercise their technical capabilities at any time. Moreover, considering the pace of developments in the weapons field in general, it is extremely hazardous to estimate Soviet decisions for a period many years ahead; and it is possible that the rapid progress of space technology could result in weapons developments whose feasibility is not now manifest.

With respect to the longer term, we are convinced that the Soviet leadership will, if it has not already, authorize feasibility studies and perhaps research and development tests on an orbital bombardment system. For details of possible alternate systems, see NIE 11-9-63 "Soviet Capabilities and Intentions to Orbit Nuclear Weapons."

b. Defensive Space Systems

The USSR will probably develop a capability to counter reconnaissance satellites. Surface-launched non-orbiting missiles are the simplest approach to the neutralization problem, and the most likely to be used by the Soviets throughout this decade. By assembling a system using radar and passive tracking facilities and missiles and warheads from existing defensive systems, they could intercept some U.S. satellites now.

The Soviets may be developing orbiting systems for antisatellite employment. By 1965, the Soviets could use a rendezvous technique for inspection of a nonmaneuvering satellite. A more sophisticated system with an inspection, neutralization, and damage-assessment capability could be achieved later in the decade.

c. Support Space Systems

The first Soviet military space vehicles are likely to be earth satellites for use in various support roles. It is unlikely that the Soviets have as yet launched geodetic, communications, or navigation satellites for military purposes. Since they have had the capability to accomplish some of these missions for some time and apparently have not done so, they probably have felt no pressing requirement in these fields. However, the Soviet views on requirements probably are now changing; and, for example, targeting requirements may lead the Soviets to the undertaking of a geodetic space program. However, this would require improvements in tracking technology and the establishment of tracking facilities outside of the Soviet Bloc, particularly in the Southern Hemisphere. The Soviets may also develop navigation satellites to improve the effectiveness of their missile submarine forces, as well as communications satellites.

The Soviets are probably developing reconnaissance satellites which could provide useful information on certain mobile forces and could perform post-strike reconnaissance. Because of the similarity in mission requirements, reconnaissance satellites incorporating early-warning, ground-mapping, ground-inspection, and bomb-damage-assessment functions could be accomplished by the same basic vehicle. As indicated earlier, [redacted] 50X1 and 3, E.O.13526 The tele-vised photography apparently does not provide sufficient resolution for quality reconnaissance, but the weight and recovery capabilities of this system would permit other higher resolution photographic systems to be carried at the same time. While development of a photographic capability could be associated with preparations for the US-USSR cooperative meteorological satellite program in 1964 to 1965, this would in no way preclude concurrent development of other capabilities. Demonstrated Soviet capabilities in the Cosmos program to place undisclosed payloads into low earth orbit over western nations without challenge, video transmission of photography in some instances, and the recovery in the Soviet Union of undisclosed payloads under maximum security, all represent potential military implications of at least a reconnaissance nature.

Almost certainly, Soviet scientists and military experts recognize that earth satellites have a greater potential than conventional techniques for some forms of reconnaissance, early warning (EW), weather surveillance, and communications. In view of the U.S. ICBM threat, it is believed that an EW satellite is probably a most pressing requirement in this field.

d. Manned Space Flight

It is estimated that there will be a considerable increase in Soviet man-in-space activity. Within the next year, the Soviets will probably begin to employ manned satellites having some maneuverability while in orbit to perform rendezvous, docking, and transfer operations. They will probably undertake manned flights of increasing duration, and could orbit a two-man VOSTOK capsule at any time. Moreover, it is technically feasible for them to put up a small manned space station or attempt a manned circumlunar flight by 1965 to 1966 using first-generation ICBM boosters and earth-orbit rendezvous techniques. If a multimillion-pound-thrust space booster is being developed now, the Soviets could orbit a 50- to 100-ton manned space station in 1965 to 1967.

The Soviets may attempt manned circumlunar and lunar satellite flights in connection with a manned lunar landing program, even though such flights would not be essential to accomplish the mission. It is possible that such flights would be undertaken even if a manned lunar landing were not planned. Although many similar techniques would be involved, these ventures would be considerably less expensive in terms of propulsion and the other requirements for a landing and return. Moreover, if the Soviets should conclude that the United States would win a manned lunar landing competition, they might reason that earlier Soviet manned lunar flights without landings or even the establishment of a multi-manned space station would detract from the U.S. triumph.

2. Soviet Lunar Landing Program

a. Manned Lunar Landing

There is no confirmation that a Soviet manned lunar landing program is currently being pursued. However, in view of the limitations in our present intelligence collection capabilities, such a program could be well underway in the USSR without our knowledge. Some Soviet statements indicate that a program for a manned lunar landing is underway in the USSR; and, in fact, there have been many statements relating to future Soviet manned lunar goals made recently (since June 1963) by Soviet spokesmen at various official levels. The more significant of these appear to be those of Premier Khrushchev in October 1963 and November 1963. Khrushchev's statements indicate that they are working on the problem of planning flights to the moon by cosmonauts and are quite concerned about making careful preparations for a successful flight to the moon by man. There have been no specific or unique technical indicators of a vigorous Soviet manned lunar program; and on the basis of present evidence, we do not know whether or not the Soviets aim to achieve a manned lunar landing ahead of, or in close competition with, the United States.

It cannot be estimated with confidence the method which the Soviets would employ in landing men on the moon. However, it is believed that they are more likely to dispatch the lunar vehicle from an earth-orbiting or lunar-orbiting satellite than they are to attempt a direct flight from the earth. Either approach will require major new vehicle development, facility construction, and supporting activities in many other fields. The method to be employed would probably not be apparent until late in the program.

Most of the activity unique to a manned lunar program would, to date, have consisted of laboratory and ground development preparatory to the flight testing of major system components. However, if the Soviets intend to land a man on the moon in this decade, some flight testing clearly associated with a manned lunar landing should begin within the next few years. It is believed that the minimum time between the test flights of the first multimillion-pound-thrust vehicle and a manned lunar landing attempt would be about two years. This could occur if, in its first test flights, the booster were employed with the upper propulsion stages and the lunar landing craft. However, the appearance of these test articles would not, in themselves, even then prove intent for a manned lunar landing, but it would confirm capabilities to carry out alternative missions which might be the Soviet aim. In fact, there are certain factors associated with the USSR program and certain Soviet statements which suggest that an orbital space station may be a major goal of their space program. The launching of a space station could be an integral part of an eventual manned lunar developmental program and could also reduce the requirement for launching a number of smaller satellites for systems testing in support of other programs.

An appearance of activities leading to a lunar landing should provide indications as to the progress of such a program. Manned satellites, including multi-manned vehicles, would be orbited for the purpose of extending the capability of life-support systems, developing radiation shielding, and conducting studies of weightlessness. Both manned and unmanned satellites would be used to develop advanced guidance equipment and new re-entry techniques for the higher speeds involved in a return flight from the moon. A considerable amount of unmanned lunar exploration would be required. The Soviets may attempt soft landings of instrumented packages on the moon at any time, and unmanned satellites could be placed in orbit around the moon or launched in a circumlunar flight. Based on the estimated availability of a multimillion-pound-thrust booster and advanced upper stages, the Soviets could accomplish the following: In about 1965 to 1966, they could probably land an unmanned mobile exploratory vehicle on the moon; a manned circumlunar flight could be achieved by 1966 to 1967; and a manned satellite could be placed in lunar orbit in about 1966 to 1967.

In addition to the space flights required for a lunar program, concurrent research and development would be required on propulsion, guidance, and supporting systems. A manned lunar landing vehicle, as well as the chemical propulsion stages, required to take off from the moon would also have to be developed. Finally, an expansion of ground-support facilities would have to continue over the next several years. Given their ability to concentrate human and material resources on priority objectives, it is estimated that, with a strong national effort, the Soviets could accomplish a manned lunar landing in the period 1967 to 1969.

3. Scientific Satellites

The Soviets will continue to conduct scientific experiments with satellites. They will do this to enhance their capability in space physics, to provide some data for the world scientific community, and to secure information which they believe will not be available to them from U.S. or joint programs. Because the U.S. scientific satellite program is comprehensive, and its results widely distributed, the Soviet program will probably continue to be smaller than the U.S. program. While the "Cosmos" program probably serves basic scientific objectives, it is likely that much of this effort has been, and will continue to be, in support of more specific future goals, including a possible lunar program and military support programs. They will probably continue to launch probes to Mars and Venus. As greater propulsion capabilities are developed, more extensive and complex scientific investigations of interplanetary space will be undertaken.

4. International Cooperation

Economic pressures and the broader range of the U.S. space program will tend to make international cooperation stages, required to take off from the moon would also have to be developed. Finally, an expansion of ground-support facilities would have to continue over the next several years. Given their ability to concentrate human and material resources on priority objectives, it is estimated that, with a strong national effort, the Soviets could accomplish a manned lunar landing in the period 1967 to 1969.

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4. International Cooperation

Economic pressures and the broader range of the U.S. space program will tend to make international cooperation attractive to the USSR in a number of areas, but political and military considerations will probably limit Soviet participation in joining space ventures. There may be cooperation in such fields as weather satellites, and possibly other selected satellite programs. However, the political prestige at stake in a lunar race is likely to preclude cooperation in this area even though it is, by far, the most costly of the possible new programs.

The Soviets would seek a significant degree of international cooperation only if the economic burden of their space program becomes so heavy that this program or key economic and military programs were jeopardized. Under such conditions, the Soviets would prefer cooperation to competing unsuccessfully or at too high a price. Prior to undertaking negotiations, the Soviets would probably try to achieve some spectacular successes so as to maximize their bargaining position and to appear as the nation making major concessions.

E. Probable Magnitude of Soviet Effort

1. Cost of an Offensive Space System Program

Rough calculations based on US experience suggest that a very sophisticated orbital bombardment system would require R&D expenditures on the order of $2 to $3 billion. To establish and maintain a force of some 80 to 200 vehicles in orbit at all times would cost $4 to $12 billion for initial investment and an equal amount annually thereafter for the life of the program, even assuming that the vehicles had an average orbital lifetime of one year. A force of limited effectiveness, with some 10 to 25 weapons continually in orbit, would require R&D expenditures of some $2 billion—an initial investment on the order of $½ to $1½ billion a an equal amount annually thereafter. A small, unhardened force, maintained on a standby basis, would be much less expensive than a force maintained in orbit. After an initial investment on the order of $½ to $1½ billion, operating costs could be as little as $100 million annually, a portion of which would be expended to conduct one or two reliability and confidence firings.

2. Implied Costs of the Program to Date

The Soviets have done much to make their space program as economical as possible. They have kept unique vehicle development and facility costs to a minimum by utilizing military hardware and facilities as much as possible. Their payload instrumentation has not required costly miniaturization and has been less varied than that of U.S. payloads. They have concentrated on a limited number of major space missions, and the total number of launches has been only about one-third that of the United States. Nonetheless, the cost of the Soviet space program has been very great, and it has required the use of large quantities of scarce resources and hardware.

We have no Soviet data on the cost of their space program. In view of the differences in technology and operational philosophy, it is difficult to estimate an equivalent dollar cost even for the part of the Soviet program which is clearly visible and uniquely space-related; i.e., the vehicles and payloads actually launched. A figure of 1.4 billion to 2 billion is probably a reasonable minimum (produced in the US) cost for the vehicles and payloads launched through 1963. Other costs, such as research and development, provision of supporting facilities and equipment, and astronaut training, cannot be estimated in detail; but we believe that their addition would result in a total expenditure on the order of at least 2½ billion. If the Soviets have a manned lunar landing program which has reached a stage somewhat comparable to the U.S. program, we estimate that it would have required, through 1963, an additional expenditure on the order of 3½ to 5 billion. This would include the cost to date of developing a multimillion-pound booster for flight test in 1964, high energy upper stages, lunar reconnaissance systems, advanced manned spacecraft, and associated technology and facilities.

3. Implied Costs of the Future Program

We believe that the Soviet leaders are committed to a continuing space program of sizable proportions as an element of national power and prestige. Although the Soviet program to date has not been inexpensive, the feasible space missions envisioned for the future will be vastly more expensive and more demanding in terms of both skills and resources. Moreover, the Soviet space program will be competing directly for the scarce skills and resources also needed in the ICBM, air and missile defense, and economic programs. Thus, we believe that more than ever before, the future course of the Soviet space program will reflect the impact of economic considerations.

A manned lunar landing is probably the most ambitious and costly goal in space which the Soviets might undertake during the 1960's. If the Soviets undertake manned lunar landing and a few of the additional space projects within their capabilities during 1962 to 1967, the produced-in-US cost would probably be on the order of $4 billion per year by 1964 to 1965. If they should undertake a widely varied program, annual outlays would be on the order of $6 billion by 1964 to 1965. From the Soviet point of view, expenditures of $4 to $6 billion per year, involving the most advanced technology which the USSR can provide, could not occur at a more inconvenient time. The burden of military and space programs has slowed the growth of the investment program since 1959. The allocation of large quantities of highest quality resources to lunar, planetary, and military space programs would have even more serious effects on the investment program.

IV. DESCRIPTION OF NASA STAFF PAPER

A. Objectives of Paper

As given in the NASA Staff Paper, the central objective of the NASA proposals is "...to bring about cooperation with the Soviet Union, rather than to achieve propaganda gains as such."

One might, in view of their omission, interpolate two words into this objective: "...propaganda or military gains as such." If this latter objective should be adopted as the over-all basis of a cooperative lunar program, there might be a tendency to take larger risks in protecting the military and national security interests of the United States. Whether the political gains which might be achieved in an improved political atmosphere could balance out possible military and national security disadvantages is difficult to evaluate at this stage. Certainly, no broad conclusions can or should be drawn in this regard; specific consideration must be given to each suggested effort forming a part of any proposed cooperative program with the Russians.

B. Basis and Extent of Cooperation

Six specific guidelines were used in preparing the proposals contained in the NASA Staff Papers. These guidelines were:

-1 To bring about continuing cooperation with the USSR.

-2 To achieve real, rather than token, gains.

-3 To insure well-defined cooperative efforts, wherein the obligations of both sides would be clear and comparable.

-4 To avoid undertaking arrangements which would impair our independent capability in space.

-5 To protect fully national security and military interests.

-6 To preserve opportunities for other countries to participate and to share in the results of US-USSR cooperative ventures.

In a sense, this is a passive basis for cooperation when considered from the military viewpoint; i.e., although the intent may be to protect fully our military and national security interests in space, no apparent way is provided to take active steps toward gaining military advantages from such cooperative efforts. Further studies may disclose the desirability of expanding at least some of the proposals to include interchanges which offer favorable possibilities for gaining direct military benefits.

The NASA paper treats almost exclusively only possibilities for cooperation either in a lunar program or in undertakings directly related to a lunar program. This, according to the first paragraph, is because "...agreements on space matters in other areas have already been reached with the Soviet Union..." It is questionable whether agreements have been reached in all possible areas or that the type of consideration in depth which is now being given by the Joint Chiefs of Staff to the proposed NASA paper has been given to previous agreements.

C. Approach to Cooperation

1. General Nature of Approach

As pointed out in the NASA Staff Paper, it is important to obtain detailed information of the Russian lunar program. Without such information, we would have to enter into agreements with inadequate knowledge of their relative value to the United States, with too few assurances that national security and military interests could be fully protected, with unreliable measures for estimating the good faith of the Soviets, and at a considerable disadvantage in attempting to formulate the best tactics to employ in carrying on negotiations with the Soviets. To avoid this, it is proposed in the staff paper that the United States should strive for a program approach that will (1) determine the level of confidence which we can place in the USSR in the area of cooperation, and (2) provide information on the basic elements of the Soviet programs. To the extent that information on the Soviet programs would be of military and national security value to the United States and to the degree that this approach could be implemented, a program designed to achieve these twin objectives should afford possibilities for including exchanges specifically designed to gain U.S. military benefits.

2. Specific Program Approach

It is NASA's view that negotiations with the Soviet Union preferably would be based upon a four-step series of exchanges, where the early exchanges would be subject to verification and where each succeeding exchange would become progressively more meaningful. Each of these steps is discussed below, in turn, together with some general estimates of their probable military significances.

a. Implementation of Existing Dryden-Blagonravov Agreement

As an initial step, NASA has recommended pressing for material progress toward implementation of the existing bilateral (Dryden-Blagonravov) agreement. This agreement, described in detail in Part II of this Volume, provides for cooperative efforts in three fields.

b. Exchange of Data on Past Manned Space Programs

Following satisfactory implementation of the Dryden-Blagonravov Agreement, NASA proposes, as a second step, the exchange of data and information obtained from US and USSR manned space programs to date. NASA recognizes that this exchange may be of greater technological value to the US and, therefore, may be difficult to negotiate. It is NASA's view, however, that this step would represent a "practical and useful test of Soviet intentions...." and would allow a first confidence level to be established.

Failing to get this agreement, NASA feels that this second step could be essentially made a part of the third step described in "c." below.

In general, it seems unlikely that past USSR data in such areas as flight performance, biomedicine, training, etc., would be of any major operational value to the United States, even though the Russians are now more advanced than we are in manned spaceflight. The reasons for this conclusion are these: At the present time, the value of manned military space operations is still being seriously questioned. A major effort to assess the value is now being undertaken in the Air Force's Military Manned Orbiting Laboratory (MMOL) Program. These efforts, together with future NASA experience in the Gemini and Apollo programs, should provide sufficient knowledge to make a decision concerning the probable usefulness of manned military space operations. It is conceivable that data concerning past USSR manned spaceflight efforts could aid in reaching a decision earlier than it could be reached by depending wholly on data procured from present and planned US programs. It should be noted, however, that many manned military space missions which are of potential interest would involve having men in orbit for periods substantially longer than the times spent in orbit by the Russian cosmonauts. It would follow, then, that information on Soviet manned spaceflights to date would not provide sufficient data for all military purposes.

Nevertheless, some data could be obtained from the USSR which would have potential significance to manned space operations, both military and civil. Still, the United States is in a position to obtain these same data from US programs, although, it may be argued, at a somewhat later date. The benefit, then, of such an exchange to the United States would primarily be one of time (assuming that such time advantages would not be lost in negotiations—a real possibility), because it is unlikely that the exchange would modify significantly any of the three planned US projects; i.e., the MMOL, the Gemini, or the Apollo. However, there has not yet been sufficient urgency to the development of manned military operational capabilities to conclude that this benefit would be of major importance.

c. Exchange of Gross Descriptions of US and USSR Manned Lunar Programs

NASA's recommended third step provides for an "exchange of gross descriptions" of the US and USSR manned lunar programs. NASA has noted in their staff paper that this exchange would require the United States to reveal little that has not already been publicly released, while Russia would have to release, for the first time, their broad plans for a manned lunar landing program. In doing so, Russia might have to release information in such areas as launch vehicle and in-space propulsion capabilities which would be of some military interest to the United States. In the unlikely event that the Soviets would be willing to enter into an early exchange of this nature, the United States would appear to benefit more than Russia. Whether such benefits would be large, and thus significant from the military point of view, would depend upon the exact nature of specific proposals in these areas and upon whether such data could be obtained through other means.

Viewing the over-all approach and not specific proposals that might be put forward under the approach, it is not difficult to agree with NASA's statement that "...it is hardly possible to proceed intelligently or safely to coordinated, cooperative, or joint efforts without some over-view of the proposed Soviet program." Because thereare few, if any, distinguishable differences between Russia's military and civilian space efforts, the military implications in entering such an agreement would be much greater for them than they would be for the United States. The possibility of successfully concluding this step may therefore be less than for steps one and two.

d. Exchange of Precise Descriptions of US and USSR Manned Lunar Programs

It is NASA's opinion that "Significant security considerations do not arise until the fourth step is reached"; i.e., the proposed step wherein more precise descriptions of the US and USSR manned lunar programs would be exchanged. The purpose in these more detailed exchanges would be to discover, in the two programs, elements of conflict or duplication and opportunities for tradeoffs, complementary procedures or joint actions. In light of the general nature of the preceding three steps, it is difficult to agree that significant security considerations only arise in step four. For, in fact, further negotiations under step one to implement the meteorological satellite data exchange could, unless care were taken, result in agreements which could compromise some present military space programs and would thus be inimical to military and national security interests.

3. Possible Relationships that Might Develop in The Proposed Program

There are at least four types of cooperative relationships which NASA visualizes as possibly developing as a result of following the four-step procedure outlined above. These are:

-1 Cooperation to avoid operating conflicts between US and USSR space programs; e.g., bilateral cooperation for purposes similar to those toward which the recently completed work of the International Telecommunication Union was directed. The multilateral agreement resulting from that work allocated sufficient frequencies in the r-f spectrum to provide for space communications needs for the next ten to fifteen years.

-2 Cooperation which would permit the deleting of duplications from the US and USSR manned lunar programs. Cooperation of this type could result in substantial financial savings to each country; but, in those areas wherein the success of either country's program would depend upon data to be supplied from the other's, a relatively high level of confidence in each other's actions would have to exist. Accepting this type of cooperation could, in some instances result in the US placing too much dependence upon the actions of the Soviet Union. To a degree, this would be in violation of one of the guidelines used in preparing the staff paper; i.e., that we should not enter into agreements that would "impair or limit our independent capability in space."

-3 Cooperation in the exchanging of the same, or similar, data of common interest to the US and USSR programs, where such an exchange would result in increased confidence in the validity of the data.

-4 Cooperation that would result, for example, in either the exchange of different data or in the exchange of data for the use of the other's facilities. An example quoted in the NASA staff paper suggests the possibility of exchanging Vostok flight data for US radiation or micrometeorite data. One of the major difficulties inherent in such exchanges is the difficulty in assessing the relative equality of the exchange. Proposals of this nature could foster endless debates concerning the equivalence of the proposed exchanges.

a. Military Advantages and Disadvantages

Of the four types or relationships noted above, the first and third types appear to be less difficult to achieve. In most cases, it should prove relatively easy to determine the military advantages and disadvantages of these relationships at any stage of their development, and, thus, there should be less reluctance to enter into cooperative efforts in which these two types of relationships could develop. In addition, it is likely that these relationships would evolve principally from agreements in areas wherein compliance to the terms of such agreements should be relatively easy to verify. Based upon these factors, and as a general observation, there seems less inherent military and national security risks in the first and third types than there are in the second and fourth. It seems important to keep in mind, however, that it will be necessary to examine carefully the relationships which might evolve out of any specific agreement at the time of its proposal and to judge, then, the relative military advantages and disadvantages for the United States.

b. Other Possible Relationships That Might Develop Which Would Be of Military Interest

There are other relationships, in addition to the examples given in the NASA staff paper, which should possibly be encouraged. Some of these could prove of even greater value in helping to achieve military and national security objectives than the four types discussed above.

It might prove valuable, for example, to press the Soviets for a cooperative approach that would be actively pointed toward the development of these types of relationships outside of any joint projects:

-1 Cooperation in studying the potential military applications of the technologies being developed in the US and USSR manned lunar programs.

-2 Cooperation in the linking together of some US and USSR lunar ground-support networks.

-3 Cooperation in the reciprocal staffing of some US and USSR lunar ground-support facilities.

V. OPERATIONAL CONSIDERATIONS OF THE NASA-PROPOSED PROGRAM

A. Operational Factors Considered in Joint Effort

In examining specific proposals for joint US-USSR projects, where the purpose is to assess their military significance, it is useful to establish first what operational factors should be considered in making the analysis. Such factors are considered to be those parts of any suggested cooperative venture, which if undertaken, could affect, in some way, the military capabilities of either the United States or Russia.

Because the proposals to be examined are concerned primarily with cooperation in lunar activities, it seems likely that the majority of these factors would influence only military space operations. However, some factors which may be involved might modify capabilities to carry out military operations in areas other than just space. For example, proposals to establish a joint meteorological satellite system could provide the basis for improved weather prediction in remote areas of the world. Such improvements could contribute significantly to the capability for waging limited war in those regions.

It is possible to identify most of the operational factors which have potential military significance and which are likely to be present in any joint US-USSR lunar project. Doing this and then noting carefully which would be present in each of the proposed cooperative projects has permitted making tradeoffs between the values that these projects would have for the United States and Russia.

1. Operational Factors

In attempting to determine the nature of the operational factors of interest, it is recognized that there are certain operating capabilities which will be inherently needed to carry out missions in space, including any cooperative endeavors with the Soviet Union. Most of these, in the same or similar forms, will also be required for military operations in space.

Therefore, any proposed US-USSR project which would involve one or more of the following operations would seem to be of possible military interest. Thus, these are the operational factors which have been examined in analyzing the specific proposals contained in NASA's Staff Paper, "US-USSR Cooperation in Space Research Programs":

-1 Launch Operations

-2 Tracking and Control Operations

-3 On-Orbit Mission Operations

-4 Re-Entry and Recovery Operations

-5 Logistics Operations

-6 Rescue Operations

-7 Training Operations

-8 Testing Operations

-9 Operations to Acquire Data

2. Operational Tradeoffs

a. Benefits

In general, in analyzing and making a qualitative tradeoff between the value that any cooperative project would have for the United States and the value that each would have for Russia, one of five possible conclusions will be reached:

-1 From a military viewpoint, the project would benefit either equally or neither the US and USSR.

-2 From a military viewpoint, the project would benefit Russia with no accompanying benefits to the United States.

-3 From a military viewpoint, the project would benefit the United States with no accompanying benefits to the USSR.

-4 From a military viewpoint, the project would benefit the United States with accompanying, smaller benefits for the USSR.

-5 From a military viewpoint, the project would benefit the United States with accompanying, larger benefits for the USSR.

It seems clear that to arrive at any one of these five conclusions requires the rendering of subjective judgments which are based upon a knowledge of US and USSR military space plans and programs, an understanding of the military value of the NASA space program, and a clear recognition of the military implications of the operational factors involved.

b. Weighing Factors of Value

In making a tradeoff between the value one project may have for the United States and the corresponding value it may have for Russia, it is useful to establish "weighing factors of value" which can be used, at least in a qualitative sense, in measuring the relative advantage or disadvantage.

Assuming that one of the five conclusions mentioned can be reached with respect to each of the proposed cooperative US-USSR projects, then the "weighing factors of value" can be viewed in this manner: With respect to the second and fifth conclusions, the relative advantage is clearly with the USSR in each case; and with the US in relation to the third and fourth conclusions. And with respect to the first, there is no relative advantage for either country. These distinctions alone provide a gross weighing of the relative value of any proposed, joint venture. In most cases, however, a more refined evaluation will be desired; i.e., a judgment will be needed concerning whether the relative values of the projects are significant in relation to either US or USSR capabilities to conduct military operations now or in the future. In some instances, there may be no relative value to either country or the value may be so minor that there would be little, if any, military interest either for or against the proposal. With another proposal, however, the relative value may be somewhat larger; and as a result, there may be some limited support expressed either for entering into or not entering into the joint effort. Where the relative values become fairly large, strong support, either pro or con, will normally be found. Beyond these, there may be other proposals where the relative values to the Russians appear to be potentially so great that the projects should not be entered into under almost any circumstance. On the other hand, some proposed joint efforts may be so advantageous on balance to the US that they should be actively pursued to the point where fairly major political concessions might be considered.

Thus, it is clear that there is an almost continuous range of "weighing factors of value" centered between two extreme limits. At the one limit, the relative military value to the US would be so high that we might be willing to make major political concessions to obtain Russian agreement to cooperate. At the other limit, the relative military value to the USSR would be so great that the US should not agree to enter into such cooperative efforts, regardless of the political concessions the USSR might be willing to make. And at the center of the range of values, the <u>relative</u> military value to either country would be so small that there would be little military interest either in undertaking or not undertaking the suggested, cooperative efforts.

In reality, none of the proposals in the NASA staff paper are described in sufficient depth to permit making these types of judgments with any high degree of confidence. Nevertheless, some preliminary conclusions have been reached by following the analytic approach described immediately below.

3. <u>Method of Analysis</u>

Each proposal has been analyzed to determine if any of the outlined, operational factors would be involved in the suggested effort. If it appeared that there would be, the potential military significance of each factor has been discussed in terms of how it would influence present and future military capabilities.

Having carried through these discussions, the benefits which would accrue to the US and to the USSR by entering into the proposed cooperative effort have been examined. Based upon these examinations, qualitative tradeoffs have been made to arrive at a judgment concerning the <u>relative</u> military value of each proposed project to the United States.

B. Analysis of Specific Joint Efforts Proposed in NASA Paper

1. Space and Lunar Environmental Data

In proposing a cooperative program to the USSR, it is suggested in the NASA paper that the US should advance specific projects of three major types: (1) data exchanges, (2) operational cooperation, and (3) joint integrated projects which would be mutually beneficial. More specifically, with regard to the exchange of data, it is suggested that the US and USSR might exchange data on micrometeoroid flux, radiation and solar events, lunar surface charateristics (including data important to the selection of lunar landing sites), and astronaut training.

The purpose of this section is to discuss the military operational implications associated with the exchange of space and lunar environmental data. Although operational factors which were identified in the preceding section were considered in assessing these implications and in judging the value of the exchanges to both countries, it is fairly clear that, in exchanges of this nature which do not involve joint operations to acquire the data, the primary value to either country is in the usefulness of the data and not in the operations involved in their collection. This, therefore, has been taken as the basis for judgment in the following discussion.

a. Micrometeoroid Flux

It is indicated in the NASA paper that both the US and the USSR could profit from a full exchange of information on the temporal and spatial distribution of micrometeoroids in cislunar space, on their characteristics, and on effective shielding methods and materials which can be used against them. NASA's position is that the security aspects of this exchange would be minimum and that no radical problems would be expected as a result of carrying out this proposal. However, NASA has also pointed out that as recently as June 1963, in exchanging data with Russia on their Mars and our Venus flights, Soviet scientists declined to give to the US the instrumentation and programing information needed to render their data useful. NASA further recognizes that the US might be reluctant to provide data on tests of shielding materials because of their possible application of the protection of space vehicles from hypervelocity particle weapons. Since 1949, the US has been using sounding rockets in an attempt to learn more about micrometeoroids. Polliwng these early experiments, more advanced sensors have been developed; and the rocket probes have been augmented by satellites which have been launched also to measure micrometeoroid characteristics. Data upon the size, momentum, penetration capabilities and fracture properties of meteoroids are continuing to be collected by both the US and the USSR. The usefulness of improved knowledge of these properties in determining the probability of impact and resultant damage to a spacecraft is obvious. Meteoroid impacts causing injuries to personnel in space and equipment failures cannot be avoided without fundamental knowledge of meteoroid flux. Alternately, one may view the importance of micrometeoroid data in terms of its influence on attainable mission reliability. In the use of shielding to achieve a given, desired mission reliability, it is clear that improved data on micrometeoroid flux should aid in obtaining maximum payload-to-shielding-weight ratios. If lunar military operations should prove useful in the future, the ability to carry them out may depend, in part, upon the availability of micrometeoroid data. And, finally, micrometeoroid data is required to develop effective shielding materials and methods, and to aid in the design of new facilities for simulating micrometeoroid impact and erosion effects.

From this discussion, it seems clear that all operations in space will be affected to some degree by micrometeoroids and that data regarding them are of importance to the US and the USSR. Because confidence in statistical data can be improved with a larger number of data samples, an exchange of data between the US and USSR appears to be mutually beneficial assuming, of course, that the exchange would be made in good faith. Thus, with the exception noted below and from an operational viewpoint, the proposed exchange appears to be of about equal benefit to both countries, with no particular military disadvantages to either.

On the other hand, the same seems not to be true in regard to data on shielding against micrometeoroids as these data relate to the effects of hypervelocity impact weapons. The US, using its hypervelocity test facilities, has apparently moved ahead of the Soviets in the development of novel shields (such as the self-sealing variety). Therefore, in an open exchange of shielding information, the US would likely be required to give up more information than it would gain. Thus, exchanges of data on shielding against hypervelocity pellets and other exchanges of data obtained from the hypervelocity test facilities should be excluded from any formal agreement with the Soviet Union, unless they would make some significant concessions.

b. Radiation and Solar Events

More knowledge is needed to determine the location and distribution of radiation fields between the earth and the moon, and to estimate the particle density throughout cislunar space. Such data are needed to establish optimum trajectories, particularly through the Van Allen regions, and to design optimum spacecraft radiation shields.

Although NASA welcomes an exchange with Russia in this area, there is some doubt that they are as advanced in this field as the United States. And even though Russia would appear to benefit in such an exchange, it is anticipated that they would be reluctant to discuss details concerning their instrumentation, data reduction methods, etc. (See Section VI for intelligence and security implications.)

The effects of solar flares from an operational viewpoint are twofold: First, there are direct, deleterious effects on a spacecraft and its on-board equipment and personnel. Second, there are other indirect effects which result from solar-flare perturbations of the operating environment.

The direct effects of radiation and energetic particles resulting from solar flares are particularly important in the carrying out of manned operations in cislunar space. Much more data are needed to develop a capability to reliably predict the onset of solar-flare activity, in order that manned space operations can be scheduled during quiet periods between flares. Until solar flares can be predicted with a high degree of confidence, sufficient shielding must be provided for in the design of space vehicles. As with data on the effects of micrometeoroids, improved data on radiation effects will allow better design tradeoffs between safety requirements and weight penalties. Shielding will also have to be considered in planning for the construction of a lunar base if it later proves desirable to do so.

The operations of some military systems depend upon the characteristics of the operating environment. When changes occur in the environment, the performances of such systems are naturally degraded. For example, unpredictable changes which occur in the characteristics of the ionosphere as a result of the effects of solar flares, produce marked effects upon the performance of equipments which depend upon the ionosphere for their operation. Missile launch detection systems using back-scatter and certain communication links are specific examples of systems which suffer degradation in performance as changes occur in the ionosphere. Space sensors which are used for the detection of nuclear detonations and for signature analysis of foreign spacecraft might also malfunction or provide erroneous information in the presence of solar-flare activity. Thus, solar-flare activity will influence the scheduling of operational launches, lunar operations, and on-orbit missions such as detection of nuclear detonations, satellite inspection, and missile launch detection.

To improve the long-range forecasting of solar flares, the physics of solar disturbances must be better understood. Because of the random nature of solar-flare occurrences, the more data available for study and for correlation with solar events, the better will be the prediction theory which is evolved. From this point of view or from the point of view of time and cost, a cooperative exchange of solar-flare data would be advantageous if the exchange is conducted openly and in good faith.

c. Lunar Surface Characteristics (Including Lunar Landing-Site Selection)

A lack of knowledge concerning the physical composition of the lunar surface poses large risks in a lunar landing. As indicated in the NASA paper, both the US and the USSR will require this information in order that the final design of their lunar spacecraft can be completed, assuming that Russia also has such a design underway. In addition, more detailed lunar topographical and geological data will be of value in determining the best locations for a lunar base, while the chemistry of the lunar surface may be important to the sustenance of life, should either the US or the USSR undertake, in the future, extended operations on the moon.

However, it is not the purpose of this section to discuss the military operations which might require a lunar base (the military value of a lunar base is treated separately in Volume IV of this report). Therefore, no attempt has been made in this section to identify those areas of possible military operations. There are two aspects which are associated with such an exchange which appear to be of sufficient interest to merit mention at this point.

The first has to do with the importance of lunar data for research and development leading to (1) materials and equipments suitable for lunar operations, (2) test facilities for simulating the lunar environment, and (3) support equipment and operating procedures needed for lunar operations.

The second aspect is concerned with the potential importance of recent data which indicates the probable presence of volcanic activity on the moon. Spectrographs of gaseous discharges from the summit of the central mountain in the lunar crater of Alphonsus were first made by the Russian, Kozyrev, in November 1958, and again in 1959. Further evidence was obtained by James C. Greenacre on October 29, 1963, when he observed what appeared to be volcanic activity in the area of Aristarchus. Kozyrev has also recently reported on the possible volcanic activity in the area of Aristarchus. Unlike earlier spectrographs which indicated that gases rich in carbon were ejected from Alphonsus, the spectrograms which he obtained of this activity contained a number of bright lines believed to be caused by hydrogen gas escaping from the crater. Both brighter and weaker spectral lines corresponding to molecular hydrogen were also noted. It seems plausible to expect that carbon-rich gases in Alphonsus and hydrogen-rich gases in Aristarchus would have been detected if volcanic activity were actually present; because water vapor and carbon monoxide are the two most abundant gases in volcanic eruptions.

It is readily apparent that there are potentially important military and civil implications in the establishing and operating of a lunar base. Assuming that there are regions of the moon where volcanic activity is prevalent, it may prove possible to extract hydrogen for space vehicle propulsion and water for support of the lunar base. Because of these potential advantages, the USSR might attempt, at sometime in the future, to invoke national claims of sovereignty over certain areas of the lunar surface, even though the General Assembly of the United Nations, sitting in plenary session, on December 13, 1963, unanimously adopted a resolution which included a declaration that "Outer space and celestial bodies are not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means". Therefore, consideration of these factors should be given in the selection of lunar landing sites in the NASA manned lunar landing program. Whether the USSR has more scientific data concerning volcanic activity on the moon is not known, although Russian scientists have published twice as many technical papers on the subjects than have American scientists. Both the United States and Russia have revealed considerable data thus far without any agreement. Indications are that a continuation would likely benefit the United States more than Russia unless we undertake a vigorous program to collect increased data. Certainly, if the Soviets land an instrumented payload on the moon well ahead of the US, the availability of data from that payload would be highly beneficial to the US in the APOLLO program.

2. <u>Astronaut Training Data and Interchange of Astronauts</u>

NASA has suggested that the United States and Russia might be interested in the exchange of astronaut training data and in a reciprocal arrangement under which the astronauts of each country would be interchanged for training purposes, possibly leading to their participation in actual spaceflight missions of the other country. Although it may be implicit in the NASA proposal, it might be worthwhile from the military point of view to provide for the full participation of military personnel in a joint astronaut exchange, in addition to NASA's. By doing this, greater factors should be given in the selection of lunar landing sites in the NASA manned lunar landing program. Whether the USSR has more scientific data concerning volcanic activity on the moon is not known, although Russian scientists have published twice as many technical papers on the subjects than have American scientists. Both the United States and Russia have revealed considerable data thus far without any agreement. Indications are that a continuation would likely benefit the United States more than Russia unless we undertake a vigorous program to collect increased data. Certainly, if the Soviets land an instrumented payload on the moon well ahead of the US, the availability of data from that payload would be highly beneficial to the US in the APOLLO program.

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From a technical standpoint alone, a cooperative US-USSR program to exchange views on astronaut training data, procedures, techniques and devices would be highly desirable.

As pointed out in the NASA staff paper, an astronaut training data exchange program may not now be of any great interest to Russia. It might be necessary to make some fairly tangible concessions to obtain acceptance of the exchange by the Soviets. Assuming that they would, however, initial cooperation could be limited to the exchange of data obtained in earlier US-USSR flights. As mutual confidence develops in the sincerity of the other's actions as a result of these early exchanges and as the US achieves capabilities for, and experience in, manned space flight which more closely approximate those of the USSR, the pace and extent of the exchange could be increased.

The actual interchange of astronauts should probably be approached in a similar manner. Initially, informal visits of US and USSR astronaut instructors could be arranged on a reciprocal basis. If the results of such exchanges were encouraging and acceptable to both the US and the USSR, steps could then be considered which would lead to a mutual exchange of student astronauts and to their subsequent participation in selected spaceflight missions.

3. <u>Tracking and Data Acquisition</u>

Although NASA views a possible cooperative US-USSR tracking effort in a favorable light, a closer examination discloses that a proposal of this nature would be expensive and difficult to implement. At the same time, there would be, as mentioned earlier, possible national security benefits to the United States from gaining access to the Soviet tracking, data acquisition and control sites. These potential benefits are discussed in detail in a later section.

From a military operational viewpoint, it is extremely difficult to imagine that either Russia or the United States would be willing in the present or foreseeable political environment to depend upon the other to supply data needed to carry out successfully a military mission.

Certainly, the types of military space missions which are of particular interest prior to major conflicts are not the type which lend themselves to joint ventures with the Soviet. Because the nature of future military space operations is still in the formative stages, it is difficult to judge what the actual operating advantages would be of a joint US-USSR tracking and control network. The advantages to the United States might not be as great as popularly supposed; e.g., reported tracking accuracies attainable with Soviet ship-based trackers may not be sufficient for some future military operations. It is interesting to note, in fact, that the accuracy of these ship-based trackers would preclude their use in the NASA Apollo program.

In weighing the relative military operational benefits that the United States and Russia would obtain from cooperation in the use of tracking and data acquisition facilities, it appears that the advantages are not of the magnitude such that either country would be willing to make any major political concessions to obtain the cooperation of the other. Thus, the ultimate desirability of the proposal must be evaluated in terms of political and national security factors.

4. Capsule Recovery

A first step has already been taken by the United States and Russia in recognition of the mutual advantages which could result from US-USSR cooperation in the recovery of space vehicles, particularly cooperative efforts associated with emergency recovery of the vehicles of one nation in areas of the world over which the other exercises national sovereignty. Both the United States and Russia were among the signatories of the Declaration of Legal Principles Governing Activities of States in the Exploration and Use of Outer Space. This declaration, adopted unanimously in the December 13, 1963 plenary session of the U.N. General Assembly, provides that "Ownership of objects launched into outer space, and of their component parts, is not affected by their passage through outer space or by their return to earth. Such objects or component parts found beyond the limits of the State of registry shall be returned to that State..." It would be a logical next step to expand this principle to include an agreement that each nation should actively aid in the emergency recovery of foreign spacecraft.

From a practical viewpoint, however, the possibilities of achieving a US-USSR agreement of this nature would probably be confined to non-military vehicles. Both the United States and Russia would be naturally reluctant to allow the other to gain even temporary possession of military capsules carrying data of national security interest. There would be many technical and operational problems involved in joint recovery operations; e.g., the need to adopt common r-f frequencies for tracking and control purposes and to establish reliable communications between Soviet and American tracking, data acquisition, and control sites.

Some of the technical and operational problems might prove more tractable, however, by the establishing of a joint US-USSR task force patterned after the Mercury recovery concept. An approach such as this might be attractive for use in conjunction with the manned lunar programs of each country. But the usefulness of this for military space operations, appears much less apparent. Re-entry and recovery operations of a military nature seem not adaptable to this type of cooperation. Therefore, from a military standpoint alone, it is likely that neither country would accept, or would make significant political concessions to obtain, an agreement to recover and return military vehicles of the other.

5. Lunar Logistics

Following the early manned lunar landings, another future area of possible US-USSR operational cooperation would be in joint logistic support of follow-on lunar exploratory activities. As noted in the NASA paper, however, there is little hope that such efforts would be undertaken early due to the uncertainties associated with the US and the USSR future lunar programs. If the US and the USSR should plan to undertake on the same schedule large-scale lunar explorations and to build and occupy at the same time bases on the moon, there might be interest on both sides in a joint lunar logistic program. If one or the other was not planning such activities, however, cooperation in this area would probably have little appeal to either. Thus, in the discussion which follows, it is assumed that the US and the USSR will undertake programs to explore the moon and to carry out operations on the lunar surface, possibly including military operations, and that the schedules of the US and USSR programs will be roughly the same. While it is difficult to predict at this time the exact nature of future lunar operations, it is possible to gain some insight into the general nature of the logistic support which may be required as a result of operating on the moon. By doing this, some conclusions can be tentatively drawn concerning the desirability of joint US-USSR logistics activities.

Still, the high degree of uncertainty concerning future lunar activities, particularly military activities, makes it impossible to render any clear judgment concerning the relative military value of cooperative lunar logistics support.

Lunar logistics are considered here to refer to the continuing support of a lunar base, where the need will exist to transport relatively large quantities of supplies to the moon and to transport periodically personnel to and from the lunar base. Because it seems unlikely that a joint US-USSR venture would be carried out either to establish a lunar base or to place a man on the moon, (see the discussion in 6 below), it will be necessary for each country to develop its own booster, space vehicles, and tracking and support facilities needed to effect a lunar landing. It seems probable that these same launch vehicles, spacecraft, and facilities could be used in the same, or modified form, to establish and to support a base on the moon. With these capabilities at their disposal, each country might be less eager to enter into agreements covering joint logistics support.

There are certain common factors which place constraints upon all logistic operations, regardless of the cargoes to be transported or their destinations. Of these factors, the design of the cargo carrier, the packaging methods, and the nature of the facilities at the receiving terminals are probably of most concern to the considerations here of possible joint lunar logistics support. Difficult technical and operational problems will undoubtedly arise in attempting to cooperate, unless the US and the USSR come to some early agreements which will insure the compatibility of Russian and American booster; cargo and cargo carriers, and handling equipment. In view of the probability that the manned lunar programs of the Soviet and the United States will continue to be independent endeavors, the likelihood is extremely small that the design efforts of the two countries could be so coordinated.

6. US Space Ship - USSR Booster

If sufficient confidence can be established in the Soviet's intentions through exchanges such as those which appear advantageous in 1. through 5. above, NASA feels that it may be feasible to enter into some more advanced, more integrated undertakings. One such possibility which is reported in the NASA staff paper is concerned with the wide-spread suggestion that a joint US-USSR manned lunar landing might be effected in a program which would be designed around the use of a Soviet booster and an American spacecraft, or possibly vice versa.

There are some rather obvious technical difficulties in this proposal, such as the problems that would arise in mating a US spacecraft to a USSR launch vehicle, as well as military and political problems that might result from the need to interchange on a large-scale design and operating data. It also seems likely that a joint US-USSR crew would be used. This would pose language difficulties, but it should be relatively easy to overcome these by appropriate crew selection and training. It might not be a simple matter, however, to circumvent the historic reluctance of the Soviets to disclose details of, and to provide access to, their programs and facilities. Even assuming that these difficulties could be surmounted, there would still be present in such an endeavor many of the operational factors discussed in Section IV. A., above. The extent to which these factors appear to be of military significance is discussed below.

a. Analysis of Operational Factors Present in US Space Ship - USSR Booster Proposal

From the military viewpoint, observing or participating in Soviet launch operations and gaining access to their launching sites would be of considerable interest. Because Soviet ICBM R&D facilities are co-located with their space launching facilities, having access presumably would provide opportunities to gain some information of military value or to verify some existing information. In the unlikely event that Russia would seriously entertain a proposal to allow access to their launch sites, they could build the lunar launch facilities at a separate site.

However, accepting foreign nationals in their launch areas and allowing them to observe (and, to participate in) their launch operations would represent a radical departure from Russia's present position, and would doubtlessly be considered by them as a major concession on their part. From a national security point of view, this, in itself, would be extremely important and might possibly signal either a real acceptance of US-USSR cooperation or a greater separation of the civilian and military elements of their space program. In the former instance, such acceptance might presage the possibility of undertaking joint endeavors of more direct military interest; e.g., cooperative space operations to carry out various peace-keeping functions. In the latter case, the separating of their military and civilian efforts could indicate their intention to apply space technology to specific military applications. This, of course, would be of major military import to the United States.

There seems little doubt that in a joint lunar landing program, both nations would want to exercise some combined control over the launching, in-space, and re-entry and recovery operations of the spacecraft, and that it would be profitable for both to provide some of the required tracking coverage. Therefore, it would be necessary to link together the tracking and control and the communications networks of the two countries. Common telemetry codes would need to be adopted and a common timing reference would have to be used. Conceivably, it might also prove advantageous to staff some tracking, control, and communications stations with both US and USSR personnel. And if this was agreed upon, it would be necessary to train these personnel in the operation of each other's equipment.

The relative military value to either country in carrying out joint tracking and control operations seems low. From an American point of view, however, the gaining of access to their tracking, control and communications facilities would have the same national security implications as those discussed above in reference to launch site operations.

Because the military value of operating on or near the lunar surface is still largely speculative, it is difficult to assay the military significance of landing men on the moon and in their carrying out some limited exploration of its terrain. It does seem likely that if time discloses that there are major military advantages to be gained from lunar operations, a joint US-USSR lunar landing and exploration would provide comparable gains for each country toward obtaining such future advantages. The almost certain presence of both American and Russian astronauts, the sharing by both nations of the data from the venture, and the necessity to exchange launch vehicle and spacecraft technical data in the early stages of the combined program would all contribute to the providing of each country with near-equal benefits.

The remainder of the operational factors seem to lack any major military significance for either the US or the USSR. Several of them do, however, offer possibilities for gaining access to Russian facilities and thus could possibly provide some national security gains to the United States.

b. Relative Military Value of US Space Ship - USSR Booster Program

Taking into account the above discussion and its implications for present and desired military capabilities, it is difficult to foresee from the proposed US Space Ship - USSR Booster Program any major contributions to the achieving of US military space operational objectives. There would be some possibilities for both the United States and Russia to gain technical data from the other; e.g., the US might be benefited by Soviet manned space flight technology, but, on balance, there appears little relative advantage to be gained by either.

If there is any potential military or national security value in the proposed undertaking, it would probably stem from having increased access to the Soviet space program and facilities. (For intelligence and security implications, see Section VI of this volume.)

As mentioned earlier, the USSR would almost surely consider their cooperation in the proposed effort as a major political, and possibly military, concession on their part—more so than would appear warranted in view of the true military or national security benefits to the United States. The USSR would undoubtedly expect in return either major military or political concessions by the United States. In view of the apparent absence of any substantive military benefits for the United States, it would be important not to make any significant military or national security concessions to gain Russia's agreement to cooperate.

It should be noted at this point that with regard to US military space capabilities, it is doubtful that technical or operational needs exist now which cannot be met in the National Space Program; i.e., in the combined elements of the military and civilian space programs. Therefore in making judgments concerning this proposal and the proposal discussed below in 7., it seems safe to conclude that the real value to either country would potentially be in terms of savings in time or money. It is unlikely that there would be a time advantage to the US, however, when viewed in the context of achieving operational military capabilities earlier in a combined US-USSR program. The length of time that it would take to negotiate and to complete projects of the nature described in B.. through 5., above, would undoubtedly be several years. Thus, it will likely take many years to attain the degree of confidence in the Soviet's intentions which would be needed to undertake an integrated project of this nature. And, with respect to money, again, because of the time required to gain confidence in the Soviet's intentions, it is unlikely that any major change would be made in the US space programs. Therefore, cost savings would probably not be at all significant. In fact, because the NASA Apollo program is so far along in design and because there would need to be very substantial alterations in the design of the Apollo—if not a need to develop a completely new spacecraft—the costs of a joint, manned, lunar landing program could conceivably be larger than if the US proceeded alone.

7. <u>Turner Proposal - US LEM</u>

An alternate proposal for a joint US-USSR manned lunar expedition is described in the NASA staff paper and rejected primarily for the reason that the proposal "... implies that neither side would develop the total resources to conduct a manned lunar program by itself. We (NASA) regard this, at this time and in this context, as an unacceptable interdependence...." It is also pointed out in NASA's commentary on the proposal—and correctly so—that even though many of the technical complications inherent in the US Space Ship - USSR Booster proposal described in 6., above, would not be present in this proposal, there would still remain severe technical problems to be overcome.

As the operational concept was conceived by Thomas Turner, a Republic Aviation Company engineer, and as it is described in Life Magazine (October 11, 1963); the Soviets would launch into a parking orbit about the earth two cosmonauts in a 3-man spacecraft. The United States would launch one American astronaut in the two-man lunar excursion module (LEM), which is being developed for final descent to the lunar surface in the Apollo program. The LEM would be placed as near as possible into the same parking orbit as that of the Russians. The US and USSR vehicles would rendezvous and dock; and the American would transfer to the 3-man Russian spacecraft. Using the propulsion capability of the Russian spacecraft, the combined space ship would subsequently be launched out of the parking orbit and onto a path toward the moon. Upon reaching the vicinity of the moon, the space ship would be injected into a lunar parking orbit. At the appropriate time, thereafter, an American astronaut and a Soviet cosmonaut would enter the LEM, de orbit, and descend to the lunar surface, leaving the Russian spacecraft in orbit and in the control of the one remaining Soviet cosmonaut. After an unspecified stay-time on the moon, the American and the Russian would launch the LEM into the lunar parking orbit of the Soviet spacecraft, and the two vehicles would then rendezvous. After docking, the American and Russian would re-enter the 3-man spacecraft, jettison the LEM, and return to earth.

This proposal was put forward as a possible stratagem to overcome the anticipated reluctance of the Russians to disclose details about their booster program or to allow access to their launch facilities. Thus, this approach to a joint lunar landing endeavor depreciates markedly any military or national security gains potentially achievable through the gaining of added access to the Russian space program and facilities. In other respects, the military advantages and disadvantages to the US and USSR appear quite comparable to the proposal in 6. Because of this, the relative military gains which could conceivably accrue to the United States from participating in the proposed US Space Ship - USSR Booster Program appear not to be present in the Turner Proposal. On the other hand, there appear to be no significant military advantages to the Russians. On balance, this proposal seems to be the type where, from a military and national security viewpoint, there would be very little interest for or against it; and, therefore, neither country would be willing to make any substantive political concessions to obtain the other's agreement to conduct the proposed program. Thus, the advantages or disadvantages would have to be weighed almost purely from a political standpoint.

VI. INTELLIGENCE AND SECURITY IMPLICATIONS OF THE NASA-PROPOSED PROGRAM

A. General

The tight security restrictions placed upon the Soviet space program and the limitations of such evidence as is available preclude an extensive analysis of their intentions, objectives, technology, and the hardware items in their space program. By contrast, a great deal of what the United States finds in space is made available to the general public through the press and other news media; however, the technologies associated with these discoveries are not in some cases released. For example, some of the phenomena discovered in basic research could crucially affect spacecraft design, and in some cases the information and the developments resulting therefrom have cost considerable time, money and talent. Security classifications placed on this type of data assist in maintaining the U.S. as a leader in space, and also cause a competitor to expend his own time and resources to obtain this information. In the analysis of the intelligence and security implications of the NASA-proposed program, an attempt has been made to identify the intelligence gains to each country in such a cooperative venture, the disclosures resulting therefrom, and the exceptions or revisions in U.S. security policies required to implement the proposed program.

B. Analysis Factors

Perhaps the most important factors bearing on this analysis are the critical gaps in U.S. knowledge of the Soviet space program which limits our capability to identify clearly the strengths and weaknesses of the Soviet program relative to the U. S. program. This section discusses some of the apparent inadequacies in the Soviet space program related mostly to scientific and technical capabilities. The objectives and intent of the USSR in space have already been treated above in Sec III of this volume. The current primary indicator of the over-all Soviet space program is the near-earth satellite exploration program which appears to be pointed to the achievement of the Soviet's next major goal - an operational near-earth manned orbital space station. This program may be judged to be integral to, and a pacing factor for, an eventual manned lunar system development program. Likewise, it may be the logical predecessor for near-earth future manned military space programs.

One factor of primary importance in analyzing the Soviet space program concerns the yardstick used in measurement of their over-all scientific capabilities and limitations. The current National Intelligence Estimate 11-1-62, The Soviet Space Program, dated 5 December 1962 states: "We know of no scientific weaknesses that are likely to be limiting factors on future Soviet space programs." In essence, this states that there are no major roadblocks prohibiting the Soviet Union from the orderly exploration of space. Therefore, the inadequacies stated herein are not major obstacles but are areas of space technology within the Soviet Union requiring concerted effort and continued development. More specifically, it is in these areas that the US could expect to find Soviet interest and where the US must carefully evaluate the Soviet benefits before proposing elements of a cooperative program which embraces these areas.

1. Critical Gaps in US Intelligence

The following chart of desired intelligence information about the Soviet space program contains only those elements which are considered to be most needed in answering the critical questions about the program. These elements are not intended to be all inclusive. Much additional information must be gathered to enable the development of clear understanding of all significant aspects of the Soviet program.

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INTELLIGENCE GAPS

Programs

1. Organization of Soviet Space Program and principal personnel involved.
2. Knowledge of Soviet manned lunar program, its objectives and time schedule.
3. Soviet plans and intentions for the military use of space.
4. Soviet long-term programs for interplanetary space operations.

Systems

1. Development of Soviet reconnaissance satellite (photographic, ELINT, etc.)
2. Development of a satellite disabling system.
3. Development of a space-based attack system.

Physical Characteristics

1. Configuration, characteristics, performance, and mission for each new Soviet space system, particularly as required for threat assessment.
2. Physical characteristics of Kapustin Yar Cosmos launch vehicles.
3. Physical characteristics of Cosmos payloads.
4. Physical characteristics of lunar and planetary probes.

Performance Characteristics

1. Knowledge of any aerodynamic re-entry space vehicle being developed.
2. Capabilities of any high energy upper stages under development.
3. Knowledge of any million plus pound thrust-launch vehicle being developed.
4. Maximum duration of current life support system.
5. Method for spacecraft stabilization and capability for transfer from earth's orbit.

Facilities

1. Capability to identify Kapustin Yar and Tyura Tam pads and facilities used in space vehicle launchings.

Table 1

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2. <u>General Areas of Potential Soviet Gain</u>

In general, U.S. intelligence has identified two general areas of possible inadequacy in Soviet science and technology. These are applications engineering and the apparent scope of the Soviet space program.

Traditionally, the Soviet Union has emphasized theoretical science to the detriment of practical application. The National Intelligence Estimate 11-6-62, Trends in Soviet Science and Technology dated 23 May 1962 states: "As a result, though Soviet scientists have excelled in a number of theoretical fields, there has been difficulty in harnessing their scientific thoughts for practical purposes. When Soviet capabilities for experimentation and application become more generally developed, the USSR will be able to derive even more advantage from its excellence in theoretical science."

U.S. intelligence is generally agreed that the Soviet space program has, in the past, lacked adequate depth and has been relatively narrow in scope. This may have provided short-term advantages, depending upon immediate Soviet objectives; but it will most certainly be detrimental to future development programs which involve orders-of-magnitude increases in complexity, sophistication, and cost. Although recent steps have been taken by the Soviets to correct this general inadequacy with the Cosmos, Polyot, and Electron series of satellites, the US continues to lead in orderly space exploration. Additionally, economic pressures and the fact that any Soviet manned lunar program would have to compete for available resources in other Soviet efforts, such as military space systems and missile systems, would tend to limit the scope of such a lunar program. Thus, we believe, more than ever before, that the Soviet space program of the future will reflect the impact of economic considerations.

3. Soviet Needs Relative to the NASA-Proposed Program

Limitations in the Soviet space program are herein examined only as they relate to the NASA-proposed cooperative US-USSR Space Research Program.

a. Environmental Mapping of Space. The NASA proposal envisages an exchange of data on micrometeoroid density, radiation mapping and solar flare activities including prediction thereof. It is estimated that the Soviets are deficient in extensive mapping of space in regions from about 1000 n.m. to cislunar distances. Although the Soviets have an extensive program in solar flare predictions, they have publicly stated that more effort is required to refine predictions of intense solar flare radiation.

b. Astronaut Training. There are no known deficiencies in the Soviet Astronaut Training Program, although the fact that the Soviets admitted that Titov was ill has created speculation in U.S. intelligence circles that cosmonaut selection criteria may have been inadequate. It is estimated that their Cosmonaut Training Program is adequate and thorough although it differs in concept and application from U.S. training.

c. Tracking and Data Acquisition. The Soviets do not currently possess a world-wide tracking capability. By U.S. standards, a capability for continual tracking and data flow (world-wide) would be extremely desirable for a manned lunar program. The Soviets appear to be taking steps to establish such a capability by negotiating for sites in Indonesia, Africa, Chile, Afghanistan, and Cuba. The Australians have also been approached on this subject. In addition, Khrushchev initially proposed that US-USSR cooperation in deep space tracking be accomplished, but this proposal was later withdrawn for "security reasons."

d. Capsule Recovery. NASA has proposed an exploratory cooperative effort to perform emergency rescue of astronauts in space and in areas other than planned recovery areas. The reliability and relative precision of past Soviet manned recovery efforts on land indicates no known inadequacies in this area. Rescue of spacecraft is discussed in paragraph 2.f. below. Actual or simulated experiments in high velocity re-entry from lunar missions have not occurred. Therefore, no intelligence is available in this area.

e. Lunar Logistics. Since U.S. intelligence cannot presently determine the timetable for a Soviet manned lunar program, it is not realistic to attempt to predict possible USSR limitations in lunar logistics.

f. U.S. Spaceship - USSR Booster and Turner Proposals. Both of these proposals imply that neither side would develop the total resources to conduct a manned lunar program by itself.

The U.S. spaceship - USSR booster combination is not consistent with the U.S. objective of achieving a leading space capability since the U.S. would have to delegate the development of an adequate booster to the Soviet Union. A reversal of the proposal would not appear to be in the national interest since it would employ an advanced U.S. capability to place a Soviet spacecraft first on the moon. It would also entail Soviet access to U.S. launching sites and techniques without the possibility of access to USSR sites.

In the Turner proposal, the U.S. would forego the development of a large booster and concentrate on placing a LEM in earth orbit. A Soviet spacecraft would rendezvous with the LEM and carry it into lunar orbit. The LEM would separate and descend to the lunar surface with both Soviets and Americans aboard. It would then return to lunar orbit, the occupants would transfer to the Soviet spacecraft abandoning the LEM, and return to earth. The Turner proposal would seriously prejudice the U.S.'s ability to proceed with its own program in the event that the Soviets did not live up to their agreement over the extended period of years required to implement it.

In both of the above proposals the US would be dependent upon Soviet performance, thereby impairing or limiting an independent capability in space. The present state of US-USSR relations are such that there is little or no likelihood that even a small fraction of the interchange required to implement the program would be forthcoming from the USSR.

C. Intelligence and Security Analysis

1. Preliminary Observations

It is questionable whether the USSR's space program can, on a comparative basis, maintain the dynamic thrust it has displayed. So far, they have essentially conducted space operations with systems derived from military rocketry. To proceed much farther in manned space exploration and exploitation will require much more than the adaptation of components and techniques derived from missile systems. For example, a manned lunar landing program or even a large manned space station will be orders of magnitude more complex, expensive, and demanding of scarce resources. Thus, the stage is set for possible cooperative US-USSR space ventures.

The NASA proposal discusses twelve subject areas where US-USSR trade-offs might be considered. There are, of course, many more such subject areas; however, this section addresses itself primarily to those proposed by NASA. In addition, a review was made of the 15 basic scientific disciplines and the derived relative US-USSR capabilities. These areas may well be items for future studies, singularly or as a group.

In any cooperative space venture, the U.S. and U.S.S.R. stand to gain some information of both technical and intelligence value. Therefore, the analysis must continue beyond this point to determine which side would gain over-all. The results are not surprising considering the philosophies of the two countries—i.e., an "open" versus "closed" society. Over-all, the U.S.S.R. can be expected to gain technologically in these areas, whereas the U.S. would obtain a considerable gain in intelligence. This stems partly from the fact that most data obtained by NASA is already available to the Soviets (although not necessarily the engineering and methodology), whereas the information released by the Soviets is relatively meager. The conclusion is therefore drawn that the Soviets would stand to gain considerably more in engineering know-how than we would have expected, particularly in the field of instrumentation. Conversely, the intelligence gaps that the U.S. might fill through exchanges of information are also significant. Although we know much of the Soviet capabilities in space, we are constantly frustrated by lack of knowledge of their intent. Even limited access to some of the Soviet space facilities, programs, and raw data would enable intelligence analysts to make a considerably more realistic evaluation of the over-all Soviet threat to this country than is now possible. Thus, it follows that the intelligence gain to the U.S. is the most attractive feature of any proposed US-USSR Cooperative Space Program; and for this very reason, the Soviets will in all likelihood be reluctant to reach and implement suitable agreements. (Refer to Section II above which discusses past cooperative US-USSR ventures.)

A review of 15 scientific disciplines applicable to space exploration shows the US and USSR generally at parity (see Table 2). The

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ESTIMATED STATUS SOVIET SCIENCE COMPARED TO U.S. SCIENCE

GENERAL FIELD OF SCIENCE	APPARENT SOVIET INTEREST	LAG TIME					At Parity With US	LEAD TIME				
		Over 4 Yrs	4 Yrs	3 Yrs	2 Yrs	1 Yr		1 Yr	2 Yrs	3 Yrs	4 Yrs	Over 4 Yrs
Celestial Mechanics	Intense											/--xx--/
Solid State Physics	Intense				/----	-----	xxx-------	--/				
Plasma Physics	Intense					/---	-xxx---/					
Geodesy and Gravimetry	Intense						/-------x	x-----	-----/			
Geomagnetism	Intense					/----	-xxx----/					
Non-Linear Mechanics	Intense											/--xx--/
Atmospheric Physics	Intense						/--xxx--	---/				
Ionospheric Properties	High						/-------x	xx----	----/			
Solar Astronomy	High					/----	-xxx----	----/				
Radio Astronomy	High								/--xx	x----/		
Electromagnetic Wave Propagation	High					/---x	xx-----/					
Nuclear Physics	High					/----	-xxx----/					
Meteorology	High				/----	-----	- xxx---	----/				
Meteoric Research	High, But Declining							/---x	xx---/			
Theoretical Physics	Average					/----	-xxx----	-----/				

TABLE 2

[redacted]

Soviets appear to be more advanced in some areas, for example, in celestial and nonlinear mechanics, but they may be lagging in as many as eight of the remaining disciplines. In the basic disciplines both the U.S. and USSR can gain through mutual exchange of information. The biggest stumbling block is the Soviets' tendency toward practiced secrecy at supposedly completely open forums.

Unsurprisingly, additional areas of possible mutual interest and benefit became evident during the study. These have been grouped with the future studies recommended.

2. Analysis and Evaluation of Suggested Program Elements

a. Micrometeoroid Flux - Data Exchange

US-USSR Capabilities. Soviet work in meteoritics in the past has been competent, but somewhat limited by the lack of modern equipment and has therefore lagged behind similar work in the West. Although Soviet space vehicle instrumentation may adequately serve immediate Soviet needs, it is generally less sophisticated and diversified than that employed by the U.S. Explorer satellites which, in a wide variety of elliptical orbits, have explored space systematically to a distance of approximately 32 earth radii for the collection of micrometeoritic data. The Soviets have concentrated their efforts below 1,000 nautical miles with some of the Cosmos series vehicles, in addition to acquiring some data from their lunar and interplanetary vehicles.

Evaluation of Technical Trade-offs. Both the U.S. and the USSR could profit from a full exchange of information acquired on the temporal and spatial distribution, mass penetration characteristics, and shielding of micrometeorites in earth-moon space. The Soviets, however, in addition to gaining more complete data to fill existing voids in their own program, would probably profit from the engineering design and methodology revealed by U.S. instrumentation.

Intelligence Gain and Security Implication. From an intelligence viewpoint, such an exchange would result in more accurate U.S. estimates on Soviet state-of-the-art in instrumentation and shielding, and possibly provide a clue as to the direction of the Soviet program and man's role therein. Conversely, the disclosure of data affecting spacecraft design is currently classified by NASA. Some micrometeoroid data is included therein. Therefore, an exchange of some micrometeoroid data first requires changes to present disclosure policies before it can be undertaken.

b. Radiation and Solar Events - Data Exchange

US-USSR Capabilities. The Soviets have shown considerable interest in radiation and have collected considerable data in the near-earth region of space (below 1000 n.m.). They have adequate radiation instrumentation for a manned lunar program. As early as 1959, there were 15 solar radiation laboratories in the USSR equipped with the finest equipment. The 380 plus hours of manned space flight accumulated by the Soviets has given them an unequaled amount of radiation effects data on humans, at altitudes below 200 n.m.

The U.S. has acquired a greater over-all knowledge of radiation in space than the Soviets, through the Explorer satellite program. These vehicles have systematically mapped the Van Allen belts and all space out to about 32 earth radii.

Both the U.S. and the U.S.S.R. are outstanding in their general research of radiation and solar proton event phenomena.

Evaluation of Technical Trade-offs. The U.S. and U.S.S.R. are using similar equipment, sensing hardware, and approaches to measurement of the radiation in space. Both sides seek greater knowledge of radiation and particle fluxes in cislunar space, particularly associated with solar proton events. The Soviets stand to gain in any exchange by filling in voids in their program, particularly at altitudes above 1000 n.m. They would also profit from the engineering and operational techniques revealed by U.S. instrument design and use. The U.S. could profit by obtaining additional information at the lower altitudes and from the biological effects data held by the U.S.S.R. On balance, the gain for each side would be about equal.

Intelligence Gain and Security Implications. From the intelligence standpoint, the U.S. would gain over-all. More accurate and precise judgments could be made as to the importance the Soviets attach to radiation, its hazards, and solar research. The extent of their knowledge in radiation sensor technology could more easily be assessed. Most importantly, identification of the direction and objectives of the Soviet space program, and the place of man in it, would be enhanced. As with micrometeoroid data, NASA classifies solar radiation data since it affects spacecraft design. Cooperative data exchange in this area would therefore require changes to existing security policies.

c. Lunar Surface Characteristics and Selection of Lunar Landing Sites - Data Exchange

US-USSR Capabilities The U.S. and the U.S.S.R. are about equal in capability for conventional lunar research. On the basis of the Soviets' earlier capability for lunar research (Luniks I, II, III, 1959) and their reluctance to release information concerning the instruments aboard these experiments, it is probable that they are more advanced in this area. Furthermore, U.S. intelligence credits the Soviets with a current capability for lunar soft landing, and estimates that a demonstration could occur anytime.

Evaluation of Technical Trade-offs. Both sides require information on the characteristics of the lunar surface for final design of spacecraft and for selection of suitable landing areas on the moon. A basis for an exchange relationship depends in part on the relative schedules of the two programs. If the Soviets are ahead they may acquire or will have acquired intelligence on the lunar surface before we do and thus have little interest in any contribution we might wish to make. However, if our schedules are similar and if the lunar surface is discovered to have radical characteristics not anticipated, then such information could become critical to equipment design and even mission success. Under such circumstances it becomes an important element in a space race itself, with critical tactical and security implications. Either side might well wish to withhold knowledge of this kind. Thus, the actual degree of interest and potential for cooperation will probably depend upon technical requirements and relative time schedules; if the latter are not similar, the leading side could be expected to be relatively disinterested in cooperating, whereas, if they were close, information could become critical in a closely competitive situation.

Intelligence Gains and Security Implications. From an intelligence viewpoint it appears the U.S. would gain. The Soviets have firm information on the U.S. lunar program and its schedule. However, the opposite is not true as indicated previously. From data exchange in this area it should be easier to assess the seriousness with which the Soviets view a U.S.S.R. lunar program and the establishment of a U.S.S.R. lunar base. The security implications depend upon who reaches the moon first and what either side will ask for in exchange for data on lunar surface characteristics.

d. Astronaut Training and Interchange

US-USSR Capabilities and Experience. The U.S.S.R. has 380 plus hours of manned orbital flight below 200 n.m. - the U.S. has 52 hours. The U.S. and Soviet training programs are based on different concepts and use different approaches; however, both are thorough and satisfactory for a manned lunar landing program. Both countries have adequate research and training facilities. Because the Soviet philosophy toward bio-instrumentation has been both extensive and sophisticated, it is believed that the Soviets possess the largest body of bio-astronautic data available in the world.

Evaluation of Technical Trade-offs. Technically, the U.S. could gain from the Soviets if data on astronaut training, and/or astronauts were exchanged. Astronaut exchange is especially attractive to the U.S. because of the access it provides to Soviet facilities, specific hardware, and approach to training. U.S. intelligence would benefit in that future objectives and scope of the Soviet space program would become more apparent. For example, use of new Soviet centrifuges to evaluate high "G" profiles would indicate research on acceleration tolerance applicable to the earth re-entry problem associated with manned lunar flights. Knowledge of Soviet schemes for radiation protection would also indicate future space goals.

Intelligence Gain and Security Implications. In addition to the direct technical intelligence gains indicated above, there exists the possibility for other unique intelligence collection opportunities. Living, working, and generally circulating in and out of the Soviet Union launch complexes should provide the opportunity to collect and confirm other intelligence. However, it should be noted that present U.S. simulation and training equipments and programs under Apollo are classified when they reveal specific information on the spacecraft, launch vehicle, or mission. Thus, present release policies covering exchange of information on astronaut training will necessarily have to be amended if the U.S. expects to profit from such an exchange.

e. Mutual Tracking Support

US-USSR Capabilities. The U.S. currently has a world-wide tracking capability which will be augmented to provide full support to the manned lunar program. The U.S.S.R. lacks a global tracking network and does not have a capability for continuous observation and communication with satellites and space probes. The Soviets have claimed a need for a tracking accuracy of one second of arc, and they have probably achieved this by redundant triangulation and data processing from combined radio and optical systems.

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Evaluation of Technical Trade-offs. A capability for tracking in both hemispheres would aid the Soviets in achieving greater mid-course and terminal guidance accuracies. The U.S., on the other hand, would probably derive a technological benefit from a knowledge of Soviet techniques in this area.

Intelligence Gains and Security Implications. Intelligence on the location, number, and capabilities of Soviet tracking and support systems and data on the future disposition of such facilities would be a valuable aid in assessing intentions and objectives. In addition, valuable intelligence on the capabilities and limitations of equipment and systems, including ICBM systems, could be extrapolated from Soviet raw tracking data. From a security viewpoint it must be recognized that access by the Soviets to the Apollo spacecraft ground monitoring and control facilities would compromise security precautions. However, if we track their vehicles and passed the data to them, security is maintained.

f. Space Capsule Recovery (Earth and Space) - US-USSR Experience

US-USSR Capabilities. The U.S. recovery experience with man-in-space has been confined to water landings, whereas the Soviets have always recovered on land. The Soviets have recovered more large vehicles (Vostok Program-65° Cosmos Program) but the U.S. has recovered many smaller packages (Discoverer Program). Both sides have considerable experience in recovery techniques, i.e., command and control, re-entry orientation, and re-entry shielding.

Evaluation of Technical Trade-offs. Because of the past experience and success each country has had in different earth recovery techniques and the lack of any experience by either country in space rescue, it is fairly clear that each side would find this capsule recovery program beneficial. Both countries would be required to exchange information on signals and procedures used in each other's emergency recovery program, if either side is to effect actual recovery of astronauts in specific areas under their control. Also, as mentioned in connection with operational considerations, it is obvious that technical problems are associated with in-space rescue because of docking hardware, procedures, etc. involved. If the U.S. could effect a complete exchange of earth recovery techniques through implementation of this proposal, it appears the U.S. would gain over-all. This statement is based upon the intuitive feeling that land recovery would be the preferred approach at least from an economical viewpoint.

Intelligence Gain and Security Implications. In an exchange of capsule recovery technique the U.S. would stand to gain from an intelligence standpoint. This would be true because the U.S. data is largely available "open-source." The U.S. could gain considerably more knowledge of Soviet space systems hardware, capabilities, technology, astronaut training, etc. if such a program was to be agreed upon and operated.

From the security viewpoint, this proposal which provides for both sides to develop and employ common docking hardware to enable "rescue" of spacecraft in distress would not likely be attractive. Even if the development of such a capability was deemed feasible, the security concern would rule out the required exchange of guidance systems, docking hardware, rendezvous and docking techniques, and capabilities and limitations, particularly at early stages. Detailed plans for use and locations of operational military ships and aircraft for specific Apollo recovery operations are classified until declassified by the recovery force commander. Because negotiations with other countries for capsule recovery resulting from inadvertent landings in their territories remain classified until completed, the security problem associated with this joint venture is further complicated.

g. Lunar Logistics

Since U.S. intelligence cannot currently forecast the timetable of a Soviet manned lunar program, it is not feasible to evaluate the possibility of cooperation in this area. A general discussion of the Soviet interest associated with this subject has been presented in the section "Soviet Needs Relative to the NASA-Proposed Program."

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3. Release and Disclosure Aspects of a Cooperative US-USSR Program

a. Security Policy. Both NASA and DOD security policies have a common root in Executive Order 10501. This is implemented by NASA in Chapter 3 of Part I of the NASA Management Manual, titled Security Classification Policy and Program. DOD Directive 5200.1 implements Defense Policy.

Contrary to popular and erroneous belief arising from the "Space is for peaceful purposes" theme, NASA has an integral and active security classification and control program and implementing organization. It is concerned equally with the protection of military information and selected non-military information that meets the criteria of the Executive Order, since both military and non-military are included in the term "defense information". Accordingly, the NASA classification program is not concerned solely with information of potential or actual military significance. There is little question but that any DOD military experiments and research included in pertinent NASA programs can receive the full degree of protection called for by the DOD assigned security classification. NASA Security Classification Guide SCG-11 covers "Project Apollo Spacecraft and Flight Missions," the area of principal consideration in this DOD study. It is thorough and extensive in delineation and coverage. Most areas not of common knowledge are covered by "Confidential" classification assignment, with "Secret" reserved for aspects of tracking, guidance, command and control, and their vulnerabilities to outside interference.

b. Release and Disclosure Policy. Basic policy governing disclosure of classified military information is contained in a secret publication, title: (U) U.S. National Disclosure Policy, MIC 206/29, a complete revision of which is presently being staffed with the Departments of State, Defense, and other interested agencies. The National Disclosure policy provides for a State-Defense Military Information Control Committee (S/D MICC) which developes policy and provides for a Secretariat to the S/D MICC which deals with disclosure matters related to public international organizations (i.e., NATO).

NASA Management Manual—Part II, Chapter 24 (classified Confidential) entitled "Release of Classified Defense Information to Foreign Governments" the authority of the Presidential Directive of 23 September 1958 and Section 304(a) of the National Aeronautics and Space Act of 1958—includes both nonmilitary and military information within the scope of "Classified Defense Information," but requires the NASA Director of Security to obtain release approval "of the proper military authority" for military information.

Classified nonmilitary information may be released to foreign governments by the Administrator, his Deputy and Associate Administrator, and authorized "releasing officers." These include five NASA Directors, who may redelegate to approved Assistant Directors.

NASA release considerations include downgrading or declassification review, coordination with other departments and agencies having a significant interest in the information and their consent if, in fact, they originated it.

Stipulations for agreement by the recipient government include U.S. equivalent of protection, no third-party release, respect of private rights and patents, and use confined to the purpose for which the information was given. Procedures for waiver of this security assurance are provided for officials or military representatives of foreign governments authorized by their government or organization "to receive classified defense information."

c. Policy Decisions Required. More significant than the probable difficulty of having the USSR agree to such provisions, and the improbability of having them abide by them, is a fundamental difference in the specific DOD and NASA release authority documents. NASA does not exclude the U.S.S.R. specifically. The DOD release authority document specifically includes and tables the specific foreign nations and the types and categories of information they can receive, but nowhere includes the U.S.S.R.

Independent therefore of the specific advantage-disadvantage factors dealt with elsewhere in this study, and the classification of any information or material that may in the future be specifically selected for trade-off or joint use, it is obvious that national policy decisions, approved by the President, will be required and procedures and authority not now specifically existing will have to be delineated to support any future cooperative US-USSR Manned Lunar Program and the release or declassification of classified information for the U.S.S.R.

As National Disclosure policy is presently designed to deny the Soviet Bloc all security information and to limit release and disclosure to friendly nations on the basis of their need-to-know and their ability to safeguard any material they may receive from the United States, a policy to support the lunar program would have to be devised and oriented on the elements essential to such a program.

It would appear that a specific policy guide, approved by the President, would be essential, and the establishment of a Lunar Information Security Control Committee would be a desirable working arrangement, possibly within the framework of S/D MICC, Specialized policy for special intelligence will have to develop within that system through guidance that has developed by coordinated action of the major departments and agencies concerned, and approved by the USIB and the President.

The alternative, probably unacceptable, and less workable would be approval and delegation by the President of authority to one person, to make decisions on release and/or disclosure, on an item-by-item and document-by-document basis.

VII. GENERAL CONCLUSIONS

As a result of the detailed analyses described in the foregoing parts of this volume, the following broad conclusions have been reached:

-1 Based upon the character of past US/USSR cooperation, it is unlikely that any major cooperative projects of substance will be undertaken by the Soviets, unless major changes occur in present USSR policies.

-2 Although there would be very difficult practical problems in carrying out a cooperative lunar program with the USSR, in balance, and if properly done, such a program might prove beneficial to the United States by providing critical technical information on USSR facilities, systems, and plans.

-3 A special Lunar Information Security Control Committee would be advisable to coordinate national disclosure policies for a joint US/USSR cooperative lunar program.

-4 The United States must develop and maintain a pre-eminent United States military space capability independent of a cooperative US/USSR lunar program.

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