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THE SOVIET SPACE RESEARCH PROGRAM

MONOGRAPH II
OBJECTIVES

CIA/SI 32-59
21 August 1959

CENTRAL INTELLIGENCE AGENCY

OFFICE OF SCIENTIFIC INTELLIGENCE

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Scientific Intelligence Report

THE SOVIET SPACE RESEARCH PROGRAM

MONOGRAPH II
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NOTICE

The conclusions, judgments, and opinions contained in this finished intelligence report are based on extensive scientific intelligence research and represent the final and considered views of the Office of Scientific Intelligence.

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PREFACE

The objectives of the Soviet space research program have been obscured by frequent and variant Soviet statements, often by responsible officials. Nevertheless, the immediate and long-range objectives can be determined to a considerable degree by a review and evaluation of Soviet statements and activities relating to principal astronautical goals, the purposes of current space projects, and the political, military, and scientific aims of the USSR. In considering Soviet statements, the greatest weight must be given to those by officials and scientists who are in a position to know Soviet plans and who have proved to be fairly reliable spokesmen in the past.

This monograph is based on information available to 15 May 1959 and is one of 12 monographs (listed below) on the Soviet space research program. Monographs II through XII are designed to support the conclusions found in Monograph I, which will be an overall evaluation of significant Soviet space research capabilities and will be published last.

Monographs on the Soviet Space Research Program:

I Estimate 1959–74

II Objectives

III Organization, Planning, and Control

IV Space Vehicles

V Propulsion System

VI Guidance and Control

VII Telemetry, Communications, and Reconnaissance Instrumentation

VIII Ground Support Facilities

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THE SOVIET SPACE RESEARCH PROGRAM

MONOGRAPH II
OBJECTIVES

SUMMARY AND CONCLUSIONS

The Soviets are fully aware that their penetration of interplanetary space will present unique opportunities to advance their national objectives, particularly those of a political, military, and scientific nature. At this stage of their conquest of space, they probably have not been able to formulate detailed plans along these lines, but there are indications that they intend to take full advantage of opportunities as they arise. Since there are many unknowns in space research, the Soviets will undoubtedly find it necessary to reexamine their space program from time to time.

One of the objectives of the USSR space program which became apparent at an early date was the use of Soviet accomplishments for political propaganda purposes, especially in an attempt to convince the world of the superiority of the USSR and the Communist system and to intimidate the rest of the world by the missile capabilities implied by space successes.

The Soviets have been cautious in speaking of the military objectives of their space program, but they have discussed them, and it is believed that they will use space vehicles for offensive and defensive purposes and for military communications, electronic countermeasures, navigation, and reconnaissance.

The early Soviet space efforts, particularly Sputniks II and III, demonstrated a strong Soviet desire to advance basic science and to increase knowledge of the earth, the solar system, and the universe. In the fields of astronomy and geophysics, immediate Soviet objectives include greatly improved observations by means of instrumented satellites and probes; fundamental physical experiments have also been planned. Much of the scientific interest appears to result from Soviet objectives to find methods of tapping new energy sources in space and exploiting the natural resources of the moon and planets. Some of the immediate practical objectives of the scientific program in space include improved communications; weather observations; geodetic measurements; sea-ice and polar surveys; high precision cartography; nuclear test detection, and the determination of environmental radiation hazards.

The principal objective of the USSR in the field of astronautics is to place manned and unmanned controlled vehicles into interplanetary space. For manned controlled ve-

hicles its projects concern: (a) the vehicle recovery problem; (b) space bio-medical problems; (c) protection against radiation hazards; and (d) space environment research. For both manned and unmanned controlled vehicles, the Soviets are developing: (a) space navigation communications, guidance, control, tracking, data handling, and calculating devices and procedures; (b) more powerful propellants and sources of power; (c) lunar and interplanetary probes, with Venus and Mars as the most probable early planetary objectives; and (d) artificial satellites for scientific, communications, and reconnaissance purposes. The Soviets have indicated that some of their current projects will lead eventually to the establishment of multi-purpose stations in space and on the moon and planets.

The Soviets have discussed the problem of sending probes beyond the solar system into interstellar space, but there is no evidence that such a program is being seriously considered at this time.

Indications are that the Soviets intend to continue to use the resources of the entire Bloc area in space research and possibly to encourage some high-altitude-rocket sounding programs in other leading Bloc nations. Communist Chinese reports that they will launch research rockets and artificial earth satellites probably indicate that the Soviets are considering assisting in such a program for political and propaganda purposes.

DISCUSSION

INTRODUCTION

Events leading directly to the Soviet launching of Sputniks I, II, and III and the Lunik/Mechta rocket are generally known. Much less known, however, is the history of astronautics in Russia, which dates from the end of the nineteenth century, when I. V. Meschersky investigated theoretically the dynamics of bodies of variable mass and K. E. Tsiolkovskiy began his work on the principles of rocket flight.[1,2] Although Tsiolkovskiy is usually credited by the Soviets as being the founder of scientific astronautics, several of his contemporaries also made fundamental contributions.[2,3] In 1929, Ya. I. Perel'man, I. P. Fortikov, and other followers of Tsiolkovskiy founded a rocket organization known as GIRD (Group for the Study of Reactive Motion). Some of the papers produced by GIRD indicated a high degree of technical competence in the various aspects of rocketry and space exploration.[4] Members of GIRD who are still very active include I. A. Merkulov, Yu. A. Pobedonostsev, and M. K. Tikhonravov.

The Soviet Government is reported to have organized a rocket research program in 1934, only five years after Germany had done so.[5] The Soviets have supported an aggressive rocket research policy since 1945. They appropriated most of the German rocket factories and test facilities and put several hundred German rocket experts to work for them in the USSR. Subsequent developments indicate that the Soviet effort has been more than an extension of the German program and that it is based upon independent thinking and research.[6]

By 27 November 1953, the Soviet program had advanced to such a point that A. N. Nesmeyanov, President of the Academy of Sciences, USSR, was able to make confidently the following public statement: "Science has reached a state when it is feasible to send a stratoplane to the moon, [and] to create an artificial satellite of the earth. . . ."[7]

Soviet interest in space flight was further emphasized by the action of the Presidium of the Academy of Sciences, USSR, on 24 September 1954 in establishing the K. E. Tsiolkovskiy Gold Medal for outstanding work in the field of interplanetary communications (travel), to be awarded every three years beginning with 1957.[8] The name of the first winner of the award was withheld, probably for security reasons.

An Astronautics Section of the V. P. Chkalov Central Aeroclub of the USSR was organized early in 1954. Its stated objective was "to facilitate the regulation of cosmic flights for peaceful purposes." Its charter members included chairman N. A. Varvarov, V. V. Dobronravov, I. A. Merkulov, A. D. Seryapin, K. P. Stanyukovich, Yu S. Khlebtsevich, and International Astronautics Prize Winner A. A. Shternfel'd.[9]

In April 1955, the Soviets announced the formation of the Interagency Commission for Interplanetary Communications (ICIC) composed of outstanding Soviet scientists and engineers. L. I. Sedov, a leading hydrodynamicist, was named chairman, and M. K. Tikhonravov, who as early as 1934 designed and successfully launched liquid-propellant atmospheric research rockets, was appointed vice chairman. One of the first tasks assigned to the group was the creation of an "automatic laboratory for scientific research in cosmic space" (an artificial earth satellite) as the "first step in solving the problems of interplanetary travel." The work in the field of astronautics is on a national scale. The ICIC acts as a coordinating committee to direct the activities of the various institutes.[10]

The U.S. announcement of 29 July 1955 that it intended to launch an earth satellite during the International Geophysical Year (1957–58) led to much speculation concerning Soviet capabilities and plans in this field, but the Soviets refused to disclose their intentions at that time. A short time later, on 2 August, Sedov held a press conference in which he made a guarded statement indicating that the Soviets were working on a satellite, possibly larger than that of the United States, to be launched in the "comparatively near future." [11]

An active Soviet satellite program was confirmed on 11 September 1956 by Academician I. P. Bardin, chairman of the IGY National Committee of the USSR, during a meeting of the *Comite Special de l'Annes Geophysical Internationale* (CSAGI) in Barcelona, Spain. Bardin stated that the USSR intended to launch a satellite for upper atmospheric research during the IGY, but he declined to outline the Soviet program or to disclose further details.[12]

In 1956, the Academy of Sciences, USSR, applied for membership in the International Astronautical Federation (IAF) and was accepted during the Seventh International Astronautical Congress in Rome in September of that year. The Soviet's lone delegate, L. I. Sedov, was elected a vice president, but more than a year passed before the USSR complied with the by-laws of the IAF and submitted a description of the Academy's ICIC and a list of members.[13]

In December 1956, the Soviets disclosed details of the extent and nature of their upper atmosphere rocket research program. This came about when a delegation of 13 scientists, headed by Academician A. A. Blagonravov, attended the first International Congress on Rockets and Guided Missiles in Paris. Papers presented by S. M. Poloskov and B. A. Mirtov revealed some unique features of Soviet upper-atmosphere research rockets, and the presentation by A. V. Pokrovskiy indicated an extensive Soviet experimental aeromedicine program. Subsequent to the release of this information, various articles appeared in Soviet newspapers and scientific journals supplying additional information on the Soviet rocket effort. Among the significant items was the Soviet admission that rocket studies of the atmosphere had been conducted since about 1947.[14] [15]

The Soviet rocket and satellite program for the IGY was outlined in a general manner in June 1957 in a letter from I. P. Bardin to IGY headquarters (CSAGI), Brussels. The program indicated that the Soviets would fire 125 meteorological research rockets from three different geographical zones and would place into orbit an unspecified number of artificial earth satellites.[16]

On 1 June 1957, Nesmeyanov was quoted in the Soviet press as saying that the necessary equipment and apparatus had been created to solve the problem of artificial earth satellites.[17] A week later, Nesmeyanov stated, "Soon, literally within the next months, our

planet will acquire another satellite. . . . The technical difficulties that stood in the way of the solution of this grandiose task have been overcome by our scientists." [18] Other indications of an impending satellite launching included announcements in Soviet astronomical and radio journals giving instructions on methods of observing satellites and receiving their transmissions.[19 20] These indications were available to few people in Western countries.

On 27 August 1957, the Soviet press carried announcements that successful tests of an intercontinental ballistic missile had been carried out "in conformity with the plan of scientific research work in the USSR." [21] Then came the successful orbiting of Sputnik I on 4 October 1957, followed by Sputnik II on 3 November 1957, and Sputnik III on 15 May 1958. These launchings introduced the new space age and impressed the world with Soviet scientific and military accomplishments, thereby scoring a major propaganda and psychological triumph. Sputnik III in particular has been evaluated as a major scientific accomplishment.[22]

The next important Soviet step in the space research field was the launching of the so-called cosmic rocket on 2 January 1959. There is little doubt that it was intended as a lunar rocket, considering advance statements by Soviet newspapers and astronautical experts, the 62-hour life of the power supply, the significance of the unofficial name "Lunik," * the scientific experiments planned, and the marker carried for the purpose of leaving evidence of the first rocket to impact on the moon.[23-26] The Soviets were clever enough to reorient their propaganda line after it became apparent that the rocket would not strike the moon but would be drawn into an orbit around the sun by the gravitational attraction of that body. At first, some began to call it "Mechta." ** Thereafter they referred to it as the first cosmic rocket, the first artificial planet, and the first solar rocket. In spite of failure to achieve its lunar mission, the rocket demonstrated that the Soviets were making progress in their space flight program.

* "Lunik" is a coined word, a play on the word sputnik, meaning a little moon or a moon satellite. Some Soviets also referred to the rocket as "lunalet" (moonship or moonflight).

** "Mechta" means an unattainable dream.

PRINCIPAL ASTRONAUTICAL OBJECTIVES

Manned Interplanetary Flight

Manned space flight on an interplanetary scale is the announced goal of the Interagency Commission for Interplanetary Communications (ICIC), of the Academy of Sciences, USSR.[10] Various spokesmen have repeatedly confirmed this as a principal Soviet objective.[26-29] Controlled flight in vehicles capable of returning to earth is implied in the ICIC statement.

Unmanned Controlled Vehicles

A number of leading astronautics experts, have mentioned the desirability of using unmanned controlled vehicles in interplanetary space exploration, pointing out that the use of such devices eliminates many of the basic difficulties — such as biological, shielding, recovery, and excessive weight problems — encountered in manned vehicles. The development of unmanned space vehicles is expected to continue to receive a great deal of attention by the Soviets because their initial investigations of space will be conducted with such vehicles. Highly developed unmanned rockets and satellites, therefore, will be important stepping stones in the accomplishment of manned space flight and, according to some Soviet views, they will always be preferable because of cost and safety factors for certain types of space exploration. A. G. Karpenko,[31] V. I. Krassovskiy,[32] and Yu. S. Khlebtsevich [33 34] have advocated the use of vehicles of this type. The Institute of Automatics and Telemechanics, of the Academy of Sciences, USSR, reportedly is working on associated problems.[35]

Interstellar Flight

Responsible Soviet scientists have not encouraged the belief that flight beyond the solar system into interstellar space is attainable in the foreseeable future. Typical of the statements relating to this problem is that by

V. V. Dobronravov, who said, "Some scientists are even thinking of space ships which will take man to other stars of the galaxy. But this is something for a more distant future." [30]

CURRENT SPACE PROJECT OBJECTIVES

Responsible Soviet authorities recognize that their principal astronautical goals can only be attained through a series of developments, each being an important achievement in itself and contributing in a cumulative manner over a number of years to the ultimate objectives — manned and unmanned flight by means of controlled space vehicles. [26-39] Soviet statements and recent events indicate that the space program is well underway and that current projects probably have the major objectives which are outlined in the following sections.

Recovery Problem

A practical solution to the problem of recovering satellites and other space vehicles is regarded as a prerequisite to sending humans into space, according to A. N. Nesmeyanov, L. I. Sedov, and other leading figures. Several have openly admitted that the USSR is working on a recoverable satellite or a recoverable capsule or glider from a satellite.[26 29 38 40] Other similar indicated objectives may include landings by winged, powered vehicles of the boost-glide type. Retardation by utilizing the resistance of the atmosphere appears to be favored, especially in the early stages. V. V. Dobronravov apparently expressed the opinions of many Soviets in July 1958 when he said, "It is quite possible that the first problem will be that of producing so-called guided or recoverable satellites." [37 41 42] Solution of the vehicle recovery and reentry problems will result in the return of animals and later humans from experimental space flights.

Navigation, Communications, Guidance, Control, Tracking, Data Handling, and Calculations

Yu. S. Khlebtsevitch has pointed to the role that radio-electronics must play in providing improved communications, guidance, control, tracking, data handling, and calculating devices.[33] Other leading authorities who have indicated similar Soviet aims to provide support to the space program include V. Dobronravov,[43] I. Kucherov,[44] L. Yanitskiy,[45] and G. V. Petrovich.[29 46]

A Soviet broadcast of 6 May 1958 stated, "The creation of intercontinental ballistic missiles and the launching of the Soviet artificial earth satellites were made possible to a significant degree by the admirable achievements of our radio-electronics. Applying radio-electronic methods evolved by Soviet scientists, it became possible to launch the satellites with exceptional accuracy on previously calculated orbits." [47]

Published orbital calculations and demonstrated ability to compute rapidly the ephemerides of artificial earth satellites indicate the existence of a Soviet objective of some priority to support the space program with adequate tracking, ground communications, and computing devices and procedures. The astronomical approach to the space navigation problem was being considered as early as 1952.[48]

Propellants and Sources of Power

The Soviets have made many statements indicating a long-standing objective of high priority to find and develop new, more powerful propellants and sources of power. Premier Khrushchev has bragged of the enormous power used to launch the Sputniks.[6 p. 9] Current Soviet propulsion systems appear to utilize chemical systems based upon conventional liquid bi-propellants. Higher-energy fuel combinations will be required for launching significantly heavier payloads to great distances. The Soviets have expressed interest in fluorine, hydrazine, and boron compounds, all of which have potential applications in the development of high-energy fuels; solid propellant fuels have also received attention. Statements by K. P. Stanyukovich, V. G. Fesenkov, and others indicate high interest in nuclear propulsion.[6 p. 21 50 51 180] Plans to develop free-radical fuels and ion, photon, and other so-called exotic propulsion systems are undoubtedly being considered as part of a long-range research program.[52-57 60] Other

methods, such as utilization of atmospheric energy and fields of force in space, appear to be of only secondary interest at present and probably can be classed as long-term objectives.[58 59 85]

Bio-Medical Problems

Current Soviet statements, their prolonged tests of life-sustaining systems under space equivalent conditions, their animal recovery experiments from vertical rocket flights, and the orbital experiment with a dog in Sputnik II, all indicate the wide scope and seriousness of the bio-medical space research effort in the USSR.[61] There is no doubt that the Soviets intend to advance their program to the point where they can sustain life and recover man from orbital and powered space flight. Typical of the statements relating to this objective is that of A. D. Seryakin who, after pointing out that much detailed study of the effects of space flight on man was necessary, stated, "One thing is certain: Soviet medicine, in cooperation with Soviet technology, will ensure safe conditions for man's life on a cosmic ship . . ."[62 115]

Soviet statements indicate that they are working on the use of algae as food for space vehicle crew members and as the active component in a carbon dioxide-oxygen exchange system.[63] In addition, it should be assumed that they are studying the possibilities of use of the same or similar organisms as the active agents in waste disposal systems. In the perfect closed biological system all of the waste materials, including solids, liquids, and gases, enter into the system with the regeneration of useful products. It is not anticipated that biological systems for regeneration of food and oxygen will be used in early flights of comparatively short duration, except for testing purposes. Only with long duration flights can a saving of weight and space be made through the agency of air, algal food, water, and gas cycling systems.

Soviet astrobiological research is aimed at determining whether life exists on other planets of the solar system. Most of the Soviet effort has been expended on a study of the possibility of the existence of plant life on Mars. There are recent indications that some Soviet facilities and personnel formerly devoted to astrobiology have been transferred to studies of man's survival in space.[64] It can be assumed that Soviet interest in astrobiology will continue, but probably at lower priority for the time being.

Soviet interest in problems connected with the effect of the different factors of interplanetary travel on the human organism has been expressed by I. S. Balakhovskiy, V. B. Malkin, V. V. Rozenblat, Ye. Yugove (Yugov), A. Serov, and others.[66–69 71] Ye. K. Federov stated in a press conference in Moscow on 16 May 1958 that Soviet space research with live animals will continue.[70]

Space Environment Research

In addition to lunar and planetary investigations, the Soviets plan to conduct further studies of the nature and processes of the space environment, mostly in the area of astronomical and geophysical research, in support of the space program. This objective has been clearly defined by Soviet statements and by the rocket and satellite program to date.[72–75]

A more complete understanding of the upper atmosphere, including density, temperatures, pressure, winds, chemical composition, and ionospheric properties would be extremely useful for space communications and for the design and operation of space vehicles. Increased knowledge of solar and cosmic radiation, of the earth's magnetic and gravitational fields, and of the distribution of meteors, dust, and other constituents of the upper atmosphere and space are of considerable importance to the development of a space program.[76 p. 36–37] With the U.S. discovery of the Van Allen belts, the radiation problem has become important in the attainment of manned space flight. Much work remains to be done in understanding the processes involved, the spacial boundaries, and variations in intensity and extent as well as in determining means of protection or avoidance of the belts.

Prominent scientists who have discussed the environmental aspects of the Soviet space program include V. V. Mikhenevich,[79] B. A. Mirtov,[119] S. N. Vernov, V. L. Ginsburg, L. V. Kurnosova,[78] V. V. Belousov,[75] Ye. K. Fedorov, G. A. Skuridin,[74 116] D. Y. Martynov,[81] V. Fedynskiy,[82] Boris Kukarkin,[66] and V. G. Fesenkov.[80]

Radiation Shielding

L. I. Sedov and others have mentioned the protection of life against radiation hazards as another important problem to be solved.[26] Shielding and associated weight problems are probably being investigated as the results of space environmental and bio-medical research are analyzed.

Lunar and Interplanetary Probes

The Soviet rocket Lunik/Mechta, launched on 2 January 1959, furnished evidence that the development of lunar probes is high on the list of current Soviet space-project objectives. G. V. Petrovich stated in March 1959 that Lunik was "only the beginning of a study of the closest heavenly body to us, the Moon." He predicted later flights around the moon; an artificial moon satellite; landing of scientific equipment on the moon's surface; and the landing of a manned rocket on the moon, possibly two manned rockets to insure safe return to the earth. He stated that a manned circumlunar flight will precede a manned earth-to-moon flight with landing on the moon.[29]

Petrovich also stated that flights to the planets Mars and Venus, our closest planets, are now "completely within reach." His comments indicated that exploratory trips, approaching the planets as close as possible for observation, would be undertaken before landings are attempted.[29]

In his opening address to the annual general assembly of the Academy of Sciences, USSR, on 26 March 1959, A. N. Nesmeyanov said "There is no doubt that such gigantic tasks as the attainment and exploration of the moon and, subsequently, of the nearest planets will be accomplished before the current Seven-Year Plan ends.[84] Nesmeyanov's statement is believed to refer to the use of unmanned instrumented satellites or probes.

Many other reputable Soviets have indicated plans to explore the moon and planets, including Yu. S. Klebtsevitch. According to his statements in December 1958, the Soviet conquest of the moon will begin within 10 years and will be accomplished in 3 stages: (1) impact with scientific and reconnaissance instruments; (2) landing of radio-controlled rockets with special apparatus and travelling tank laboratories equipped with television and other complex apparatus; and (3) creation of a permanent, manned station on the moon. In the third stage, preparations and provisions will be made for insuring regular trips between the moon and the earth, according to this Soviet authority on radio telecontrol.[110]

Other well-known Soviet scientists who have indicated plans for lunar and interplanetary flights include V. V. Dobronravov,[85-87] Ye. K. Fedorov,[88 89] A. A. Blagonravov,[90 91] Nikolai Varvarov,[92] L. I. Sedov,[39 58 94] V. Kaznevsky,[60] and V. G. Fesenkov.[64] In October 1958, L. I. Sedov predicted unmanned space flights to the Moon, Venus, and Mars "in the nearest future."[96]

Artificial Satellites

There are numerous indications that the Soviets are engaged in a program to launch a series of artificial earth satellites for scientific, reconnaissance, communications, and other purposes. These include statements by A. N. Nesmeyanov,[173] V. V. Dobronravov,[97] S. Katayev,[98] and others.[99 100] In March 1959, G. V. Petrovich stated that Soviet space research is concentrated into three principal areas, one being the creation of a number of artificial earth satellites "of different tonnage and purpose." He continued, "First among these in a group of satellites which will provide constant observation over the whole surface of the earth and the air surrounding it. These are to be equipped with the complex scientific apparatus, both optical and television, necessary for this purpose. . . . Further development in this area will bring about

richly equipped observer satellites, real stations outside the earth, cosmic laboratories and observatories. In time, these stations will fill additional functions connected with servicing the interplanetary flights of cosmic rockets." [101]

Solar satellites, lunar satellites, and earth-moon satellites have been mentioned in addition to earth satellites. A. A. Shternfel'd has elaborated on space stations of various kinds, including so-called stationary artificial earth satellites, artificial sun satellites, natural satellites of the planets, and lunar and planetary stations.[76] [78] A. N. Nesmeyanov on 3 October 1958, speaking of a long-term program, mentioned the establishment of a large "cosmic" station which would serve as an intermediary station in space travel.[102] [178]

OVERALL NATIONAL OBJECTIVES

It is accepted as axiomatic that the Soviets engage in a space program because they expect to advance their national objectives, especially those of a political, military, and scientific nature. If this were not so, they would not expend the effort which they are putting into the space program. Since there are still many unknowns in space research, the Soviets will undoubtedly find it necessary to reexamine the various phases and time scales of their space program from time to time. A typical finding leading to a reexamination is the recent discovery of the Van Allen radiation belts with their possible hazards to space flight. Present evidence indicates that the USSR is working on a number of problems in the space field and will attempt to exploit each development to the utmost.

Political Objectives

Whether by advance plan or not, the Soviets are using their accomplishments in space research as propaganda instruments (1) to convince the world of the superiority of the USSR and the Communist system, particularly in the development of science and technology and (2) to intimidate the rest of the world by the missile capabilities of the USSR as implied by accomplishments in the rocket and satellite field.

The launchings of Sputniks I, II, and III and Lunik were accompanied by prolonged and intensive Sino-Soviet Bloc propaganda campaigns. Typical of the statements following Sputnik I was that on 6 October 1957 by Kuo Mo-jo, President of the Communist Chinese Academy of Sciences, who said, "Following the successful manufacture of the inter-continental ballistic missile, the Soviet Union again succeeds in the launching of the first man-made satellite. These are the most precious presents to the commemoration of the 40th anniversary of the great socialist revolution. They have much significance in the safeguarding of world peace and the promotion of welfare of mankind. The Soviet Union's successes in scientific technology since the October revolution 40 years ago has clearly demonstrated that this socialist country is the most advanced in the world. The Soviet success may be attributed to the correct leadership of the Communist Party and the superior nature of the socialist system." [103]

Following the same event, Nikita Khrushchev made the following statement, "The United States does not have an ICBM, otherwise it would also have easily launched a satellite of its own. We can launch satellites because we have a carrier for them, namely the ballistic missile." [104]

In November 1957, following the launching of Sputnik II, A. N. Nesmeyanov made a characteristic statement, "A second Soviet satellite has been launched into infinite space. The second satellite is carrying more than half a ton of scientific equipment. This figure alone testifies to the extraordinary power of the rocket device which carried it. And the launching itself of the second satellite less than a month after the first, and a second satellite which is more perfect as far as its scientific equipment is concerned, shows that we have really entered the era of the exploration of cosmic space, that we are really rapidly progressing toward interplanetary communications. The whole world sees that the launching of the second satellite is not just

a piece of luck, but the fruit of a great preparation of mature thinking, and of the perfect technology of the Soviet Union." [105]

On 18 May 1958, after the launching of Sputnik III, a *Pravda* editorial stated, "It is with admiration that the entire world speaks of the third Soviet artificial earth satellite. Its successful launching is a new and vivid testimony to constant technical progress; it is the result of the outstanding success of science in our country." The article quoted Khrushchev as saying, "These successes are explained by the character of the socialist order which creates the most favorable conditions for uninterrupted progress in the culture of the entire population, for the growth of scientific cadres, and for the development of scientific and technical thought." [106]

Following the firing of the Lunik/Mechta probe, Soviet Defense Minister Rodion Malinovskiy stated in a speech on 3 February 1959, ". . . intercontinental ballistic rockets . . . cannot be stopped by any antiaircraft means of defense. They are capable of delivering without fail a hydrogen warhead of colossal power to any point on the globe, or precisely to any point. They are exceedingly accurate. No need to doubt this, for the first rocket of this kind has experimentally risen into the cosmos and is now proudly carrying the Soviet pennant around the sun. What other proof is needed of the rocket might of the Soviet power?" [107]

Although all available evidence shows otherwise, prominent Soviet scientists have also claimed that the USSR was the first to discover the belts of radiation now known as the Van Allen belts, after the principal U.S. investigator.[108] This phenomenon is the most important recent geophysical discovery relating to astronautics, and the Soviets undoubtedly would like to assume credit for it.

According to some reports, current Soviet space projects include the development of communications satellites which would solve the problem of simultaneous broadcasting of television programs throughout the world.[100] There is little doubt that the Soviets are working on the problem and that, if successful, they will exploit it to the utmost for propaganda purposes.

Military Objectives

It has been stated that every vehicle invented by man has been used in warfare. It is unlikely that space vehicles will prove to be an exception, therefore it must be assumed that the Soviets will employ them for such purposes.

Soviet officials have made very few statements relating to the military objectives of their space research and development program. The Soviet articles which do mention military objectives usually quote and comment on statements by citizens of Western countries. These Soviet articles are always liberally interspersed with the usual Communist "peace" propaganda.[76] [99] [885] [888]

Military uses of satellites were considered by Major General G. I. Pokrovskiy in his article "The Role of Science and Technology in Modern War," published in 1957. He wrote, "The development . . . has also led to artificial earth satellites. These satellites, together with their scientific value, also have military significance. From them it is possible to observe the opponents' territory and to throw atomic bombs on that territory." [109]

G. V. Petrovich, commenting on the Soviet Lunik/Mechta rocket, stated, "A powerful improved ballistic rocket was used to create the one-and-one-half-ton 'solar' rocket. This rocket can be used to launch earth satellites of any weight up to several tons, or to deliver loads of even greater weight to any point on the earth's surface . . ." Petrovich spoke of "satellites which will provide constant observation over the whole surface of the earth and the air surrounding it" as being among the first of the Soviet objectives. According to him, these satellites will be equipped with both optical and television equipment. Petrovich does not mention the obvious military applicability of these reconnaissance satellites.[101]

These and other Soviet statements indicate that reconnaissance satellites are being developed in the USSR.[110] [111] Eventual refine-

ment of these techniques can be expected to permit surveillance of naval movements, airfields, military equipment, nuclear and missile tests, and other activities of considerable military importance. During the East-West Conference on Problems of Detecting Nuclear Explosions, Geneva, July 1958, the Soviets indicated a firm conviction that the use of instrumented satellites for detecting very high altitude nuclear detonations was both feasible and desirable.[112]

It is possible that some of the present Soviet emphasis on recovery of satellites or capsules and on landings from powered space vehicles stems from the relation between these problems and the delivery of bombs from space vehicles. Manned, powered space vehicles and space stations for offensive and defensive purposes are probable long-range Soviet objectives.

Other areas in which space vehicles could be used profitably include military communications and navigation. Although Soviet statements usually relate to civil applications, it is evident that the Soviets have the military communications uses well in mind, particularly the receipt by satellites of military messages and their transmission or relay to headquarters, or land, sea, air, or space forces. Intercept of enemy radio transmissions and communications would be of considerable intelligence value and jamming of enemy radios from satellites would be useful for military purposes.[46 98-100]

Scientific Objectives

Space research affords new and unique opportunities for scientific observations and experiments which will advance basic science and add greatly to knowledge of the earth, the solar system, and the universe. The Soviets have demonstrated in the early stages of the space age that they intend to use space vehicles as a means of advancing science.

In the field of astronomy, immediate Soviet objectives include greatly improved observations of the solar system by means of instrumented satellites and probes. A. N. Nesmeyanov, in a speech presented on 1 December 1958 relating to the tasks of Soviet science in the next seven-year plan, said, "The seven year plan for the development of science devotes considerable attention to elaborating new means of astronomical investigations both with the aid of new powerful optical and radio-technical instruments and with the use of space rockets and artificial satellites which make it possible to send instruments beyond the earth's atmosphere." Commenting on the significance of astronomical research, Nesmeyanov said, "It should be noted that the very idea of controlled thermonuclear reactions arose in studying the sources of energy of the sun and stars. Today astronomy investigates the nature of physical processes arising in outer space in conditions which still cannot be reproduced in laboratories on earth (super-high pressures and temperatures, super-powerful processes of energy emission, etc.). Of great interest for astrophysics is also the problem of the generation of cosmic particles whose energy is millions of times greater than the energy of particles now obtained with the aid of the most powerful accelerators."[113] Nesmeyanov's remarks and those of other Soviet scientists not only indicate a purely scientific interest but hint at a Soviet objective to tap new energy sources in space and to exploit the natural resources of the moon and planets.[50 62 66]

Soviet astronomers, biologists, physicists, and geophysicists have expressed the intention to conduct fundamental research in space.[49 70 76 80 82 88] V. G. Ginzburg, outstanding theoretician, has advocated the use of space vehicles to obtain further verification of the general theory of relativity.[78] Ye. K. Fedorov and others have suggested the need for experiments and new theoretical work in the physics of high vacuum, gaseous discharge, electrical plasma, magnetohydrodynamics, low temperature physics, and other fields which space penetration will provide an opportunity to investigate.[73] S. M. Poloskov has reported Soviet plans for improved solar research.[83]

In the field of geophysics, Fedorov and G. A. Skuridin have outlined problems for investigation which include an explanation of

changes in the intensity of the earth's magnetic field, of various currents in the atmosphere, the nature of solar corpuscular emissions, the role of ultraviolet and x-ray radiation in the formation of the ionosphere, the influence of cosmic rays on processes in the high atmosphere, the study of the chemical structure of the ionosphere, of the degree of recombination of atoms and molecules in various strata, and the frequency of collision of free electrons.[116]

Fedorov has indicated that satellites will be used for weather observations;[198] A. A. Mikhaylov has indicated that geodetic observations will facilitate measurement of the exact shape of the earth;[117] A. A. Shternfel'd has mentioned photosurvey and high precision cartography and polar and sea-ice observations by means of satellites;[76 pp. 858-861] and other research problems have been proposed.[77-79 118-121]

OBJECTIVES RELATING TO SINO-BLOC PARTICIPATION IN THE SPACE PROGRAM

Communist China

Statements from Communist China, including reported declarations by Kuo Mo-jo, President of the Academy of Sciences, indicate an intent to launch research rockets and artificial earth satellites.[122] A typical statement is one by Kuo, who was quoted in *Pravda* in May 1958 as follows, "Chinese scientists are seriously studying the Soviet Union's most advanced technology so that China may launch her own Sputnik in the nearest future."[123] An expanding satellite tracking program and increased activity in astronomy and other fields related to space research have been noted in Communist China.[123 124-126]

If successful in launching a satellite, the Communist Chinese would score a major propaganda coup, especially in Asia. There is no evidence that Communist China itself has such a capability; but, with considerable assistance from the USSR, the orbiting of a satellite from the Chinese mainland is a possibility.

The European Bloc

Most of the European Bloc nations have shown interest in astronautics and some of them, particularly East Germany, Czechoslovakia, and Poland, possess capabilities of some significance in supporting scientific and technical fields.[136-146 148] The Bloc countries have been of considerable assistance to the USSR in satellite tracking, and some Bloc scientists are known to have been invited to the USSR to assist in the space program.[129-135 139 147] Soviet exploitation of German rocket design and propulsion experts since World War II is well known.

Polish statements in 1957 of intent to launch an artificial earth satellite do not appear to be backed by the necessary achievements to date and are therefore discounted insofar as they apply to launching a satellite from Polish territory.[149-151] Yet, Polish enthusiasts appear to be going ahead with a small rocket research program.[144] Undoubtedly groups in other leading European Bloc countries have similar objectives.

From recent trends it appears that the USSR intends to continue to exploit the scientific and technical resources of the European Bloc countries to advance its own space program.

NEXT 8 PAGES

DENIED-IN-FULL

APPENDIX B

SINO-SOVIET BLOC STATEMENTS RELATING TO THE SPACE PROGRAM

Soviet Statements of Astronautical Objectives

Manned Vehicles, Landings, and Recovery.--Dr. Yevgeni K. Fedorov, Director of the Institute of Applied Geophysics, Academy of Sciences, USSR, and a leading official in the Soviet IGY rocket and satellite program, on 6 October 1957, shortly after the firing into orbit of Sputnik I, wrote in Pravda that his country was working on the problem of designing an artificial satellite able to return to earth undamaged. 151/

In February 1958, Fedorov is quoted as saying, "Soviet physiologists believe it is absolutely necessary to carry out much more numerous and detailed, prolonged experiments with animals before sending a man into cosmic flight. 152/ The next day, he said, "Despite the offers of many Soviet citizens, human beings will not be sent up in a rocket until a number of problems are solved." 36/

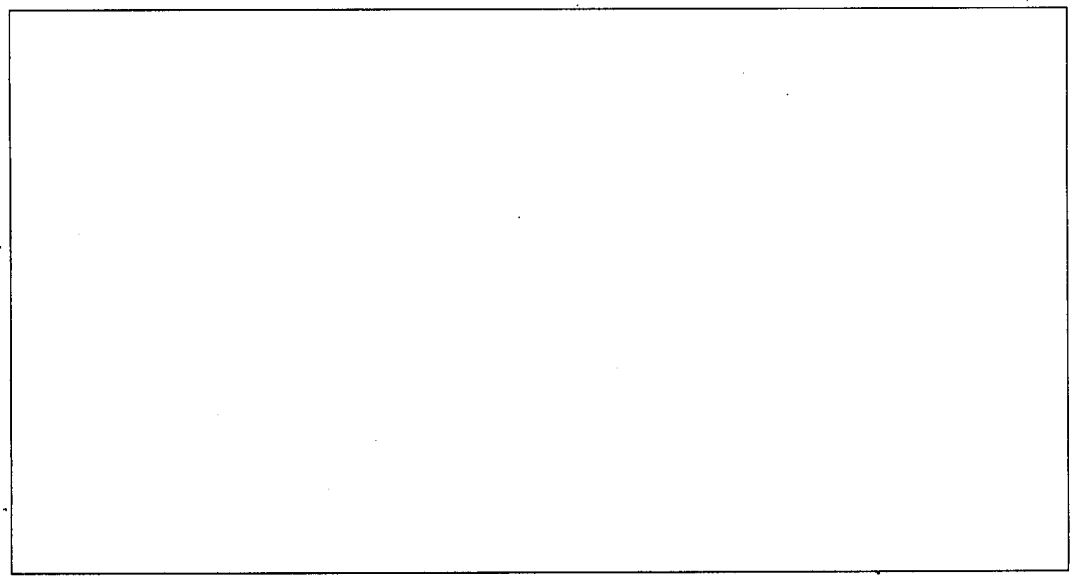
In May 1958, Fedorov again admitted that the subject of retrieving a satellite was being studied in the USSR. He added, "The question of the possibility of flights to the moon and of the launching of a satellite carrying a human being is closely connected with this problem." 153/

V. V. Dobronravov, Chair of Theoretical Mechanics, Moscow Higher Technical School, on a visit to Berlin in July 1958, is quoted as follows, "It is quite possible that the first problem will be that of producing so-called guided or recoverable satellites. In such a case....the satellite must be 'oriented' in relation to the earth; i.e., its axis must at all times maintain in cosmic space the same position in relation to the earth... This satellite must not rotate on its own axis. When it is at point A /apogee/, the power can be turned on for a brief period, and the satellite will come closer to the earth. The propulsion power can also be used as breaking power..." 41/

Another source quoted Professor Dobronravov, on 3 October 1958, as follows, "At the present stage, the most logical thing would be construction of satellites which can return to earth. Such satellites would make it possible to receive the results of observations not only in radio signals but also recorded on tapes and film. Important biological experiments could also be carried out. Scientists would be able to send animals into outer space, knowing that they could come back safely."

Professor Doboronravov continued with the statement that Soviet scientists and engineers were capable of making a satellite which would not burn up when entering the atmosphere or be damaged from the shock of landing on a planet. Doboronravov noted that such a retrievable satellite must have engines with a fuel reserve to help it approach the earth at the appointed time and to help break its speed when it enters the dense layers of the atmosphere to protect it from burning up. 37/

The Moscow publication, "Krasnaya Zvezda," 3 July 1958, contains an article by P. Isakov, Candidate of Biological Sciences and Stalin Prize Winner, on the problem of returning satellite crews. He discussed two possible methods: returning the crew in the satellite and returning the crew in a capsule only. He said, "If the satellite can be slowed down to the desired speed, the currently used methods of ejection can be employed." He stated that problems yet to be solved included: heat due to breaking, the effect of heat on crew and equipment, the G-effect of deceleration, and the effect of rapid rotation on the crew's bodies." 42/



An NBC television program "Youth Wants to Know", shown in the United States on Sunday, 5 October 1958, consisted of an interview with Professor A. A. Blagonravov which had been filmed in Moscow in July 1958. Asked whether a man-carrying satellite would be launched in the "near future," Blagonravov replied: "Sooner or later most probably we will be able to send up a man-carrying sputnik that will be circling the earth. I can't say when that will be at present." 155/

By 28 March 1958, Blagonravov seemed more assured. He is reported to have stated that the Soviet Union was close to sending a man in a rocket out into cosmic space and back. He said that the Soviet single-stage rocket that went about 295 miles into space on 21 February 1958 pointed the way. Asserting that the rocket of more than one-and-a-half tons landed precisely where scientists planned, Blagonravov said that, with the addition of a second stage, one could imagine that the time was quite near for solution of such a problem as cosmic flight of a man in a rocket. 156/

A Tass press review, 16 May 1958, celebrating the launching of Sputnik III, quotes Academician L. I. Sedov, a leading figure in Soviet rocket activities: "The new sputnik...could easily carry a man with a stock of food and supplementary equipment. However, such an experiment would have been premature. Before it is attempted, more knowledge must be gained about the conditions of man's existence in cosmic space, and the basic problem of the return to earth must be solved." 38/

Sedov, stated on 3 October 1958 that the standards of rocketry today are so high that automatic flying laboratories, manned earth satellites, and cosmic rocket ships should be regarded as distinctly realistic prospects. He said that there are two main difficulties in the realization of these projects. The first is protection of living organisms against certain radiation during long flights in cosmic space, and the second is the problem of safe return. He expressed the hope that these difficulties would not put off for long the conquest of cosmic space. 26/

A Soviet scientific spokesman (believed to be Sedov) stated, during the 9th Congress of the International Astronautical Federation at Amsterdam, 25-30 August 1958, that the USSR was giving top priority to something more important than a moon probe. Western scientists attending the Congress believed he referred to a project to send a man into space. 157/

In an interview with the U.S. publication Missiles and Rockets during the 9th IAF Congress, professor K. F. Ogorodnikov, of the University of Leningrad and one of the foremost astronomers in the USSR, is reported to have said, "We are pushing the man-in-space program hard. This is the big thing; we are making fine progress. The re-entry problem has been solved." 27/

The magazine Sovetskaya Aviatsiya (Soviet Aviation), 1 December 1958, contains an article by Professor V. V. Alexandrov, a Soviet scientist, disclosing that the USSR is working on a "rocket plane" that looks like a combination of jet fighter and space ship, in its campaign to be the first nation to achieve space flight by man.

Alexandrov said it would be built in the shape of a jet plane, but with folding wings. It would blast off into space and then continue its flight in a trajectory "like an artillery shell." The wings would be folded against the plane for the flight in space. Returning, the wings would be extended on reaching the earth's atmosphere, enabling the plane to slow down and glide back to its base. 158/

A broadcast by Radio Moscow, 15 April 1958, describes a talk given by N. A. Varvarov, Chairman of the Astronautics Section of DOSAAF, in which he discusses two possible methods of recovering a scientific package from a satellite: (1) return of the package only, or (2) use of a rocket plane type apparatus. He stated, "Manned flight will only be possible when return can be assured." 40/

Joseph Sinka, Secretary of the Hungarian Space Travel [illegible] Committee, told newspapers on 7 August 1958 that he had learned from a prominent Soviet scientist that the USSR plans three new satellites, one of which would bring a test animal back to a pre-selected area on the earth's surface. 159/

Professor Pyshnov, writing in Soviet Aviation on 20 July 1958, stated, "Soviet scientists are preparing to release a glider from the upper layers of the atmosphere having a speed of some kilometers per second." Pyshnov indicated that wings can insure smooth and prolonged gliding for a cosmic rocket after entering the atmosphere. The glider, during the approach to earth, will be subjected to so-called wave resistance which he said was a more convenient means of braking than friction because a considerable part of the energy is thus transferred to the air medium through a shock wave. The machine must be stable, controlled, and protected from such phenomena as corkscrew and vibration, according to the professor. 160/

A U. S. citizen, an Officer of the International Astronautical Federation, after contacts with Soviet Bloc officials, said in November 1958 that he doubted that Soviet missilemen are overly interested in shooting at the moon; instead, they are working on extremely high-thrust rocket engines in the multi-million pound range and on carefully instrumented animal flights aimed at putting a man into orbit and bringing him back to earth. 161/

Professor A. C. B. Lovell, Director of Britain's radio-astronomy work at Jodrell Bank, University of Manchester, Cheshire, after a visit to Moscow, said on 29 August 1958 that he believes the Soviets are planning to send up a manned satellite. His belief was based upon "definite information" from several

Soviet astronomers that the USSR had no immediate intention of firing a rocket to the moon. 162/

V. I. Krasovskiy, Chief Scientist of the Institute of Physics of the Atmosphere, Academy of Sciences, USSR, at the Ninth Annual Congress of the International Astronautical Federation, Amsterdam, 25-30 August 1958, commented on the existing thinking in the USSR on efforts to send a man into space aboard a vehicle. In his opinion it is unnecessary to use a manned space vehicle since contemporary science can provide a space vehicle with excellent instrumentation. He specifically mentioned the excellent results obtained through use of television, and emphasized that the unmanned space vehicle, properly instrumented, can accomplish the desired results. 32/

In a collection of items on the launching of Sputnik III, Tass reported that A. A. Shternfel'd, Chairman of the Scientific-Technical Committee of Cosmic Navigation of the Astronautics Section of DOSAAF, said, "The third Soviet satellite could have become an inhabited ship. It only remains to solve the problem of the return of a satellite to earth to realize man's dream of flight into space." 28/

Shternfel'd, in his book Iskusstvennyye Sputniki (Artificial Satellites), Moscow, 1958, wrote, "The descent from an artificial earth satellite to the earth will obviously take place by means of a special flying vehicle. During the descent it is necessary to retard the motion of the vehicle. This may be done either by the aid of a rocket engine, or by utilizing the resistance of the air.

"However, the method of retardation by reversing the thrust of the rocket engine should be used only in cases where utilization of the atmosphere is impossible.

"On the other hand, the retardation of a flying vehicle in the atmosphere, utilizing the resistance of the air, demands no consumption of fuel whatever, and therefore the weight of a vehicle for descending will be relatively small. Such a retardation will be of great importance not only for landing after descent of an artificial satellite, but also for the landing of superlong-range terrestrial rockets as well as space ships."

Shternfel'd follows with a very competent discussion of the physics of retardation by the atmosphere and of possible designs and trajectories for descending space vehicles. 76/

Lunar Flights.--Professor V. V.Dobronravov, in an interview with Leninskoye Znamya, the newspaper of The Communist Party in the Moscow area, in February 1958, cautiously suggested in a carefully worded statement that the Soviets may send a space ship to the moon and bring it back to earth within the Soviet Union "in the near future." Dobronravov avoided positive terms in explaining the moon trip. He said, "The space ship will be a sputnik whose orbit will take in not only the earth, but the moon." 85/

Later, in May 1958, Professor Dobronravov, in an article in the Literary Gazette, said, "The lack of an atmosphere and the sudden great changes of temperature on the moon cannot prevent man from visiting it. The further improvement of unmanned space ships such as sputniks will contribute to this end. The construction of guided space ships, able to return to earth, can be expected in the near future." 86/

On 3 October 1958, Dobronravov stated, "The question of flights to other plants, and first and foremost to the moon, which is nearest to the earth, also arises...Now there is no doubt that by changing the structure of the rocket /Sputnik III/ slightly and using different fuels, the final stage of the rocket can be given the necessary speed for a flight to the moon..." 87/

Dr. Ye. K. Fedorov, while attending the 8 July 1958 Geneva East-West talks on the detection of atomic tests as chairman of the communist scientific delegation, indicated that the United States was likely to shoot a rocket to the moon before the Soviet Union. Talking with a reporter before the meeting, Dr. Fedorov expressed an interest in U.S. plans for lunar exploration and asked when a shot at the moon was planned. He was told the first shot probably would take place in August or September 1958. Asked when the Soviet Union planned a rocket shot at the moon, Dr. Fedorov replied, "not quite so soon," He explained that the Soviet Union was not having difficulties in its lunar program but that it took time to build the large rocket necessary for such research. 88/

In March 1958, during a press interview, Fedorov told the correspondent of the Italian communist daily L'unita: "The flight to the moon, or a rocket which will fall on the moon's surface is a matter of a year or two. It is also possible to launch a rocket which will become for a certain period the satellite of the moon and the earth. What has not been technically solved is the flight of a rocket which will land on the moon and then return to earth." 89/

According to a Tass report on 29 December 1957, Dr. A. A. Blagonravov, a member of the ICIC, stated in a Soviet Aviation article dealing with Soviet science, "a new earth satellite will soon make its appearance and later, rockets will be sent to the moon." 90/

According to an item in the Hungarian press in November 1957, Professors A. A. Blagonravov and Ye. K. Fedorov, both of the Soviet Academy of Sciences, are reported to have stated that the USSR does not wish to indulge in scientific adventurism in regard to the launching of a moon rocket. "It is not probable that such a rocket will be launched during the IGY" (ending 31 December 1958), the professors said, "but there is no doubt that science will solve this problem, too, in a short time." 91/

Nikolai Varvarov, chairman of the astronautical section of the V. P. Chkalov Central Aeroclub, during a press interview in March 1958, stated: "The moon can even now be reached with rockets propelled by chemical fuels. Astronautics research is now faced with the task of dispatching automatically guided rockets to the moon and of creating an earth satellite suitable for the accommodation of human beings and the necessary equipment." 92/

Professor Kirill P. Stanyukovich, Academy of Sciences, USSR, in an interview with a Polish press representative in November 1957 is reported to have said, "The USSR plans to lanuch a rocket to the moon within 18 to 24 months. It hopes to send a rocket to the moon with humans aboard within five to ten years." 207/

[redacted]

Yu. S. Khlebtsevich in July 1954 and again in November 1955 suggested landing a mobile "tankette-laboratory" on the moon. The tankette, radio controlled from the earth, would explore the surface of the moon and transmit its findings back to the earth. The information obtained in this manner would make possible the next stage-landings on the moon by manned vehicles in the next five to ten years. 163/

A paper by V. A. Yegorov on "Some Questions on the Dynamics of Flight to the Moon," published in 1957, disclosed that the Soviets

in the period 1953-55 had systematically investigated problems of computing trajectories to the moon. In all, more than 600 trajectories were calculated, using electronic computers. Among the problems investigated were (1) the problem of hitting the moon; (2) the problem of circumflight of the moon; (3) the special problem of circumflight of the moon in which the rocket returns obliquely into the earth's atmosphere; (4) the problem of periodic circumflight; and (5) classification of trajectories in the plane of the moon's orbit and the problem of rocket acceleration. 164/

The problem of plotting the trajectory of a rocket which is launched from the earth, makes a close flight around the moon, and returns to earth without expending its fuel enroute is presented by P. A. Tsitovich in "Trajectories for the Flight of a Rocket Around the Moon." Five orbits having symmetrical axes are constructed by a method of graphic integration which was developed by the author. These orbits are divided into two types. The first type forms two loops, one of which envelopes the earth, the other the moon. The second type forms one loop embracing both the earth and the moon. 165/

The New York Times reported that U.S. delegates to the 9th IAF Congress held in Amsterdam on 25-30 August 1958 said they had evidence of much Soviet work on a moon probe. 93/

Interplanetary Flights.--The official Soviet announcement in April 1955 of the establishment of the Interagency Commission for Interplanetary Communications (ICIC) stated that one of its first tasks would be to organize work on the creation of an automatic laboratory for scientific research in cosmic space and that this would be the first step in solving the problems of interplanetary travel, thus allowing Soviet scientists to probe more deeply into the secrets of the universe. 10/

A. G. Karpenko, Scientific Secretary of the ICIC, in announcing the formation of the Commission in April 1955, stated, "The problem of realizing interplanetary communications is undoubtedly one of the most important tasks among those which mankind will have to solve on the way to conquering nature. The successful solution of this task will become possible only as a result of the active participation of many scientific and technological collectives. It is precisely for the unification and guidance of those collective efforts of research workers that the permanent Interagency Commission for Interplanetary Communications has been established at the Academy of Sciences, USSR. The Commission is headed by Academician L. I. Sedov and is composed of outstanding scientists -- physicists, mechanical engineers, astrophysicists, and others -- among them Academicians P. L. Kapitsa and V. A. Ambartsumyan...." 10/

Academician Leonid Sedov, Chairman of the ICIC, wrote in Pravda on 16 May 1958, that a trip to Mars to solve the riddles of that planet seems to be quite feasible within the next 20 years. He stated his belief that the time is not far off when man will proceed from artificial earth satellites to rockets flying between planets. 94/

During a gathering of Soviet scientists celebrating the first anniversary of the launching of Sputnik I, A. N. Nesmeyanov, President of the Academy of Sciences, USSR, made a speech in which he predicted that, "The time is not very far distant when we will pass from earth satellites to rockets which make interplanetary flights." 166/

Engineer V. Kaznevsky, writing in the periodical Soviet Aviation on 1 December 1957, stated, "It will become possible for the Soviet Union to launch manned interplanetary space ships in the next few years." 167/

A. V. Topchiev, Chief Scientific Secretary of the Academy of Sciences, USSR, in March 1958 stated, "...Our scientists can now handle the most diverse problems in the investigation of the upper layers of the atmosphere and in the region of cosmic space closest to the earth. It is clear, also, that the solution of the problem of long flights in cosmic space and the attainment of other planets lies only in creating satellites of great weight." 168/

An article in Izvestiya, 9 July 1958, by two Soviet scientists, A. A. Il'yushin and V. Lenskiy, the former Director of the Institute of Mechanics, Academy of Sciences USSR, claimed that with existing fuels and rocket designs the Soviet Union had the capability of launching a missile with a speed of over 25,000 kilometers per hour, which would take it beyond the earth's gravity. They conclude, "The time of launching a space ship now is only a matter of expediency." 169/

In 1954, A. A. Shternfel'd, Chairman of the Scientific-Technological Committee on Cosmic Navigation of the Astronautics Section, Chkalov Central Aeroclub of the USSR, said, "...I can state that soon the strenuous work of engineers, physicians, and scientists of various specialties will be crowned by building the first cosmic ship. I am convinced that this will happen before the eyes of the present generation." 95/

Academician V. G. Fesenkov, a leading Soviet astrophysicist, writing in Izvestiya on 3 October 1958, stated, "A space ship, to be able to fly off beyond the boundaries of the solar system,

needs no more than double the take-off thrust of modern Soviet rockets. In the foreseeable future it will become possible for rockets to circle the moon, Mars, and other close planets and to land on them." 70/

Radio Moscow reported a speech made on 14 November 1958 by Nikita Khrushchev to graduates of the Soviet Military Academy in which he told them that preparations are now going on inside Russia for "flight to celestial bodies." He gave no details. 171/

Space Stations.--ORBITAL SHIPS-- A. A. Shternfel'd has said, "Theoretical calculations show that it will also be possible to build powered artificial satellites of the earth and powered artificial planets (i.e., artificial satellites of the sun) which, moving on an elongated elliptical orbit, will regularly cruise in the universe as transportation means by suitable correction of the orbit by the aid of a rocket engine (to eliminate the perturbing influences of other heavenly bodies). They will move on their orbits like the planets and their satellites and will thus periodically pass close to the earth.

"We will designate such artificial heavenly bodies as orbital ships, since they could be used for the purposes of space transportation. An expedition proceeding, for example, from the earth to the moon might utilize an orbital ship as a transfer facility. After flying on a small rocket to such a ship, the astronauts would transfer to it and continue their journey. Then, after approaching the moon, the travelers would again transfer to a small rocket which would land them on the surface of the moon.

"Living quarters, workshops, and observatories will be set up on orbital ships. Here the astronauts will find everything necessary for further flight." 76, p. 343-344/

Shternfel'd quotes Tsiolkovskiy as proposing the utilization of an artificial earth satellite as a peculiar kind of transfer station, thereby dividing a space journey into stages. The space station would be used as a supply base, an assembly plant to put together the parts of a space ship delivered in separate parts, and as a platform to gather data for space flights. Take-off from the space station would require a considerably smaller fuel supply than for take-off from the earth, because the space station would impart its own velocity to the departing space ship. Shternfel'd notes that the use of space stations will not be needed after "powerful atomic ships of the future" are developed. 76, p. 393-407/

Speaking of a long-term program, Alexander Nesmeyanov, President of the Academy of Sciences, USSR, mentioned on 3 October 1958, the setting-up of a cosmic station which would accommodate a considerable number of people for a lengthy period. He stated his belief that communications between the inhabitants of the cosmic station and the earth could be maintained by means of special rockets. Such a station, permanently functioning in cosmic space, would considerably facilitate the investigation of solar environs and it might also serve as an intermediary station in space travel, he continued. 102/

EARTH SATELLITES--Vladimir V. Belousov, Chairman of the Soviet IGY Committee, on 15 May 1958 said in an interview, "The time has come to ask ourselves whether we are not rapidly approaching the realization of the dream of K. E. Tsiolkovsky to create very long-living or even permanent satellites of the earth as stations for cosmic interplanetary flights." 172/

In his book, Artificial Satellites, A. A. Shternfel'd says, "A satellite can be created which, while moving relative to the fixed stars, is motionless relative to an observer on the earth." According to Shternfel'd, if a satellite is placed into orbit at an altitude of 35,810 kilometers above the equator, moving from west to east in the plane of the equator, then its angular velocity would be equal to the angular velocity of rotation of the earth about its axis and it would remain motionless with respect to a terrestrial observer. He points out that a stationary artificial satellite would have a number of advantages over other satellites for communications and reconnaissance purposes. He states that at least three stationary satellites would be required to observe the entire earth, except for the polar zones. 76, p. 74-80; 393/

Professor Nikolai Barabashev, Chairman of the Planets Commission of the Astronomical Council of the Academy of Sciences, USSR, on 22 May 1958 was quoted as saying that it is theoretically possible to create immobile satellites of the earth which could serve as transfer stations on cosmic flights. 97/

NATURAL INTERPLANETARY STATIONS--A. A. Shternfel'd has stated that the moon is not suitable as a space station because of its distance from the earth and because its mass, and consequently its attraction, is relatively high and would require a large amount of fuel first for the retardation of a space vehicle descending to its surface and later for the take-off. Discovery of one or more natural satellites of the earth revolving closer to the earth than the moon, even if they were very small, would be an important step in space travel, according to Shternfel'd.

He mentioned that natural satellites of other bodies of the solar system are of great interest for astronautics. For example, space ships may be able to descend on the Martian satellites, Phobos and Deimos, from which prolonged investigations may be conducted, of the surface of Mars. Since the gravity of Phobos and Deimos is negligible, early landings on them would be easier than on Mars itself. 76, pp. 407-410/

Miscellaneous.--(The following statements pertain to at least two of the topics discussed in the preceding sections.)

During the course of a speech given to a group of scientists and representatives of the public in Moscow on 3 October 1958 to commemorate the launching of the first Soviet artificial earth satellite, Dr. A. N. Nesmeyanov stated, "The immediate prospects in astronautics are: the design of permanent and oriented artificial satellites; solution of the problem of bringing sputniks to the earth, and the launching of a rocket to the moon and nearest planets." Nesmeyanov said that the Soviet program is directed toward all of these. 173/

Another source reported that in his speech Nesmeyanov listed Soviet space projects for the coming year as follows:

The creation of long-lasting earth satellites to circle the globe at great altitudes, the development of satellites whose flight and speed could be controlled and directed, the return to earth of a satellite or part of it, the construction of rockets for space flight, safe flight by man in such rockets, and the creation of manned space stations in touch with the earth by rocket ship. 114/

Pravda, 3 October 1958, carried an article by Academician Leonid I. Sedov, Chairman of the ICIC, in which he predicted that unmanned space flights to the moon, Mars and Venus would be made "in the nearest future." He also said, "The time is not far off when we will be able to launch manned rocket ships into interplanetary space and to other planets." 96/

Sedov in an interview reported in the Soviet Novoye Vremya (New Times) in 1958 said that one of the problems awaiting solution in this field is the return of the satellite to the earth. He further stated that, at present, projects for sending rockets to the moon and to circle it and return are being examined; that it is, however, difficult to say in what order these tasks will be solved. 174/

At the 8th Congress of the International Astronautics Federation, held in Barcelona, Spain from 6-12 October 1957, Sedov, a Soviet delegate, said, "Space flight with manned vehicles to other planets is still a number of years off. A rocket to the moon is much closer. Manned satellites will soon be achieved too." 175/

According to a report in Soviet Aviation, Professor V. V. Dobronravov has said, "The Soviet satellite program is aimed at two immediate developments: one, launching of a guided and returnable satellite including manned sputniks; and two, launching of sputniks to the zone of the moon." Dobronravov is also reported as saying that the necessity and advisability of sending a human into space still is being discussed, with most Soviet scientists favoring it. 97/

In a Moscow radio broadcast on 22 November 1957, Professor V. V. Dobronravov, Head of the Department of Theoretical Mechanics at the Bauman Institute of Technology, is quoted as having said: "The Soviet Union can build and launch at any time as many artificial earth satellites as it likes. If necessary, the Soviet Union can launch a sputnik weighing a ton.... Soviet scientists are at work calculating trajectories and routes for flights to the moon, Mars, and Venus. Some scientists are even thinking of space ships which will take man to other stars of the galaxy. But this is something for a more distant future." 30/

Professor K. Sergeyev, in an article on space flight in Pravda of 10 December 1957, stated that it was technically possible to send a rocket to the moon now but that other projects had a higher priority with Soviet specialists. He suggested that Soviet scientists were thinking more seriously about studying the upper reaches of the earth's atmosphere, solving the problem of re-entry, and trying to develop a permanent interplanetary station. Human flight into space is another problem being studied. For this purpose, he said, it will be necessary to recover animals from test flights, and Soviet specialists are devoting much attention to the problem of re-entry from space into the earth's heavy atmosphere. 176/

Ye. K. Fedorov stated in the 29 December 1957 issue of Pravda, "Calculations of trajectories for flights to the moon and planets are now being made." 39/

Soviet Statements of Scientific and Technical Objectives

Astronomy.--K. E. Tsiolkovskiy, father of Soviet astronautics, in pointing out in 1929 that the sun radiated energy more than two billion times greater than the energy received from it by the earth, stated, "That is the kind of energy that man can possess if he is able to establish himself in celestial space."

Tsiolkovskiy's pupil, F. A. Tsander, wrote, "For astronomers, the future interplanetary ship must represent an astronomical flying laboratory."

Yu. V. Kondratyuk, another pupil, wote, "What can we specifically expect...? Undoubtedly the enrichment of our scientific knowledge with its corresponding reflection in technology." 62/

In 1954, K. P. Stanyukovich, a member of the Scientific-Technological Committee on Astronomical and Physical Problems of the Astronautics Section, Chkalov Central Aeroclub of the USSR, stated, "I do not agree completely with...all who consider the realization of cosmic flights a very simple affair." After quoting figures on the probability of a space ship colliding with meteors, and pointing out the resulting dangers, he concluded, "I want to express the hope that flight to the moon of a rocket with a crew can take place. But it is somewhat premature to speak about flights to another planet at this time. One must first learn how to cope with the dangers of meteors." 115/

Sergei M. Poloskov, Soviet Delegate to the Rocket and Satellite Conference, Washington, in October 1957, reported that the USSR was working on plans to take coronograph observations of the sun from an artificial earth satellite. He spoke also of plans to photograph the corona spectrum and to record various wavelengths of ultra-violet radiation from the sun. He did not explain how the images would be transmitted back to the earth. 83/

Academician V. Fesenkov, of the Institute of Astrophysics of the Academy of Sciences, Kazakh SSR, regarded the creation of Sputnik I as the notable start of a new era. He is quoted by Izvestiya on 4 October 1958 as follows: "For astronomy, the event opened the possibility of gradually transferring investigations into cosmic space and with it the elimination of the serious disturbances of the terrestrial atmosphere which frequently render the most powerful and modern apparatus completely useless. It is certain that in the very near future, flights around the moon, Mars, and other planets of the solar system will be possible...In order to hasten the day of astronomy's greatest

development, Soviet observatories must be able to use the flights of artificial earth satellites in the interests of science." 80/

A Shternfel'd, winner of the International Prize for the Promotion of Astronautics, stated in 1958 that when artificial satellites have been suitably developed they should prove useful for investigations of such distant heavenly bodies as the moon, the sun, and other planets. Among the projects suggested by Shternfel'd were moon satellites to photograph and observe at close range the entire surface of the moon and artificial satellites of the planets, comets, and the sun to study these bodies as an aid to interplanetary travel and to settle certain controversial scientific questions, such as the density of Mercury. Other projects visualized by Shternfel'd included scientific expeditions landing on planets, such as Venus, and "powered artificial planets /i.e., artificial satellites of the sun/ ... from which exploration of the universe will take place."

Concerning astronomical observations from artificial earth satellites, Shternfel'd pointed out the advantages of observations and photographs from above the earth's atmosphere. He suggested that earth satellites be instrumented to take radioastronomical observations and to study the aurora, zodiacal light, the solar spectrum, cosmic rays, and other extra-terrestrial phenomena. He quoted Criquis, of France, as stating that in the future, artificial satellites would be equipped with electronic devices and with television transmitters which will permit observers on the earth to view the sky through telescopes set up on the satellites. 76, pp. 328-356; 371-381/

Professor D. Y. Martynov, Director of the Shternberg State Astronomical Institute, commenting on Sputnik III on 16 May 1958, stated, "We astronomers expect mostly new information from the cosmos with regard to the investigation of the corpuscular radiation of the sun, cosmic rays, and micrometeors." 81/

In a Tass interview in June 1958, Professor V. Fedynskiy, a Soviet astrophysicist, discussed meteorites. He said, "So far there has been no indication that the third Soviet satellite has encountered any micrometeorites which could constitute even an insignificant danger to the space ship of the future." 82/

Professor Boris Kukarkin, Vice Chairman of the Astronomical Council of the Academy of Sciences, USSR, was reported by Moscow Radio to have said on 3 October 1958, "We shall shortly be able to conduct systematic astronomical observations from artificial earth satellites." Kukarkin stated that long distance cosmic flights would extend our knowledge of the atom and the elementary

particles; and that it is quite possible that processes we know nothing about, processes different from the reaction of fusion and fission, are taking place in the natural "laboratories" that are the interiors of the stars and the sun. He mentioned as feasible and highly promising, though still a distant prospect, the establishment of the nature of the white dwarf stars with their fantastic density. 66/

Biology and Medicine.--In 1954, Stalin Prize Laureate, A. D. Seryakin, Chairman of the Scientific-Technological Committee on Space Flight, after reviewing the problems of the effects of space flight on man, said, "Such are the basic factors which man will encounter during flight into cosmic space. Their detailed study will still require very considerable efforts of biologists and physicians. One thing is certain: Soviet medicine, in cooperation with Soviet technology, will ensure safe conditions for man's life in a cosmic ship; and the time will come when flight from planet to planet will be just as safe from the medical point of view as flight from Moscow to Leningrad aboard a passenger airplane." 115/

In August 1956, I. S. Balakhovskiy and V. B. Malkin, in an article entitled, "Biological Problems of Interplanetary Flights," after reviewing the various problems involved, conclude, "So we see, there are still many unsolved problems connected with the effect on the human organism of the different factors of interplanetary travel. The successes attained in this field in recent years, however, make us think that the human organism, reliably protected against the harmful action of factors unfavorable for it, will sustain interplanetary flight without injury to itself." 67/

Several Soviet scientists have discussed the problems of weightlessness on the human organism. Most of them refer to the solution of this problem proposed years ago by Tsiolkoskiy. For instance, V. V. Rozenblat in his 1956 article "Before Flight Into the Cosmos" writes, "How then will one get rid of weightlessness? The answer to this question has already been found by K. E. Tsiolokovskiy, who spoke about the necessity of creating artificial gravity on cosmic ships. For this it is necessary to rotate the rocket (or the cabin with the passenger) around its longitudinal axis. Then as a result of the action of centrifugul force on the walls of the ship an artificial gravity will arise; it will be equal to the earth's if the velocity of rotation is in the necessary relation to the radius of the rocket". 61/

Moscow Radio, on 14 September 1958, broadcast a discussion of the 450-kilometer research rocket flight, launched on 27 August 1958, in which two dogs were reportedly recovered successfully. The broadcast concluded by saying that this experiment "was to work out a system of returning animals and apparatus to earth, as part of the space flight program." 68/

In an article in "Izvestiya," 4 October 1958, by Ye. Yugove and A. Serov, Candidates of Medical Services, it is stated that "the true conquest of space can come only with man's entrance into the cosmos. First must come a knowledge of the effect of a number of unusual factors -- G-stress, dynamic weightlessness, cosmic radiation and solar radiation -- will have one the human organism. For the solution of these problems, scientists are depending on a new science - space medicine....science at present can see no principal difficulties to be overcome in order to insure man's sojourn into cosmic space. However, for an engineering solution to this problem, there is still much work to be done. 69/

Moscow Radio on 22 February 1958 broadcast a program on the effects of space flights on living beings. Among the statements made with the following: "Just what effect flying in space has on a living organism is not clear yet.... Even the launching of the second Soviet satellite with a dog on board has not cleared up the question entirely. However .... it would seem that the idea of living beings -- including human beings -- making flights into space is far from being a dream. It is a real possibility. Even before the second Sputnik was put into its orbit, Soviet scientists had sent rockets with animals in them 130 miles up into space. They had a variety of complicated instruments in them which enabled scientists to determine the temperature and pressure at great heights, and the changes of biological processes of animals at different heights." Among the mentioned physiological observations on dogs were rate of breathing, heartbeat, blood pressure, temperatures, and any sounds uttered. 72/

In his book Artificial Satellites, Moscow, 1958, A. A. Shternfel'd stated, "To realize a manned artificial satellite, it is not sufficient merely to give a rocket an orbital velocity. It is also necessary that the human cargo be able to return unharmed to earth. However, to investigate the possibility of a safe descent, it will be necessary to run tests at a high rate of acceleration and then to decelerate by any available methods, for instance, by the combined action of resistance of the air and of the rocket engines....

"No doubt," Shternfel'd continued, attempts to launch artificial satellites with human passengers will not be undertaken until preliminary experiments have been successfully completed with manned superlong-range and intercontinental rockets with greater radii of action and higher rates of acceleration. On such rockets, the pilots will be trained not only to reach the orbital velocities (i.e., velocities at which the rocket can move in a closed orbit) but also to reduce such velocities by means of the resistance of the air and of a rocket engine. This is why flights on such rockets are a preparation for the flight of man on an artificial satellite and for living on such a satellite. The persons participating in flights on an intercontinental rocket will receive the necessary conditioning for flight on an orbital rocket, since the physiological sensations of a passenger on an intercontinental ballistic rocket will not differ from those in a space rocket: namely those involving the G-force during acceleration and deceleration, and the complete absence of gravity during the entire flight with engine off." 76, pp. 185-186/

Shternfel'd also wrote, "The artificial satellite is of interest from the point of view of studying the possible accomplishment of manned interplanetary flights. The influence of weightlessness on the physiological and psychic processes could be studied on such a satellite, as well as the action of cosmic, solar, and other radiations on living organisms not protected by the earth's atmosphere.... Such experiments were actually staged on the Soviet Sputnik II.

"On the artificial satellite it will be possible to verify the hypothesis expressed by K. E. Tsiolkovskiy that plants and organisms, from the simplest to the most complex, will grow and develop far more rapidly under conditions of weightlessness than in the presence of gravity." 76, pp. 384-385/

Shternfel'd, commenting on the implications of Sputnik II, stated, "The fact that a living organism was able to function for a period of several days under conditions of weightlessness allows us to hope that man will also be able to survive a space journey...,this achievement confronts us squarely with the realization of the next stage, namely the building of artificial satellites of such dimensions that they can carry not only instruments but human beings as well." 76, p. 2/

Tass reports a press conference in Moscow, 16 May 1958, on the launching of Sputnik III, in which Ye. K. Fedorov, member of the Soviet IGY Committee, was the spokesman. Among other statements, he said, "The tasks of this satellite do not include

the studies of biological phenomena. In the future, such research using live animals will continue." 70/

Soviet Aviation, 25 July 1958, contains an article by V. Borisov, Candidate of Medical Sciences, on hermetic cabins of space vehicles. One significant statement recommends that the "air" in the cabin be half oxygen and half helium. "Helium is better than nitrogen because it has better thermal conductivity, also, if cosmic rays penetrate the cabin, nitrogen would be transformed into radioactive carbon which is dangerous to human life." 71/

At the 9th IAF Congress in Amsterdam, during a discussion of the press reports of the Soviet launching on 27 August 1958 of a research rocket containing two dogs that were reportedly recovered safely, Soviet scientist K. F. Ogorodnikov termed this experiment "just routine work." "It just gets them higher than we have done before," he said, "and is another step in the Soviet space program." 177/

The publication Soviet Aviation, 9 September 1958, contains an article by V. Malkin, Candidate of Medical Sciences, on Soviet medico-biological research in the upper atmosphere, primarily discussing the tests of dogs launched in research rockets. He states, "This program is most important for insuring the safety of manned flight into outer space and beyond." 178/

Lucien Barnier, scientific editor for L'Humanite, Paris communist daily, after his return from the USSR in February 1958, stated that the USSR would launch a third sputnik in a few weeks, and that the Soviets would try to create living matter using inorganic matter and cosmic rays. "The third satellite," he stated, "will contain a mixture of ammonia, methane, steam, and carbonic acid, reproducing the composition of the earth's atmosphere toward the beginning of the first era. The action of cosmic rays on this mixture will possibly verify U.S. and Russian hypotheses about the origin of life." 49/

A Tass report of 4 October 1958, discussing the Bogomolets Physiology Institute, Kiev, stated, "In the laboratories of the institute, in specially equipped rooms simulating the conditions on space ships, there are grown algae containing a large quality of proteins and also molluscs which can be the source of a tasty and highly nutritional fat. It has been estimated that about 200 liters of algae can be grown in a rocket - enough to cover the nutritional requirements of one man for six months. These plants will not only offer food for the space travelers but also re-oxygenate the atmosphere within the space vehicle. Chlorella,

...tance, in one hour excretes a volume of oxygen 50 times ...volume." 63/

...According to G. A. Tikhov, a leading Soviet astrobotanist, ...ll soon be convinced as to the existence of plant life on ... 179/

...Rocket Technology.--In 1954, Professor K. P. ...ukovich, Doctor of Technical Sciences, stated, "The greatest ...tevement of science -- the discovery of methods of producing ...ic energy -- undoubtedly will exert great influence on ...ving the problem of interplanetary flights. The conversion ...jet engines to atomic energy will be of tremendous importance ...building cosmic rockets. 180/

...Stanyukovich treated the subject of nuclear-powered rockets in greater detail in an article entitled "Problems of Interplanetary Flights" published in 1956. He predicted flights to the moon in five to ten years and to Mars within fifteen years, the latter being accomplished with nuclear fuels. 181/ Diagrams of nuclear-powered turbojet, ramjet, and rocket engines illustrate G. Nesterenko's article, "The Atomic Airplane of the Future," published in Nauka i Zhizn'. Included is a sketch of a six-stage cosmic rocket in which the first stage is powered by a liquid-fuel rocket engine, the second stage by a ramjet engine, and the three final stages by liquid-fuel rocket engines. 6, p. 21/

Professor Ivan Losev, a leading Soviet chemist, was reported on 20 May 1958 by Radio Moscow as saying that at least half of the measuring instruments on board Sputnik III are made of synthetic materials. Losev stated that the bodies of instruments, the panels for electronic devices, and miscellaneous insulators, all can now be made from plastics, synthetic rubber, and organic silicon compounds. Losev revealed that chemistry furnished foam plastic and glass textolite as insulating materials for Soviet satellites. A plastic lighter than wood but as strong as tank armor plating protects the sputniks from collision with meteors, according to Losev. 182/

Professor V. V. Dobronravov stated in October 1958, "The rockets which launched the Soviet satellites into cosmic space were remarkable in the properties of their metal alloys. These alloys were produced by Soviet metallurgists; Soviet chemists produced fuel with unprecedented properties for these rockets." 183/

A few years ago the Soviets published tables of thermodynamic properties, ranging from 298° K to 5000°K, for such chemical species as F_2, HF, CH, CH_2, CH_3, and C_2. It has been pointed out

that the first two indicate an interest in fluorine as an oxidant in chemical rocket propellant systems, and the latter four, an interest in hydrocarbons as possible propellants in nuclear rockets. 6, p. 21/

According to Engr. Maj. V. Parfenov, "Interplanetary flights will be possible soon if employment of free-radical fuels becomes feasible." 184/ This probably is concerned with the use of free radicals produced on the ground and carried in the space vehicle. Another Soviet source refers to the use for propulsion of atomic hydrogen, oxygen, and nitrogen found in the upper atmosphere. 50/

Soviet Premier Khrushchev made the following statement in a speech at Minsk on 22 January 1958: "The whole world was amazed by the fact that the second artificial satellite weighed over six times more than the first one; it weighed more than half a ton. But even this is not the limit. We can double, even more than double, the weight of the satellite, because the Soviet intercontinental rocket has enormous power which makes it possible for us to launch an even heavier satellite to a still greater height; and we shall probably do so." 6, p. 9/

A U.S. official of the International Astronautical Federation, after a visit to the USSR in 1958, stated that the Soviets are working on extremely high-thrust rocket engines in the multi-million-pound range. On the basis of his observations, he concluded that Soviet rocketry is of high quality. 161/

In June 1955, Academician V. G. Fesenkov, prominent Soviet astrophysicist, wrote, "Work on the utilization of atomic energy for cosmic travels is carved out with extraordinary intensity, and the success of this work will make feasible all the tasks of astronautics, at least with respect to the power of jet engines." 51/

Another Soviet authority has stated, "the problem of achieving greater distance in the flights of rockets in the future necessitates the search for new sources of power based on the utilization of chemical, nuclear, and thermonuclear fuels." 52/

I. I. Drakin, of the Moscow Aviation Institute, said in January 1958 that the fantastic speeds necessary for space ships in interplanetary travel are obtainable by using photon rockets. He stated that thermonuclear reactions arising in a nuclear reactor create powerful beams of photons; that the reactions must take place outside the rocket since otherwise the material of the rocket could not withstand the resulting temperatures; and that

reactions must take place in the focus of a reflector, thereby exerting a pressure which also would serve as the driving force necessary for the acceleration of the rocket's flight. He indicated that the problem of the photon rocket is in its initial stage and that substantial progress in developing the rockets depends on attainment of a low-weight, continuous-operation reactor. 53/

Professor G. Babat, Doctor of Technical Sciences, stated in 1956 that research on photon propulsion should consider only the possible development of an engine in which atomic nuclei are completely transformed into small quanta of radio waves. 54/

Lecturer Prokin, Air Institute, Moscow, is said to have asserted that preliminary calculations are being made for a so-called photon rocket. 55/

In a 1957 issue of Znaniye-Sila (Knowledge is Strength), Professor Georgi Babat writes that a photon rocket may be developed and launched experimentally within the next few years. 57/

Engineer Yu. L. Kamganovich, writing in Soviet Aviation, 28 June 1957, stated that there is considerable interest in the possibility of utilizing the solar energy stored in the upper atmosphere in the atomic form of the usual molecular gases for the propulsion of space craft in the initial stages of the flight. 58/

Prof. Kirill Stanyukovich, Doctor of Technical Sciences and a member of the Interagency Commission on Interplanetary Communications, stated to Tass correspondents in 1955 that so-called graviplanes, machines that overcome the earth's pull of gravity, are alternatives to the usual rockets for reaching outer space. According to him, the problem of gravitation would be studied thoroughly starting in 1958. 185/

Anatoly Karpenko, Scientific Secretary of the ICIC, Academy of Sciences, USSR, has suggested in Zvezda, according to a Tass broadcast of his article in October 1958, that space flight be effected by means of rockets moving in an unfolding spiral through the principle of electric acceleration of reactive jet particles. 56/

Professor Georgy Pokrovskiy, well-known specialist in rocket technology has made the statement, according to a Tass report, that the solution of the problem of cosmic flight lies in the ion rocket and not in photon rockets, nor in thermal rockets, whether powered by conventional chemical fuels or atomic energy. 60/

In 1958, Professor Pokrovskiy stated in an article in Tekhnika Molodezhi that plans have already been completed for special equipment which utilizes electric and magnetic fields in space for propelling space ships, namely through the process of building up negative or positive charges on the space ships, by the ejection of the requisite charged particles so that the ship is attracted or repelled by the field in space. The equipment has not yet been constructed, he said. 186/

V. L. Ginzburg, an outstanding Soviet theoretical scientist in 1957 advocated the use of artificial earth satellites to obtain further experimental proof of the general theory of relativity, one of the most fundamental physical concepts. 73/

Yu. V. Kondratyuk, in his book, The Conquest of Interplanetary Space, 1947, considered the question of using improved fuels such as lithium oxide and boron coupled with hydrogen and the metallic elements. 187/

A Hungarian publication, Hetfoi Hirek (Monday's News) was quoted on 15 September 1958 as saying, "Sputnik III was propelled by a special fuel called boron, which is a compound consisting of boron and hydrogen. Other compounds are also being made in the Soviet Union through the aid of which the capacity of rockets can be increased by 40-50 percent.

"Soviet scientists are engaged intensively in the construction of rockets with a nuclear propulsion system ..."

The publication also stated, "The shell of the Soviet satellite moons was made of a special aluminum alloy." It added that "special protective coatings" were applied to the parts of Sputnik III exposed to greatest heat due to friction. "Part of Sputnik III was coated with magnesium but silesium and a special coating of synthetic materials are also suitable. According to present concepts, titanium and molybdenum will be used to protect the shells of rockets returning to earth...." 65/

K. Malyutin, engineer, stated in an article published in Sovetskiy Flot (Soviet Fleet), 8 January 1959, that the head of carrier rockets for earth satellites is constructed of refractive

[illegible]or of special compositions consisting of phenolic resins [illegible] pulverized asbestos, to prevent heating up of the rocket's [illegible]. In order to cool the rockets, the fuel of the engines is [illegible]red through low openings in the exterior covering of the [illegible]. 211/

Electronics and Communications.--In 1954, Yu. S. Khlebtsevitch, Chairman of the Scientific-Technological Committee on Radio [illegible]control of the Astronautics Section, Chkalov Central Aeroclub of the USSR, stated, "Radio-controlled rockets will open the way [illegible]man into the cosmos.... After obtaining all the necessary [illegible] by means of many automatically radio-controlled instruments, [illegible] himself will be able to perform flight to the moon and the [illegible]nets of the solar system and will be assured of the possibility of returning to his native planet--earth... The first rocket on the Moscow-to-moon route also will be automatically controlled by radio. A special radar station constantly computing the [illegible] coordinates of the rocket in space will follow its flight." He goes on to say that radio signals will keep the rocket on course, govern its landing, and direct exploration of the moon's surface by means of a tankette carrying a television camera and scientific measuring instruments, the image and data from which will be transmitted back to earth. 33/

Professor V. Dobronravov, in an article in Soviet Aviation, 3 October 1958, wrote, "Soviet scientists and engineers have already tackled the solution of stabilizing artificial earth satellites. A rocket launched 27 August (1958) to the height of 450 kilometers was stabilized to prevent rotation around either the vertical or horizontal axis.

"The vertical axis of a stabilized recoverable satellite in flight must lie in an invariable angle to the axis of the earth. Such satellites must be fitted with a guidance mechanism to enable them to vary their course according to a prescribed program.

"Apart form the stablizing system, the satellite must have engines with stores of fuel. A special control program will switch them on at definite moments in accordance with the [illegible] satellite's position in orbit. The satellite will thus be able to coast along through the atmosphere and land at a prearranged place on the earth's surface." 43/

Speaking of a satellite which would orbit the earth, circle the moon, and return to the earth's zone, Professor Dobronravov stated," ...if that satellite were to be equipped with television apparatus, it would transmit pictures of the moon's surface back to the earth." 188/

A Soviet broadcast of 6 May 1958 stated, "The creation of intercontinental ballistic missiles and the launching of the [illegible] Soviet artificial earth satellites were made possible to a significant degree by the admirable achievements of our radio-electronics. Applying radio-electronic methods evolved by Soviet scientists, it became possible to launch the satellites with exception accuracy on previously calculated orbits." 47/

An article by A. Kaznantsev in June 1957 describes the scientific value of the observations of radio signals from an artificial earth satellite. 189/

In the Soviet magazine Radio, No. 8, 1955, I. Kucherov says of the guidance problem: "The control of the rocket which would be used for the setting-up of the artificial satellite.... is very complex. It is necessary here to guarantee not an orbital flight of the rocket but the flight to a certain point. The control of such a rocket from the earth will require not only a simple rocket guidance station but also a complicated computing system, handling navigational data for transmission to the rocket." 44/

L. Yanitskiy, in Nauka i Zhizn', November 1955 says, "It will will be very important to establish what factors affect the trajectory of flight of the cosmic laboratories. This may be achieved by means of special radio location stations in an automatic arrangement which, at the moment the satellite appears within the zone of their action, will continuously measure its coordinates with respect to the earth." 45/

Dr. I. G. Petrovskiy, a member of the ICIC, has written an article entitled "Architect in Space," in which he explains that three radio stations were used to form an "ethereal gun barrel" which guided the Sputniks into orbit. This "gun barrel" is stationary and has very great accuracy. It is used to obtain accuracy for guided missiles and as a guidance funnel for incoming space vehicles, according to the author. 190/

Professor G. V. Petrovich has said, "Successful accomplishment of the tasks of cosmonautics will also require development of means of long-distance radio communications of rocket ships with the earth, with stations outside the earth, and with each other. This radio communication must ensure the guidance of rockets and telemetric transmission of information from the rockets including television information, and must also control the trajectories of the rocket flights. 46/

Soviet Professor S. Katayev expresses his conviction that in the coming years it will be possible to receive Moscow television broadcasts not only everywhere in the Soviet Union but also far beyond its boundaries and, in particular, in China and in the Antarctic. Katayev made this statement on 1 December 1957 in Izvestiya. This Soviet scientist considers that due to the launching of artificial earth satellites, such an increase in the extent of television broadcasts has realistic possibilities. 98/

The use of a "stationary" artificial earth satellite as a base for a television rebroadcasting station was proposed by two Soviets, Candidate of Physical and Mathematical Sciences Druzhkin and Engineer Sorin. The satellite would be placed at an altitude of approximately 36,000 kilometers (in the plane of the equator), so that its period would be twenty-four hours and it thus would appear to stay at the same point to an observer on the earth. Programs would be sent to the satellite from a single station on the earth, and a two-kilowatt transmitter on the satellite would broadcast the program to almost a hemisphere of the earth, thus eliminating the need for many television stations on earth. 99/

Joseph Sinka, Secretary of the Hungarian Space Travel Committee, said on 7 August 1958 that Soviet Russia is planning three new satellites. He said they are: (1) a device that will bring a test animal back to a pre-selected area on the earth's surface; (2) one that will carry a television transmitter to report on the surface of the earth, including cloud formations; and (3) another that would solve the problem of simultaneous broadcasting of television programs throughout the world. Sinka said he obtained his information from Dr. Alla Masevich, , Secretary of the Soviet Astronautical Council. 100/

During the East-West Conference on Problems of Detecting Nuclear Explosions, Geneva, July 1959, the Soviets indicated a firm conviction that the use of instrumented satellites for detecting very-high-altitude nuclear detonations was both feasible and desirable. The following quotations from the verbatim record illustrate this conviction.

a) By Ovsey Il'ich Leypunskiy, Academy of Sciences, USSR:

> First of all, it is pleasant to note that we followed exactly the same path and came, generally speaking, to the same understanding regarding the possibility of the detection of nuclear explosions from satellites. On the basis of the calculations which we made, the radius of detection is limited by background, as Mr. Bethe pointed out, and it constitutes approximately 300,000 kilometers. In other words, explosions conducted on the moon can be recorded quite clearly on a satellite above the earth. As for explosions not so far from the earth, but high-altitude explosions, there, on the basis of our calculations, it would be sufficient to have several satellites in order to ensure this constant patrol service for the purpose of recording every explosion which has been conducted at a height of more than 30 kilometers. And if we were to use only gamma radiations, our calculations are completely identical with those of Mr. Bethe; but it we were also to use neutrons, then, in view of the difference of arrival of gamma rays and neutrons, it is possible even to determine the distance at which the explosion took place. 112/

b) By Ye. K. Fedorov, Director of the Institute of Applied Geophysics, Academy of Sciences, USSR, and Chief of the Soviet Delegation:

> It seems to me that we are in complete agreement that gamma radiation following an explosion made at a considerable height, say from thirty to fifty kilometers up to hundreds of thousands of kilometers, may be recorded with considerable certainty by the equipment installed on the earth satellites. The creation of such equipment is a problem which can be solved at the present time, I think; it is a solvable problem for us all. Despatching of earth satellites will be, I think, a very possible feat in the future. You, and we, are sending up several earth satellites a year -- and will probably continue to do so in the future, thus furthering the possibilities of control. I do not believe that the

equipment necessary for the recording of gamma radiation, insofar as its parameters are concerned, is widely different from that which we use in the Soviet Union, or that you use in the United States, for the recording of cosmic rays. It is not necessary to install the equipment on an earth satellite of great size. Such equipment can be supplied with energy from solar debris; it is possibly the simplest equipment and one which is most readily available and is of a type already in use in artificial earth satellites. I do feel that, in this particular field, hardly any differences of opinions exist between us. For that reason, I think we can recommend to our respective governments a regular placing of earth satellites, fitted with equipment for the recording of gamma radiation or perhaps of other types of radiation, but primarily for the recording of gamma radiation which might be produced by an explosion. As I say, we can recommend this as being one of the most basic and reliable methods of control. 112/

Geophysics--Ye. K. Fedorov, and G. A. Skuridin, in an article in Vestnik Akademii Nauk SSSR (Herald of the Academy of Sciences, USSR), August 1957, pointed out that the upper strata of the atmosphere (above 10 to 15 kilometers) constitute only about eight to ten percent of the total mass of the atmosphere, but it is there that a series of extremely interesting phenomena occur which can be investigated by rockets and satellites.

Some of the problems suggested for investigation included: changes in the intensity of the earth's magnetic field, various currents in the atmosphere, the nature of solar corpuscular emanations, the role of ultraviolet and X-ray radiation in the formation of the ionosphere, the influence of cosmic rays on processes in the high atmosphere, the chemical structure of the ionosphere, the degree of recombination of atoms and molecules in various strata, and the frequency of collision of free electrons.

Characteristic of the upper atmosphere is the presence of unstable chemically active atoms and molecules, large runs of molecular free paths and a relatively small number of molecules per unit volume, a particularly ionized condition of whole strata of the atmosphere, the existence of complex processes of dissociation and recombination of atoms and molecules, etc. Therefore, for research on the upper strata of the atmosphere, a new methodology was needed, one based on the type of measurements found only in the realm of the physical experiment. First and foremost, the newest achievements in the physics of the high-vacuum, gaseous discharge, and electrical plasma were brought into play.

In order to understand the complex physical picture of the upper atmosphere, the authors pointed out that it is necessary not only to compile new experimental data, but to engage in a more profound theoretical study of the processes transpiring in the plasma-type environment, especially on the basis of the new branch of theoretical physics--magnetohydrodynamics. They hailed the artificial satellite as the most promising means of studying the upper atmosphere. 116/

Fedorov, President of the Working Group on Rockets and Satellites of the Soviet IGY Committee, stated in an article in Izvestiya of 8 June 1958: "Sputniks will forecast world weather. Artificial earth satellites will initially compete and in the future, to considerable degree, replace the observations carried out by meteorological stations on earth. Launching a large automatically functioning observation station to the outer limits of the atmosphere represents a new method in geophysics. Five or six such stations could cover weather all over the earth. Observations of cloud /cover/ density could be carried out even now by a satellite more effectively than by all the weather stations on earth." 193/

Fedorov, on 3 October 1958, stated, "Satellites will in the future be regularly used for geophysical and meteorological observations. 74/

Vladimir V. Belousov, Chairman of the Soviet IGY National Committee, on 15 May 1958, stated, "There is no doubt at all that the launching of the new Soviet earth satellite (Sputnik III).... will play an immense role in increasing our knowledge of the upper strata of the atmosphere and of the fields of cosmic space nearest to our planet. As a result of the observations carried out with the help of the third Soviet satellite, our information will be greatly increased as to the nature of the composition, structure, and properties of the uppermost layers of the atmosphere. Such information is extremely important for the understanding of many processes taking place in the atmosphere, for the improvement of methods of radio communications, and for a knowledge of the conditions with which interplanetary ships will have to cope." 75/

Pravda, on 27 March 1958, carried an article on the Soviet upper atmoshpere geophysical program and methods of research which stated, "The placement of scientific apparatus on a satellite provides us with an invaluable opportunity to conduct measurements for a prolonged period of time over various areas of the globe.

"A combination of data obtained during investigations with rockets and satellites and also with the aid of various indirect

methods (ionospheric soundings, meteor studies, auroral studies, etc.), makes it possible to obtain a correct concept of the different processes themselves which occur in the upper layers of the atmosphere.

". . . The basic problems of scientific research which will be worked out by rockets during the IGY in the USSR are the determination of the temperature, pressure, and chemical composition of the atmosphere at various altitudes, a study of the properties of the ionosphere (concentration of ions and electrons, electron temperature, etc.), the investigation of cosmic rays, the study of the short-wave ultraviolet part of the solar spectrum, and a study of micrometeors. 194/

A. A. Mikhaylov, Director of the Main Astronomical Observatory, Pulkovo, in an article, "What Will Satellite Observations Give to Geodesy?" indicates that artificial earth satellites will facilitate measurements of the exact shape of the earth. However, he says, hundreds of measurements, proofs, and new observations are required for this. A great amount of difficult but very interesting work remains to be done in this field. Several flights of a satellite around the earth are not sufficient to give the exact shape of the earth. 117/

A. Shternfel'd has reviewed some of the possibilities of upper atmosphere geophysical research as follows," . . . our knowledge of the upper layers of the atmosphere is still incomplete and demands fundamental deepening; some of the information obtained, which now appears to be trustworthy, may prove inaccurate on further experimental checking. Artificial satellites will be used in solving all these questions."

Shternfel'd indicated that the artificial satellite will have many uses for upper atmospheric research including studies of temperature and "wind," ionization (distribution of ions and electrons), the earth's magnetic field, solar and cosmic radiation, and micrometeorites and cosmic dust. 76, pp. 36-37/

Shternfel'd, on the subject of meteorological observations, said, "It will also be possible to measure the albedo* of the earth by the aid of artificial satellites. The albedo fluctuates over a very wide range, mainly owing to the variability of the cloud cover of the earth . . ." Other meteorological projects considered by Shternfel'd included observations of the chemical

*The albedo is a number indicating what part of the light received from the sun is reflected by a planet (or satellite).

composition of the atmosphere, cloud cover, temperature, pressure, and density. 76, pp. 354; 367/

Shternfel'd pointed out, "At the present time, high-precision cartography of the continents has covered only 7 percent of the land surface of the earth. From an artificial satellite, however, it will be rather readily possible to map, by photosurvey, many almost inaccessible localities and to revise maps that have become obsolete as a result of the changes produced by the construction of airfields, roads, dams, etc. . . .

"From a satellite flying at various altitudes in the range of several thousand kilometers, the entire surface of the earth could be photographed in full daylight, in less than 24 hours. . . .

"It is true that large areas will always be covered by clouds, but in this case the photographic survey can be made by means of invisible infrared rays as well as by means of radar installations."

Shternfel'd, in continuing, mentions the use of earth satellites for geodetic triangulation, especially measurement of distances between continents; detection of gravity anomalies (deviations of the value of gravity from the normal) connected with the nonuniform structure of the earth's crust; and determination of the exact degree of the earth's oblateness. 76, pp. 358-360/

He stated, "Glaciologists, for example, hope that observations from an artificial satellite will confirm the hypothesis that the earth's climate is gradually becoming milder and that, in this connection, the ice cover of our planet is gradually thawing." 76, p. 361/

On the subject of oceanography, Shternfel'd wrote, "although polar aviation is making constant observations of the movement of the floating ice in the Arctic seas and oceans, . . . such observations will be considerably more efficient from artificial satellites. The instruments installed on them will warn navigators of ice packs. All icebergs of more or less extensive proportions will be 'traced' and will no longer cause shipwrecks by collision . . . " 76, p. 361

M. Yatsunskiy, in a 1957 paper, "On the Influence of Geophysical Factors on the Motion of a Satellite," mentioned factors such as air resistance, the difference in the field of

gravity of the spheroid earth from the central field, and the difference of the true field of gravity from the field of the earth spheroid. His paper presented an estimation of the present possible accuracy with which the influence of geophysical factors on the motion of the satellite can be considered. 77/

Some of the other Soviet scientists who have discussed methods of geophysical research by means of rockets and satellites include V. V. Mikhnevich, who has written on measurements of pressure; 79/ S. N. Vernov, V. L. Ginzburg, and L. V. Kurnosova, on investigations of primary cosmic radiation; 78/ B. A. Mirtov, on composition of the upper atmosphere; 119/ K. I. Gringaus and M. Kh. Zelikman, on the concentration of positive ions along the path of a satellite; 120/ B.S. Danilin and V. V. Mikhnevich, on high atmospheric densities; 121/ and Mirtov and V. G. Istomin, on the spectrum of ions in the ionsphere. 109/

Soviet Statements of Military Objectives

Soviet officials and scientists have made very few statements relating to the military objectives of their space research and development program.

The Soviet articles which do mention military objectives usually quote and comment on statements by citizens of Western countries. These articles are always liberally interspersed with the usual Communist "peace" propaganda.

A. A. Shternfel'd, for example, in 1958 quotes Werner Von Braun as proposing artificial earth satellites for aerial reconnaissance and for the bombing of enemy objectives with extraordinary accuracy. The instant of ejection of the missile from the satellite would be calculated in advance and the missile would be guided to its target from optical or radar telescopes on the satellite. Shternfel'd states that adherents of the use of artificial satellites as bomb carriers should bear in mind that such satellites are very difficult to build and much easier to shoot down. 76, pp. 385-388/

Major General G. I. Pokrovskiy, a weapons expert, in his article "The Role of Science and Technology in Modern War," published in 1957, wrote as follows, "The development ... has also led to artificial earth satellites. These satellites, together with their scientific value, also have military significance. From them it is possible to observe the opponents' territory and to throw atomic bombs on that territory. 110/

Regarding the use of satellites as reconnaissance vehicles, Professor Nikolai Barabashev, Chairman of the Planets Commission under the Astronomical Council of the Academy of Sciences, USSR, stated in 1958, "It is theoretically possible to create immobile satellites of the earth. The orbit would be over 22,000 miles high and the speed over 10,000 feet per second. It would be possible to conduct constant observation of our planet if three (satellites) were positioned in space. 111/

The Secretary of the Hungarian Space Travel Commission said on 7 August 1958 that he had been told by a leading Soviet scientist that the USSR plans three new satellities, one of which would carry a television transmitter to report on the surface of the earth, including cloud formations. 195/

In the 6 November 1957 edition of Soviet Fleet, official USSR naval publication, Professor V. V. Dobronravov discusses the techniques of determining the position of a ship by means of radio bearings taken on an artificial earth satellite. In the 21 December 1957 issue of the same publication, Soviet Naval Commander N. Tumanov discusses the practical operational aspects of the problem. 196/

A Tass Moscow broadcast of 18 October 1957 states: "Artificial earth satellites can serve as astronomic beacons, writes today's Soviet Fleet. They will help Navigators determine the location of their ships with great precision and insure dependable navigation at sea, in the stratosphere, and in the ionsphere." 63/

Statements and Events in Other Bloc Countries and Communist China

Communist China.--Pravda on 18 May 1958 reported that Communist China "is about to enter the space race and may launch a satellite 'in the near future'." The Soviet publication claimed that it was quoting Kuo Mo-jo, President of the Chinese Academy of Sciences. Kuo reportedly said, "Chinese scientists are seriously studying the Soviet Union's most advanced science and technology so that China may launch her own Sputnik in the nearest future." 208/

An American-trained Chinese scientist who spent five months in Communist China said on 3 November 1958 that the Communist regime was working on projects to put a satellite into orbit and shoot a rocket to the moon. According to the observer, the Communists have brought back the best Chinese scientists from abroad, most of them from England and the United States. He reported that technical assistance and equipment had come from

USSR but that some equipment had been "smuggled in from the United States and England." 122/

The following appeared in the Hong Kong South China Morning Post, 25 July 1958: "Chinese scientists are hard at work preparing conditions for the launching of an earth satellite in the future. In Shanghai, scientists were studying a new alloy which, they claimed, was superior to aluminum in durability and was lighter. Experiments had been carried out extensively in the past two months. Scientists told the press that if these experiments proved successful, the new alloy would be used in the manufacture of a China-made 'baby moon'." 124/

A Peking news agency, Wen Wei Pao, reported on 15 October 1958 that Tsinghua University had successfully manufactured Communist China's first radioastronomical telescope. According to the report, "It will help mankind unveil the secret of space and pave the way for interplanetary travel." 125/

An article in a Communist Chinese publication of 5 November 1957 reported that Ch'en Te-huang, Director of the Mathematics Institute, and Li Chih-hui, Director of the Physics Research Institute, gave talks on earth satellites and intercontinental ballistic missiles at Urumchi. The article also reported that twelve satellite tracking stations were being established in the country by the Communist Chinese Academy of Sciences. 126/

The president of the Chinese Communist Academy of Sciences, Kuo Mo-jo, was reported in April 1958 to have stated "China's scientists are determined to get China's artificial earth satellite into the sky at an early date." 127/

The use of miniature cameras in photographing Sputnik II is revealed by a Chinese Communist periodical. Thirty-four photographic observations were made during the period from 18 December 1957 to 18 March 1958 by the Purple Mountain Observatory, Nanking. Attempts were made to calculate satellite orbits from the observations. 128/

Albania.--None available.

Czechoslovakia.--Nauka i Zhizn', Moscow, in October 1958, carried an article by I. Novak, Chairman of the Czechoslovakian Committee for the IGY, stating that 16 stations scattered throughout the country "are now observing Sputnik III." The article stated that photographic observations of the satellite had been taken and that geodetic information had been obtained. 130/

The official Czechoslovakian program for the IGY stated that two or three stations for visual observation of artificial earth satellites and monitoring of radio signals from satellites were planned as of 1957. 198/

According to a Hungarian source of 17 October 1957, a new type of radar was installed at the Ondrejov observatory in Czechoslovakia which made possible the observation of meteors. 199/

Frantisek Link and Ludek Neuzil are the authors of a book, Rocket Flights and Upper Atmosphere Research, published by Czechoslovakian Academy of Sciences in 1957, which, among other subjects, considers artificial earth satellites. 200/

Workers of the People's Observatory in Presov followed the radio signals of Sputnik I as did those in the Physics Institute of the Pedagogic College in Presov in October 1957, according to press reports. 131/

Workers of the Astronomical Institute of Brno University and of the Peoples Observatory, Brno, were tracking Sputnik I, according to a press report of October 1957. 132/

The radar at the observatory at Ondrejov, designed to track meteors by means of its directional antenna, began receiving signals from Sputnik I, according to a Prague report of 8 October 1957. The article stated that this was the only radar of its type in central Europe. 133/

After Sputnik I was launched, the astronomical observatory on Lake Skalnate showed that it was able to contribute more than was expected, according to a Prague report. The results of the satellite observations were so valuable that members of the observatory were invited to Moscow to work in close cooperation with Soviet scientists, not only in observing the satellite, but also in making calculations. The observatory had more than 50 photographs of satellites and had made more than 150 measurements up to 9 February 1957. 129/

A short unsigned article in a Bratislava paper of 9 March 1958 discussed the theory of ion propulsion which would allow space

locities of 200 kilometers per second. The article was companied by a rough sketch of such a rocket. 201/

According to a Czechoslovakian broadcast, the Slovak Academy of Sciences on 11 December 1957 received as a gift from the USSR twenty-two telescopes for observation of artificial earth satellites. 202/

130/

At a 27 February 1958 meeting of representatives of Czechoslovakia's astronomical observatories which discussed the problems of observation of earth satellites, it was reported that the country had fourteen official observation stations. According to statements made at the conference, Soviet astronomers rated Czechoslovakian satellite observations ahead of all others. 134/

99/

Czechoslovakia is the only European country to have picked up the signals of the first American satellite well enough to be of any scientific value, according to a broadcast of 11 May 1958 from that country. Reception of the signal was by means of a specially arranged parabolic mirror, similar to those used in (radio) telescopes. 203/

East Germany.--An East German newspaper, on 7 June 1957, reported the near completion of the second-largest radio telescope in the world at the Heinrich-Hertz Institute, Berlin. 135/

A news item of 16 October 1958 stated that East Germany had recently placed into operation Europe's second-largest radio telescope in the Heinrich Hertz Institute. The diameter of the parabolic reflector is thirty-six meters. The apparatus will serve for research on radio waves of cosmic origin. 136/

Returning from an inspection of observation stations, Soviet Professor Dobronravin from the Crimean Astrophysical Observatory was reported on 12 February 1958 as being greatly impressed by both the technical facilities and the quality of the GDR research work under the satellite observation program. Professor Horst Philipps, Secretary of the GDR National Committee for the IGY, stressed the need for cooperation with Soviet scientists. 138/

Hungary.--Satellite tracking in Hungary was organized by the Academy of Sciences observatory and other groups, according to a Budapest report of 3 April 1958. The satellites are being tracked both optically and by radio. 139/

The Hungarian press reported that in December 1957 the following lectures were scheduled to be delivered at the newly organized Hungarian Aeronautical Society for Youth: "Paths in Space", by Gyorgy Kulin; "Introduction to Rocket Engineering", by Zoltan Fulop; and "Man in Space", by Dr. Emil Galle. 140/

Forty small size AT-1 type telescopes, with an 11-degree range, made in the Soviet Union, will be used by Hungarian tracking stations engaged in observing artificial satellites, according to a Hungarian source of 22 January 1958. 204/

In a Budapest article dealing with special materials used in the construction of rockets, the statement is made, ". . . the melting point of rhenium is 3170°C. It is almost wholly insensitive to oxygen. Since it is more costly than gold, it is used only to coat the rocket nose." 205/

Jozsef Sinka, secretary of a committee on space travel, in an interview recorded by the Hungarian press, stated in March 1958 that Hungary could not send up a satellite because of the prohibitive expense and the fact that there was no appropriate testing grounds available in the thickly populated area of Central Europe. 209/

Poland.--A Polish periodical reported in January 1958 that a recent meeting of the Polish Society of Rocket Engineering and Astronautics gave special attention to a report by Engineer V. Geisler and M. Paukov, who suggested the idea of using small celestial bodies, planetoids, as artificial earth satellite space stations. The speakers mentioned possible use of the planetoid Hermes, discovered in 1937. 141/

A Polish broadcast of 22 October 1957 stated, "The Institute of Basic Problems of Technology of the Polish Academy of Sciences will set up independent isotope and astronautical research centers. The astronautics research center will deal with the problem of cosmic flight." 142/

A report of 4 June 1957 is quoted as follows, "Poland also plans to build an artificial earth satellite, according to a statement of K. Zarankievicz, President of the Polish Astronautical Society." 149/

A Polish astronomy journal in 1957 described the Andrzejow observatory instrument for meteor photography as consisting of [illegible] fixed cameras which cover more than half of the sky. An identical installation was set up at a station in Preicy, 40 kilometers from Andrzejow. Other identical stations and at least two long-focus cameras were to be put into use for investigation of meteors. 206/

L. Bobrowski, of the Polish astronautical Society, informed a press representative on 24 May 1957 that the Society had decided to set up a special commission to work out in about three years a project of a manned artificial earth satellite. Some 100 scientists of various specialties were to be members of the committee. The satellite would be capable of changing its orbit by means of ion-driven engines. It was assumed that the project would not be implemented in Poland. 150/

[redacted]

A Warsaw report of 10 October 1958 stated that the Cracow branch of the aeronautical society and associated groups on that date launched an experimental rocket, the beginning of further work on atmospheric research rockets. 144/

Missiles and Rockets reported on 6 October 1958 that the Polish Astronautical Society now has 500 members and two new sections in Bydgoszez and Lublin. Professor Z. Paczkowski was named president and Professor K. Zarankievicz vice president last spring. 145/

[redacted]

Polish IGY officials reported on 10 October 1957 that preparations were in progress in their country for visual and radio observations of artificial earth satellites. 147/

According to a Soviet report of 13 November 1958, scientists of the Polish Peoples' Republic are allotting significant attention to work on the creation of rockets for meteorological and other

investigations in the upper layers of the atmosphere. The report continued, "Recently, the Polish Press reported the launching in Blendovskoy Pustyni of the second stage of such a rocket created by the Krakov Department of the Polish Society of Astronautics and the Rocket Section of the Mining-Metallurgical (Gornometallurgicheskoy) Academy in Krakov. The launching of the rocket was necessary to indicate the correctness of the calculations and statistical experiments carried out. 48/

Rumania.--None available.

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