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The Soviet Space Program

Submitted by the
DIRECTOR OF CENTRAL INTELLIGENCE
Concurred in by the
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The following intelligence organizations participated in the preparation of this estimate:

The Central Intelligence Agency and the intelligence organizations of the Departments of State, Defense, the Army, the Navy, the Air Force, AEC, and NSA.

Concurring:

Director of Intelligence and Research, Department of State

Director, Defense Intelligence Agency

Assistant Chief of Staff for Intelligence, Department of the Army

Assistant Chief of Naval Operations (Intelligence), Department of the Navy

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The Atomic Energy Commission Representative to the USIB

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Abstaining:

The Assistant Director, Federal Bureau of Investigation, the subject being outside of his jurisdiction.

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THE SOVIET SPACE PROGRAM

THE PROBLEM

To evaluate the current status of the Soviet space program and to estimate its progress over the next 5 to 10 years.

CONCLUSIONS

A. The underlying motives of the Soviet leaders in planning their space program, as for all major programs, are to enhance the security of the USSR and to increase its power and prestige, gaining advantages over the US where possible. In making decisions about the specific projects to be included in their program, the Soviet leaders will continue to be guided by such general considerations as the political and military gains that are likely to result from particular space accomplishments and the technical and economic limitations that determine the range of their choices. We believe that these considerations, as well as the desire to achieve scientific gains, will incline the Soviets toward a space program of much broader scope than in the past, but attempts to accomplish spectacular "firsts" will continue. (*Paras. 45–46*)

B. Our evidence as to the future course of the Soviet space program is very limited. Our estimates are therefore based largely on extrapolation from past Soviet space activities and on judgments as to likely advances in Soviet technology. (*Para. 47*)

C. The Soviets have recently expanded their unmanned space flight program, in part because future Soviet space missions will require a considerable increase in scientific data. Unmanned satellites will continue to be used to collect data on the near-earth space environment and to test new space components and systems for manned space vehicles. In addition, the Soviets may attempt an unmanned soft landing on the moon or the orbiting of an unmanned satellite around the moon at any time. They

will probably continue to launch probes to Mars and Venus. As greater propulsion capabilities are developed, more extensive and complex scientific investigations of interplanetary space will be undertaken. However, the high failure rate in Soviet interplanetary attempts to date indicates difficulties which may handicap or modify their future program for deep space exploration. (*Paras. 4, 13–16, 55*)

D. Dramatic manned space flights are likely in the course of the next few years. Using space systems presently available, the Soviets will probably begin, within the next year, to employ manned satellites having some maneuverability while in orbit and to perform rendezvous, docking, and transfer operations. They will probably undertake manned flights of increasing duration, and could orbit a two-man capsule at any time. It would be technically feasible for the Soviets to put up a small manned space station or attempt a manned circumlunar flight by 1963–1964 using first-generation ICBM boosters and earth orbit rendezvous techniques. If a military booster of about 1.5 million pounds thrust becomes available in the next year or so, this booster could be used to accomplish the same feats in a less complex manner. If a multimillion pound thrust space booster is being developed now, the Soviets could orbit a 50–100 ton manned space station in 1965–1966. (*Paras. 25–27, 51, 53–54*)

E. Some Soviet statements indicate that a program for a manned lunar landing is under way in the USSR, but we have no confirmation that it is currently being pursued. The top Soviet leaders have not committed themselves publicly to a lunar race with the US, and it is highly unlikely that they will do so. However, the prestige attached to the first manned lunar landing, its probable political impact, and its importance for future advances in space, would probably lead the Soviet leadership to compete unless the cost were considered prohibitive or the US seemed to have an insurmountable lead. On the basis of present evidence, we cannot say definitely at this time that the Soviets aim to achieve a manned lunar landing ahead of or in close competition with the US, but we believe the chances are better than even that this is a Soviet objective. Given their ability to con-

centrate human and material resources on priority objectives, we estimate that with a strong national effort the Soviets could accomplish a manned lunar landing in the period 1967–1969. (*Paras. 48–52*)

F. On the basis of evidence presently available, we are unable to determine the existence of Soviet plans or programs for the military use of space. The limitations of this evidence, however, are such that our chances of identifying military programs are poor. We believe that the USSR almost certainly is investigating the feasibility of space systems for military support and offensive and defensive weapons. Moreover, it is possible that space exploration, which is totally new to human experience, will offer unforeseen opportunities for military application. Soviet decisions to develop military space systems will depend on their expected cost and effectiveness as compared with alternative systems, the political and military advantages which could be gained, and the Soviet estimate of US intentions and capabilities in comparable fields. We believe that the USSR will produce and deploy those military space systems which it finds to be feasible and advantageous in comparison with other types of weapons and military equipment. (*Paras. 5, 56*)

G. Greater emphasis than heretofore will probably be placed on military applications of space vehicles, both to meet specific Soviet requirements and to keep pace with military programs which the Soviets expect the US to undertake. The first Soviet military space vehicles are likely to be earth satellites used in various support roles—reconnaissance, early warning (EW), geodetic, communications, or navigation. We believe that such satellites could be launched at any time; some recent satellites probably have carried out cloud photography and possibly other experimental reconnaissance missions. Other possible future Soviet developments include an orbital bombardment satellite system and an orbiting satellite inspection system. However, we do not believe that Soviet space technology has progressed sufficiently for the USSR to have made the decision to proceed with large-scale programs for offensive or defensive space weapons. (*Paras. 57–64*)

H. Within this decade, the basic factors of reaction time, targeting flexibility, accuracy, vulnerability, average life, and positive control for an orbital bombardment system almost certainly will not compare favorably with ICBMs. We believe that a Soviet decision to develop and deploy an orbital bombardment system would depend in large part upon the extent to which these drawbacks can be overcome. A demonstration of an orbital bombardment satellite could occur at any time, but we believe that in the near term its military effectiveness would be minimal. If the Soviets decide to develop an orbital bombardment force, it would be preceded by a developmental system of limited military effectiveness which could appear as early as 1965. (*Paras. 60–61*)

I. In sum, we estimate that Soviet space efforts in the next decade are likely to include increased man-in-space activity, some military support systems, scientific satellites, interplanetary probes, and lunar exploration. Specific major developments which could occur within the period of the estimate are manned space stations in earth orbits and manned lunar landings. In addition, demonstrations of developmental space weapons systems may occur. We believe that Soviet scientific and technological capabilities are adequate to accomplish these objectives. However, this Soviet program will be vastly more expensive than it has in the past. It will be competing directly for the scarce skills and resources also needed in the ICBM, air and missile defense, and economic programs. Nevertheless, we believe that the Soviet leaders are committed to a continuing space program of sizable proportions as an element of national power and prestige. (*Paras. 17–44, 66–71*)

DISCUSSION

I. AIMS AND ACHIEVEMENTS TO DATE

1. In 1955, long before the USSR successfully launched Sputnik I, the Soviets announced that the goal of their space program was manned interplanetary travel. The space activity which they have since undertaken is consistent with this goal, but would also be consistent with other objectives. The announced goal, therefore, sheds very little light on the specific objectives of the Soviet space program.

2. A review of Soviet space accomplishments to date makes it clear that the USSR has been engaged in a well-planned, long-term program, heavily emphasizing manned space flight. The political impact of the first Sputnik had great influence on the subsequent course of the program. This initial success probably led the Soviet leadership to allocate resources to the program very generously and led them to seek additional spectacular "firsts," in some respects subordinating other objectives to cold war objectives. Successful space ventures have been used to support claims of military strength, scientific and technical advancement, and the general superiority of Soviet society.

3. The Soviet approach has contributed to an impressive record of pioneering achievement over the past five years. The Soviet record includes: orbiting the world's first earth satellite and by far the heaviest satellites; launching the first vehicle to impact the moon; launching the first vehicle to transfer from earth orbit to a trajectory towards a planet; the first successful orbiting and recovery of a man; and, most recently, the first concurrent orbital flight and recovery of two manned satellites. These successes represented technical achievements of the first order. They were made possible in large measure by the availability of the first-generation Soviet ICBM booster, a very reliable vehicle using clustered engines to achieve considerably higher thrust than any US booster now operational.

4. The collection of scientific data by Soviet space vehicles was fairly limited and selective through 1961. There was an apparent lack of systematic and comprehensive in-flight measurement of the space environment needed for future space ventures, but this need was at least partly met by US data available to the USSR, primarily through COSPAR. Beginning in late 1961, the Soviet program was apparently broadened so as to place greater emphasis upon the collection of data on the space environment of the earth. We believe this broader program was undertaken to remedy whatever weakness in this area might adversely affect Soviet near-term plans for space exploration.

5. The Soviets almost certainly have investigated the feasibility of developing space systems for military and perhaps economic purposes.

We have no firm evidence that the Soviets have launched any space vehicles specifically for military purposes, but their space experiments have produced information which would be useful in the development of military space systems. At least the initial testing of such systems would probably be conducted under the guise of scientific experiments. Despite the absence of specific intelligence, therefore, we believe that the Soviets could be proceeding actively to develop space systems for reconnaissance, surveillance, and other military purposes. Some of the Soviet developmental work could also have commercial applications, as in communications satellites.

II. SOVIET SPACE FLIGHT PROGRAMS [1]

Vertical Firings

6. Soviet space exploration began in 1949 with vertical launchings designed to investigate near-earth space and the effects of that environment on biological subjects. The purposes of these firings included upper atmosphere research, photographing the earth's cloud cover, and space biology. The first firings—to altitudes of about 55 nautical miles (n.m.)—probably involved the collection of geophysical data. Between 1951 and 1960, a series of geophysical and biological experiments were undertaken with vertical firings to about 60, 115, and 250 n.m. Dogs were used as specimens in tests of sealed cabins, pressure suits, ejection methods, and re-entry techniques. The data obtained in the Soviet vertical firings contributed directly to the development of life-support equipment and recovery techniques for Soviet manned satellites.

Early Unmanned Satellites [2]

7. Sputniks I, II, and III, launched in 1957 and 1958, were instrumented satellites designed to collect geophysical data on near-earth space, and to provide some biological data. After these three shots, Soviet launchings until the spring of 1962 were devoted to lunar and planetary exploration, and particularly to the man-in-space program.

Lunar Exploration

8. Other than vertical firings, the only Soviet space launchings conducted during 1959 were those related to lunar exploration. Lunik I, which was launched in January, scored a near miss, and went into solar orbit. Lunik II successfully impacted on the moon in September. Both of these flights provided some data on the nature of space between the earth and the moon. Three weeks later the Soviets successfully sent Lunik III on a circumlunar flight and obtained the first photographs of the hidden side of the moon. In April 1960, the Soviets

[1, 2] For a tabular summary of Soviet space flights to date, see Table 1, page 25.

launched another lunar vehicle which failed to reach the moon. Since this flight the Soviets have made no further attempts to launch a vehicle toward the moon. Although the Soviets have achieved some spectacular "firsts" in their lunar program, there have been a number of failures, estimated at about 60 percent of the launchings attempted.

Planetary Probes

9. A favorable opportunity to launch a probe to Mars occurred in the fall of 1960, and to Venus in early 1961. In October 1960 the Soviets were twice unsuccessful in launching probes toward Mars. In February 1961, the Soviets failed in an attempt to launch a Venus probe from Sputnik VII. They succeeded later in the month with Sputnik VIII, but lost contact with the probe early in its flight, and thus failed to achieve their major scientific objectives. The next favorable opportunity for a Venus shot occurred in the summer of 1962. In late August–early September, the Soviets made three attempts to launch a probe to Venus; in each case, they succeeded in placing a satellite in parking orbit, but due to a malfunction of the fourth stage, failed to launch the probe toward Venus. They experienced a similar failure in attempting to launch a Mars probe from an orbiting satellite in October. They succeeded on 1 November, but failed in yet another attempt on 4 November.

Man-in-Space

10. The major emphasis of the Soviet space program has been given to manned space flight. In 1960 three heavy satellites, Sputniks IV, V, and VI, were orbited for the purpose of checking out such design features as stabilization and control, life support equipment, retrorocket operation, and re-entry and recovery. In addition, Sputnik V carried a large variety of biological specimens. Sputniks IX and X, launched in March 1961, were prototype tests, probably simulating in all respects the first man-in-space shot except that the passenger in each case was a dog. Two weeks later came the flight of Major Gagarin in Vostok I, with recovery after a single orbit around the earth. In August 1961, Major Titov in Vostok II remained aloft more than 25 hours and completed 17 orbits around the earth. After the Titov flight, the Soviets undertook no more manned shots for about a year.

11. This program was resumed on 11 August 1962, when Major Nikolayev was orbited in Vostok III, and about 24 hours later, Lt. Col. Popovich followed in Vostok IV. The two were brought down on 15 August—Nikolayev after some 64 orbits in 95 hours, and Popovich after 48 orbits in 71 hours. We believe that the Soviets attempted to put the two satellites into nearly identical orbits. They were able to orbit the space ships in close proximity (about 5 n.m.) at one point, after which the distance between them widened.

12. Rendezvous or docking maneuvers [3] were not attempted, nor do we believe that they were even contemplated. However, orbiting two satellites at the same time and in nearly identical orbital planes is a necessary first step to the development of such techniques, and is also an impressive achievement in itself. The long duration of the flights undoubtedly enabled the Soviets to acquire extensive physiological and psychological data. This achievement attests to the reliability of Soviet space boosters, guidance equipment, life support systems, and recovery techniques. However, we do not believe that these manned flights represent any startling advance or breakthrough in Soviet space science or technology, or that any new space equipment or techniques were involved.

The "Cosmos" Series

13. Late in 1961, the Soviets began a new series of space launchings, the unmanned "Cosmos" series, with the stated purpose of collecting astrophysical and geophysical data, and of testing satellite structures. The first two launchings were unsuccessful. Since March 1962, a total of 11 "Cosmos" satellites have been successfully launched—7 from Kapustin Yar and 4 from Tyuratam. Our evidence on the "Cosmos" series indicates that two programs are involved.

14. The satellites launched from Kapustin Yar have transmitted data on near-earth space compatible with the Soviet claim of a scientific collection effort, probably including data on nuclear tests. This effort probably reflects, at least in part, a Soviet desire to maintain the prestige of the USSR as a leading scientific nation. The vehicles have an estimated payload of 3,000–4,000 pounds, indicating the use of a booster smaller than the first-generation ICBM. They have all been orbited at a 49° angle of inclination.

15. The "Cosmos" satellites launched from Tyuratam appear to have been primarily associated with the man-in-space program. First-generation ICBM boosters were employed to put Vostok type vehicles (weighing approximately 10,000 pounds) into orbit at a 65° angle of inclination. These vehicles were later recovered. The first two probably served to check out equipment and collect data for flights of Vostoks III and IV. [ ] How-

[3] As used in this estimate, rendezvous is the operation of modifying the orbit or trajectory of one or more space vehicles, for the purpose of bringing and maintaining them in close proximity. This operation requires some maneuvering while in orbit, in contrast to co-orbiting by precise launching of the second vehicle. By docking is meant the establishment of a physical contact between two orbiting vehicles, and by transfer is meant the physical movement of persons or equipment from one orbiting vehicle to another.

ever, we do not know the contents of the recovered capsules; their size and payload capabilities would have permitted other missions.

Soviet Space Failures

16. The USSR has announced the successful launching of 28 space vehicles and has never admitted to any launching failures. However, surveillance of Tyuratam and Kapustin Yar Range space operations reveals a ratio of failures to total launchings on the order of 40 percent.[4] The man-in-space effort has achieved the highest degree of success, with only two failures occurring during 15 launchings. Neither of these failures involved a manned vehicle. In contrast, the lunar and interplanetary programs have had a very high failure rate—estimated to be about 70 percent. The many failures to launch interplanetary probes from parking orbit indicate a low reliability for the injection stage. Lunar mission failures appear to be attributable to defects in the upper stage propulsion system. The injection systems have all had difficulty early in their development, but these difficulties have now been overcome with the exception of those in the planetary injection stage. These latter difficulties, which have persisted for the past two years, may handicap or modify the future Soviet program for deep space exploration.

17. In addition to launching failures, the Soviets have been forced to cancel or postpone launchings, and some of the space vehicles which were successfully launched had component malfunctions. For example, Lunik I was probably intended to hit the moon, but missed. The deorbiting systems contained in Sputniks IV and VI failed to function successfully. Communications with Venik II were lost shortly after its successful launch towards Venus. Each of these launchings was publicized as a success, although each probably failed to achieve the majority of its planned objectives.

III. SUPPORTING SCIENTIFIC AND TECHNICAL CAPABILITIES

18. Since its inception, the USSR's space program has been closely linked to its military missile program. The two programs have used the same boosters and launching facilities, and are mutually supporting in other respects as well. We believe that many of the scientists, engineers, and technicians who are working on space projects are also involved in the Soviet missile program. According to L. I. Sedov: "There is one large team in Russia that handles all space projects. The same key men are in charge of guidance, tracking, and other segments for each of the projects. It is a very large team and it can well take

[4] In estimating the failure rate, we have counted as failures only operations in which an actual launching occurred but the vehicle was lost or destroyed by malfunction, or, in the case of planetary probes, an earth orbit was achieved but the last stage failed to inject into planetary trajectory.

care of several projects in parallel. . . . We have no distinction between military and civilian projects."

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

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

21. Several of the major facilities involved in the Soviet space program have been identified. These include tracking facilities, the Tyuratam and Kapustin Yar test ranges,[5] a rocket engine plant (No. 456) at Moscow, a missile airframe development center (Plant No. 88) at Kaliningrad, a space flight training installation at Tomolino near Moscow (which also develops life support and safety equipment), and probably the Kuromoch static engine test complex near Kuybyshev. Except for Tomolino, all of these are also heavily engaged in the Soviet missile program. We believe that most of the facilities engaged in the space program remain to be identified. Moreover, supporting the work of the major complexes are a vast number of institutes, laboratories, design bureaus, etc., which together represent a large portion of the scientific and technical resources of the USSR.

[5] For space launch facilities at these test ranges, see Figures 1 and 2.

22. We believe that Soviet capabilities in the basic and applied sciences are adequate to support an ambitious space program for the next 10 years. This judgment is based on Soviet space achievements to date, and on a comprehensive review and evaluation of current and probable future capabilities in the major fields of science directly contributing to the space program. Pertinent Soviet scientific capabilities are considered at least adequate in most cases and are improving in all fields. In a few fields the Soviets are considered to be outstanding, notably in lunar, ionospheric, physiological, and mathematical research.

23. The USSR is enlarging and improving its conventional astronomical program and facilities with most emphasis on astronomical and astrophysical subfields of value to the space program, including celestial mechanics, moon and planet investigations, solar research, and meteorites. The Soviet radio astronomy program, which has potentialities for improved deep space tracking and communications, in addition to its utility as a powerful scientific research tool, has reached large proportions and is being pursued and expanded vigorously.

24. In recent years the Soviets have also greatly expanded their geophysical programs and ground-based facilities and have conducted a number of investigations of the upper atmosphere and space designed to determine the environment for future space flights as well as for basic research important to long-distance communications and other practical development. Soviet capabilities for investigating all types of radiation, interplanetary matter, the ionosphere, and magnetic fields in space are improving and should keep pace with the growing needs of the space program. Moreover, the Soviets are also closely following US developments in these areas.

25. We have found evidence of Soviet deficiencies in only a few of the scientific fields which directly support the space effort: meteoritic studies, organic chemistry, and glass fiber research. In each of these areas, the Soviets are making a determined effort to overcome their handicaps by concentrating their efforts on the pertinent scientific problems and by exploiting foreign research. We know of no scientific weaknesses that are likely to be limiting factors on future Soviet programs.

26. Difficulties in the Soviet space program are more likely to arise from technological than from scientific limitations. Requirements considerably more demanding than were dictated by the early needs of military rocketry must be met in confronting the future challenge in space. Such missions as orbiting a large space station or manned lunar flight will be far more complex, expensive, and demanding than past Soviet space achievements.

Propulsion Systems

27. The first-generation ICBM (termed Category "A" and SS–6 by US Intelligence) has been the workhorse of the Soviet space program to date. This reliable, powerful booster, with an estimated sea level thrust of 750,000 pounds, has enabled the Soviets to orbit the heaviest earth satellites. Employed with a powerful upper-stage propulsion unit, it has enabled the USSR to place some 14,000 pounds into orbit at an altitude of about 100 miles. Additional spectacular "firsts" such as the orbiting of two men in a single capsule are still within the capabilities of this booster system, and it will probably be used in various space activities for the next few years.

28. A new two-stage Soviet ICBM (termed Category "C" or SS–8 by US Intelligence) has been observed in flight testing on the Tyuratam range for more than a year. We have been unable to determine the size or thrust of this vehicle. It is possible that it is considerably smaller than the first-generation ICBM, and that it has a thrust of about 300,000 pounds. Alternative calculations suggest that it is considerably larger, with a thrust as high as 1.3 million pounds.

29. If the SS–8 is not a large vehicle, we believe that the Soviets are developing yet another ICBM to deliver very large payloads of up to 100 MT yield, and that they will begin test-firing the new vehicle within the next year or so. A reasonable range for the thrust of a new ICBM booster capable of delivering 100 MT payloads is one to one-and-one-half million pounds. Facilities at Tyuratam already exist to accommodate boosters of this size.

30. Such a booster would allow the USSR to undertake a number of space missions which are beyond the capability of the first-generation ICBM booster. Heavier planetary probes could be launched, facilitating unmanned planetary exploration. It could also be used for docking and transfer operations involving heavier weights of men and material. If such a booster becomes available within the next year or so, it could be used for the establishment of a manned space station or for a manned circumlunar flight somewhat earlier than the 1965–1966 date estimated for these accomplishments with a multimillion pound thrust space booster (see paragraph 56).

31. The heavier payload requirements of some of the spectacular space missions which might be undertaken within the next 5 to 10 years will require boosters with thrusts of several million pounds. The USSR will probably attempt to achieve such thrusts by clustering several engines. We believe that for this purpose the Soviets would require a single engine developing a minimum of 500,000 pounds thrust. The single engine thrust estimated for known Soviet propulsion systems or for more powerful military boosters would be too small.

32. Our evidence does not indicate whether the Soviets have begun static testing of a large single engine suitable for use as the building block in a multimillion pound thrust propulsion system. However, considering Soviet requirements, their capabilities in this field, and the limited evidence, we estimate that flight testing of a new large engine could begin at any time. Unless the Soviets plan to use a single engine as a booster for space missions, it is possible that single engine flight testing would be omitted. In either case, we believe that an engine cluster developing a total of several million pounds of thrust could be initially test flown in about 1964.

33. Such a clustered booster could subsequently be combined with suitable upper stages to support Soviet development of long-lived manned earth satellites for use as space stations and observatories. It would permit the Soviets to place some 50–100 tons in near-earth orbit, either for use as such a space station or as a step toward a manned lunar flight. Any delay in the development of such a multimillion pound booster would result in corresponding delays in advanced space programs.

34. *New Upper Stages.* The development of improved upper stages is also indispensable to successful accomplishment of a manned lunar landing. There is no evidence that the Soviets have undertaken the development of upper stages which utilize high-energy propellants. However, they almost certainly are investigating the advantages of higher specific impulse fuels for use in future propulsion systems. The specific impulse generated by the oxygen-amine fuels now in use could be increased by about one-third with oxygen-hydrogen or fluorine-hydrogen. We believe that the Soviets could begin test launches of an oxygen-hydrogen system at any time, and of a fluorine-hydrogen system in the 1963–1965 period. Upper stages of these types, when employed with the SS–6 booster, could increase its payload capacity for near-earth satellites to some 20,000–25,000 pounds. For manned lunar landing operations, the Soviets probably would combine these advanced upper stages with new, large boosters (see paragraphs 31–33).

35. At a later time period, perhaps toward the end of the present decade, the Soviets could probably have a nuclear-hydrogen powered upper stage available for first flight tests. Such a system could produce more than twice the specific impulse of present fuels, and would be useful for orbiting very heavy payloads, for deep space probes, and for interplanetary missions.

36. The Soviets are actively engaged in the investigation of electric propulsion systems for advanced upper stage vehicles. By 1963–1965 the USSR will probably have an electric propulsion device capable of providing a thrust of .01–.1 pound. Such a device could be used experimentally in orientation control systems for the proper positioning of antennas or optic systems, or to prevent orbit decay of long-lived vehicles

from atmospheric drag. Systems capable of thrusts up to one pound could be available in the 1965–1968 period. These systems would be relatively heavy, and for this reason they would be confined to specialized uses such as deep space probes during the period of this estimate.

Guidance and Recovery

37. Soviet space operations to date have been planned so as to make repeated use of established ground equipment and methods for guidance, control, and recovery.[6] All satellites launched from Tyuratam have remained within a small fraction of a 65° angle of inclination to the Equator. Thus, only minor alterations in techniques and coordination of facilities have been necessary for the various types of orbital missions accomplished to date. The launching of all "Cosmos" satellites from Kapustin Yar at an approximate 49° angle of inclination to the Equator also has facilitated standardization of operations. Space operations involving other orbits will require addition or relocation of range instrumentation and guidance equipment. We believe that the Soviets could do this at any time.

38. Soviet space vehicles launched from Tyuratam have thus far used the basic first-generation ICBM guidance—a radio-inertial system—during the boost phase. Although the Soviets have an all-inertial system operational with their missiles, they may choose to continue with the radio-inertial system for space ventures. The Vostok recoverable vehicles probably used an earth fixed reference system using optical and gyroscopic sensors. In addition, the manned Vostoks incorporated a system which enabled the pilot to assume control at will. The system has so far deorbited a satellite under only one set of conditions of time and place. The evidence does not indicate whether the system as designed could perform in any more generalized situations.

39. The orientation system used in orbiting and recovery of earth satellites has probably been adopted for the earth orbit portion of planetary probe operations. Although Soviet tracking appears capable of accurately defining the spatial location of the vehicle, the accuracy of orientation required for fully successful Mars or Venus probes may be beyond the capabilities of an earth fixed reference system. We have some evidence that the Soviets have developed a system based on stellar guidance or stellar attitude control.

Instrumentation

40. The Soviets have competent scientists and engineers in the instrumentation field, but they do not have enough to provide the wide variety of instruments and the number of refinements desirable for

[6] For typical orbital paths of Soviet earth satellites, see Figure 3.

some advanced scientific space programs. By closely following Western developments in the field of instrumentation and by concentrating Bloc resources on priority programs, the Soviets have been able to meet the needs of their space programs. They will probably be able to provide the instrumentation adequate for the space ventures which could be undertaken in the period of this estimate.

Tracking and Communications

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

42. The Soviets have demonstrated a capability for tracking and transmitting data to lunar distances, but they were less successful with the deep space shot to Venus in 1961. To date, we do not know the degree of success they are experiencing with the Mars probe launched 1 November. Although they can probably overcome the communications difficulties experienced with the Venus probe, they have not yet tested a tracking system with the sophistication necessary for deep space exploration. Tracking stations in other hemispheres would be a major aid to mid-course guidance and to achieving better terminal accuracy. There is evidence that the USSR is seeking to acquire sites for space tracking stations in Chile, Indonesia, Africa, and Australia.

43. A major element in tracking, control, and communications is the provision of adequate power supplies for the space vehicles themselves. Soviet space vehicles have not demonstrated a capability for sustained communications over long periods of time. We believe, however, that this apparent weakness can be overcome. In addition to improvements likely in solar batteries and other power sources, the Soviets probably are developing nuclear-power sources for use in space vehicles. In the near future, they could have a reactor-type power supply with an output of several hundred watts. By 1964 output could be increased to 75 kilowatts, and by 1971, it could possibly be further increased by a factor of 10.

Data Processing

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

45. The Soviets will probably continue to seek increased computer reliability and speed of operation, and will seek to reduce size, weight, and power requirements. The Soviets have in operation at least one computer capable of 50,000 operations per second, and are probably developing computers capable of 100,000 operations per second. In the 1965–1970 period, the Soviets could probably have computers utilizing only solid-state devices capable of a million operations per second. In developing computers for space vehicles, they will probably achieve some success in micro-miniaturization.

Rendezvous, Docking, and Transfer

46. We believe that over the next few years the Soviets will conduct space experiments directed toward the development of rendezvous, docking, and transfer techniques. The recent launching of two satellites into similar orbits at the same time may have been a first step in this direction. Within about the next year, the Soviets could probably conduct rendezvous operations employing space vehicles having some maneuverability while in orbit. Docking operations, which might include an initial demonstration of the transfer of a man from one space vehicle to another, could probably be achieved shortly thereafter. In order to transfer men and materials in quantities sufficient for long-lived space stations, the Soviets would probably require considerable experience, heavy satellites, and a new large booster. Such a capability could probably be achieved in about 1965.

Life Support Systems

47. We believe that the Soviets now have a partially closed-cycle oxygen system which, with their current payload capability, would permit one-man orbital missions of up to 10 days. With modification of the Vostok vehicle, this system could support two men for a shorter period. Missions of over 90 days duration would require a reliable, fully closed-cycle ecological system, capable of supporting more than one man. Barring any unexpected breakthrough, we do not expect such a Soviet development before 1966. Attainment of a capability to orbit larger

payloads would ease some of the present constraints on the size and weight of life support systems, making possible the development of manned space stations. These could serve as orbital laboratories, for obtaining more knowledge of the space environment and for testing life support, navigation, communications, and operational techniques.

IV. FUTURE OBJECTIVES AND CAPABILITIES

48. It seems clear that the underlying motives of the Soviet leaders in planning their future space effort—as in planning for other types of national effort—are to enhance the security of the USSR and to increase its power and prestige, gaining advantages over the US where possible. In making decisions about the specific projects to be included in their future space program, the Soviet leaders will continue to be guided by such general considerations as: the political benefits that are likely to result from particular space accomplishments; the potential military value of the space projects which are considered, planned, or undertaken; and the technical and economic limitations that determine the range of their choices. We believe that these considerations, as well as the desire to achieve scientific gains, will incline the Soviets toward a much broader space program than in the past. Whether particular projects will be pursued, however, will depend on the Soviet view of their potential contribution to national power and prestige, weighed against the cost of accomplishing them.

49. Thus far, the space accomplishments which have yielded significant political benefits to the USSR have been achieved by exploiting the superiority in propulsion attained in the Soviet missile program. With existing technology and hardware, the Soviets could accomplish several additional feats which still lie beyond US capabilities. As more advanced space systems become available, the range of possibilities for novel space missions will widen. However, with the increasing complexity of future space operations, the accomplishment of spectacular "firsts" will become much more difficult. Their achievement and exploitation will continue to influence Soviet planning, but they will probably be increasingly conceived as parts of a long-range integrated program.

50. Our evidence as to the future course of the Soviet space program is very limited. Soviet propaganda dealing with future space activities has canvassed the whole range of possibilities. Our estimates are therefore based largely on extrapolation from past Soviet space activities and on judgments as to likely advances in Soviet technology. Considering the available evidence and Soviet capabilities, this program probably will include a variety of specific objectives. It probably will be characterized by an expansion of man-in-space activities and by the acquisition of basic scientific information needed for future space missions. Greater emphasis than heretofore will probably be

placed on military applications of space vehicles, both to meet specific Soviet requirements and to keep pace with military programs which the Soviets expect the US to undertake. Unmanned lunar exploration will probably soon be resumed, and interplanetary probes launched when favorable opportunities occur.

Manned Lunar Landing

51. Some Soviet statements indicate that a program for a manned lunar landing is under way in the USSR, but we have no confirmation that it is currently being pursued. In view of the limitations in our present intelligence collection capabilities, such a program could be well under way in the USSR without our knowledge. Most of the activity unique to a manned lunar program would to date have consisted of laboratory and ground development preparatory to the flight testing of major system components. However, if the Soviets are competing with the US, some flight testing clearly associated with a manned lunar landing should begin within the next few years. In our view, the minimum time between the first recognizable test flights and a manned lunar landing attempt would be about two years—this could occur if, in its first test flights, the booster were employed with the upper propulsion stages and the lunar landing craft.

52. The top Soviet leaders have not committed themselves publicly to competition with the US in achieving a manned lunar landing, and it is highly unlikely that they will do so. From their statements, we know that Khrushchev and other Soviet leaders are concerned about the great expense and risks involved in a manned lunar program. On the other hand, they almost certainly would expect Soviet prestige and influence to suffer if the USSR failed to engage the US in the race to the moon, or if its program lagged far behind. Moreover, later manned interplanetary operations would be facilitated by a successful manned lunar landing. We think these latter factors would lead the Soviet leadership to compete, unless the cost were considered prohibitive or the US seemed to have an insurmountable lead. On the basis of present evidence, we cannot say definitely at this time that the Soviets aim to achieve a manned lunar landing ahead of or in close competition with the US, but we believe the chances are better than even that this is a Soviet objective.

53. We cannot estimate with confidence the method which the Soviets would employ to accomplish this feat. However, we believe that they are more likely to dispatch the lunar vehicle from an orbiting earth or lunar satellite than to attempt a direct flight from the earth. Either approach will require major new vehicle development, facility construction, and supporting activities in many other fields. However, the method to be employed would probably not be apparent until late in the program.

54. An appearance of activities leading to a lunar landing should provide indications as to the progress of such a program. From 1962 on, manned satellites, including multimanned vehicles, would be orbited for the purpose of extending the capability of life support systems, developing radiation shielding, and conducting studies of weightlessness. Both manned and unmanned satellites would be used to develop advanced guidance equipment and new re-entry techniques for the higher speeds involved in a return flight from the moon. A considerable amount of unmanned lunar exploration would be required. The Soviets may attempt soft landings of instrumented packages on the moon at any time, and unmanned satellites could be placed in orbit around the moon or launched in a circumlunar flight. Assuming that we have correctly estimated the dates of availability of multimillion pound thrust boosters and advanced upper stages, the Soviets could accomplish the following: in about 1964–1965, they could probably land an unmanned mobile exploratory vehicle on the moon; a manned circumlunar flight could be achieved by 1965–1966; and a manned satellite could be placed in lunar orbit in about 1966–1967.

55. In addition to the space flights required for a lunar program, concurrent research and development would be required on propulsion, guidance, and supporting systems. A manned lunar landing vehicle as well as the chemical propulsion stages required to take off from the moon must also be developed. Finally, the expansion of ground support facilities will probably continue over the next several years. Given their ability to concentrate human and material resources on priority objectives, we estimate that with a strong national effort the Soviets could accomplish a manned lunar landing in the period 1967–1969.[7]

Man-in-Space

56. We believe that there will be a considerable increase in Soviet man-in-space activity. Within about the next year the Soviets will probably begin to employ manned satellites having some maneuverability while in orbit, to perform rendezvous, docking, and transfer operations. They will probably undertake manned flights of increasing duration, and could orbit a two-man Vostok capsule at any time. Moreover, it is technically feasible to put up a small manned space station or attempt a manned circumlunar flight by 1963–1964 using first-generation ICBM boosters and earth-orbit rendezvous techniques. If a military booster of about 1.5 million pounds thrust becomes available in the next year or so, this booster could be used to accomplish the same feats in a less complex manner. If a multimillion pound thrust space booster

[7] For a tabular summary of the accomplishments believed to be consistent with such an effort, see Table 2, pages 26–27. For other possible Soviet space missions, see Table 3, pages 27–28.

is being developed now, the Soviets could orbit a 50–100 ton manned space station in 1965–1966.

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

Scientific Satellites

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

Military Goals

59. On the basis of evidence presently available, we are unable to determine the existence of Soviet plans or programs for the military use of space. The limitations of this evidence, however, are such that our chances of identifying military programs are poor. We believe that the USSR almost certainly is investigating the feasibility of space systems for military support and offensive and defensive weapons. Moreover, it is possible that space exploration, which is totally new to human experience, will offer unforeseen opportunities for military application. Soviet decisions to develop military space systems will depend on their expected cost and effectiveness as compared with alter-

native systems, the political and military advantages which could be gained, and the Soviet estimate of US intentions and capabilities in comparable fields. We believe that the USSR will produce and deploy those military space systems which it finds to be feasible and advantageous in comparison with other types of weapons and military equipment.

60. *Military Support Systems.* We believe that the first Soviet military space vehicles are likely to be earth satellites used in various support roles. We do not believe that the Soviets have as yet launched geodetic, communications, or navigation satellites for military purposes. Since they have had the capability to accomplish some of these missions for some time and apparently have not done so, they probably have felt no pressing requirement in these fields. However, the Soviet views on requirements probably are now changing. The recovered satellites in the "Cosmos" series probably accomplished cloud photography, and could have performed photographic, electronic, and nuclear reconnaissance, at least experimentally. In addition, one "Cosmos" satellite launched from Kapustin Yar probably monitored the radiation from a Soviet nuclear test in space.

61. Soviet scientists and military experts almost certainly recognize that earth satellites have a greater potential than conventional techniques for some forms of reconnaissance, early warning (EW), weather surveillance, and communications. In view of the US ICBM threat, we believe that an EW satellite is probably a most pressing requirement in this field. The Soviets may also develop reconnaissance satellites. Although their intelligence on deployment of fixed US targets is probably adequate, such satellites could provide some useful information on certain mobile forces and could perform poststrike reconnaissance. Targeting requirements may also lead the Soviets to a geodetic space program. However, this would require improvements in tracking technology and the establishment of tracking facilities outside of the Soviet Bloc, particularly in the Southern Hemisphere. The Soviets may also develop navigation satellites to improve the effectiveness of their missile submarine forces, as well as communications satellites.

62. *Space Weapons.* There is no evidence that the Soviets are developing systems for space warfare, but they are almost certainly investigating the feasibility of such systems, and they are keeping a close watch on US developments in this field. Soviet military writings and public statements reflect a growing concern over a military threat from space, and imply that US developments cannot be safely ignored by the USSR. However, we do not believe that Soviet space technology has progressed sufficiently for the Soviets to have made the decision to proceed with large scale programs for offensive or defensive space weapons

63. *Offensive Weapon Systems.* The Soviets have the capability to develop an orbital bombardment satellite and might decide to launch and deorbit a space weapon at an early date for propaganda or political reasons. A demonstration of such a satellite could occur at any time, but we believe that in the near term its military effectiveness would be minimal.

64. Within this decade the basic factors of reaction time, targeting flexibility, accuracy, vulnerability, average life, and positive control for an orbital bombardment system almost certainly will not compare favorably with ICBMs. We believe that a Soviet decision to develop and deploy an orbital bombardment system would depend in large part upon the extent to which these drawbacks can be overcome. If the Soviets decide to develop an orbital bombardment force, it would be preceded by a developmental system of limited military effectiveness which could appear as early as 1965.

65. Statements by the aircraft designer Mikoyan indicate Soviet interest in a suborbital vehicle, termed a "Cosmoplane." Mikoyan has stated that boosters can easily be developed or adapted for launch purposes, that trajectories would be in the upper atmosphere at 50–100 n.m., and that the "Cosmoplane" would be a further development of supersonic aircraft. The military attractiveness of such a system stems from the recoverability of the vehicle and the many purposes to which it can be put. As compared with an orbital bombardment vehicle, it provides increased accuracy, positive control, and greater reliability. We have no evidence of research and development on this vehicle, but assuming that it is now under way, a prototype could be tested before 1970.

66. *Defensive Weapon Systems.* We believe that the USSR will develop a capability to counter reconnaissance satellites. Surface-launched nonorbiting missiles are the simplest approach to the neutralization problem, and the most likely to be used by the Soviets throughout this decade. By assembling a system using radar and passive tracking facilities, missiles, and warheads from existing defensive systems, they might be able to intercept US satellites now, and they would almost certainly have a capability to do so within the next year or so.

67. The Soviets may be developing orbiting systems for antisatellite employment. By 1964 the Soviets could use a rendezvous technique against a nonmaneuvering satellite for inspection. A more sophisticated system with an inspection, neutralization and damage assessment capability could be achieved later in the decade. A more complex system designed to use a single satellite against multiple targets for any purpose would take considerably longer to accomplish.

The Possibility of International Cooperation

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

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

V. PROBABLE MAGNITUDE OF THE SOVIET EFFORT

Implied Costs of the Program to Date

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

71. We have no Soviet data on the cost of their space program. In view of the differences in technology and operational philosophy, it is difficult to estimate an equivalent dollar cost even for the part of the Soviet program which is clearly visible and uniquely space-related, i.e., the vehicles and payloads actually launched. A figure of $700 million to $1 billion is probably a reasonable minimum (produced-in-the-US) cost for the vehicles and payloads launched as of mid-1962. Other costs, such as research and development, provision of supporting facilities and equipment, and astronaut training, cannot be estimated in detail, but we believe that their addition would result in a total expenditure on the order of at least $1.5 billion. If the Soviets have a manned lunar landing program which has reached a stage somewhat comparable to the US program, we estimate that it would have required by mid-1962

an additional expenditure on the order of $1.5 billion. This would include the cost to date of developing a multimillion pound booster for flight test in 1964, high energy upper stages, lunar reconnaissance systems, advanced manned spacecraft, and associated technology and facilities.

Implied Costs of the Future Program

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

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

74. In light of these considerations, we believe that the Soviets will seek to limit the costs of their space program, and yet accomplish the major objectives they consider to be of greatest national importance. We think that for the next decade these objectives are likely to include increased man-in-space activity, some military support systems, scientific satellites, interplanetary probes, and lunar exploration. Specific major developments which could occur within the period of the estimate are manned space stations in earth orbits and manned lunar landings. In addition, demonstrations of developmental space weapon systems may occur. The cost of such an effort, while very large, would likely fall towards the low side of the annual range of $4–$6 billion.

TABLE 1

SOVIET SPACE VEHICLES
(Current as of 5 December 1962)

	LAUNCH DATE	PAYLOAD WEIGHT (lb.)	PERIGEE (nm)	APOGEE (nm)	ORBITAL PERIOD (min.)	REMARKS
Sputnik I	4 October 1957	184	123	512	96.2	Decayed 4 January 1958 [a]
Sputnik II	3 November 1957	1,120	121	902	103.7	Decayed 14 April 1958
Sputnik III	15 May 1958	2,925	122	1,016	106	Decayed 6 April 1960
Lunik I	2 January 1959	797	....	....	....	Lunar probe—now in solar orbit
Lunik II	12 September 1959	858	....	....	....	Lunar impact—13 September 1959
Lunik III	4 October 1959	959	....	....	....	Circumlunar flight—decayed about April 1960
Sputnik IV	15 May 1960	10,008	168	200	91.2	Decayed 5 September 1962
Sputnik V	19 August 1960	10,120	165	183	90.7	Recovered 20 August 1960
Sputnik VI	1 December 1960	10,060	101	143	88.6	Destroyed on re-entry 2 December 1960
Sputnik VII (Venik I)	4 February 1961	14,295	120	177	89.8	Failed to launch Venus probe—Decayed 26 February 1961
Sputnik VIII (Venik II)	12 February 1961	14,295	120	151	89.5	Launched probe toward Venus
Sputnik IX	9 March 1961	10,364	99	134	88.6	Recovered 9 March 1961
Sputnik X	25 March 1961	10,352	96	133	88.42	Recovered 25 March 1961
Sputnik XI (Vostok I)	12 April 1961	10,418	98	177	89.34	Recovered 12 April 1961
Sputnik XII (Vostok II)	6 August 1961	10,431	96	139	88.46	Recovered 7 August 1961
Sputnik XIII (Cosmos I)	16 March 1962	3,000–4,000 [b]	117	529	96.35	Decayed 25 May 1962
Sputnik XIV (Cosmos II)	6 April 1962	3,000–4,000	115	842	102.5	Now in earth orbit
Sputnik XV (Cosmos III)	24 April 1962	3,000–4,000	124	389	93.8	Now in earth orbit
Sputnik XVI (Cosmos IV) [c]	26 April 1962	10,000	161	178	90.6	Recovered 29 April 1962
Sputnik XVII (Cosmos V)	28 May 1962	3,000–4,000	110	864	102.75	Now in earth orbit
Sputnik XVIII (Cosmos VI)	30 June 1962	3,000–4,000	148	194	90.6	Decayed 8 September 1962
Sputnik XIX (Cosmos VII) [c]	28 July 1962	10,000	130	229	89.9	Recovered 1 August 1962
Sputnik XX (Vostok III)	11 August 1962	10,000	97.3	129.4	88.2	Recovered 15 August 1962
Sputnik XXI (Vostok IV)	12 August 1962	10,000	95.5	128.3	88.2	Recovered 15 August 1962
Sputnik XXII (Cosmos VIII)	18 August 1962	3,000–4,000	138.2	326.2	92.9	Now in earth orbit
Sputnik XXIII (Venik III)	25 August 1962	About 14,000	110.2	152.0	89	Venus probe failure
Sputnik XXIV (Venik IV)	1 September 1962	About 14,000	107.6	128.8	88.5	Venus probe failure
Sputnik XXV (Venik V)	12 September 1962	About 14,000	105.9	117.6	88.3	Venus probe failure
Sputnik XXVI (Cosmos IX) [c]	27 September 1962	10,000	164	199	91	Recovered 1 October 1962
Sputnik XXVII (Cosmos X) [c]	17 October 1962	10,000	119	215	90.2	Recovered 21 October 1962
Sputnik XXVIII (Cosmos XI)	20 October 1962	3,000–4,000	132	497	96.1	Now in earth orbit
Sputnik XXIX	24 October 1962	About 14,000	106	125	88.5	Mars probe failure
Sputnik XXX (Mars I)	1 November 1962	About 14,000	87.5	112	88.3	Launched probe toward Mars
Sputnik XXXI	4 November 1962	About 14,000	102	127	88.5	Mars probe failure

[a] Dates refer to decay of payload.

[b] Soviets have not announced payload weights of "Cosmos" series satellites. Payload weights for this series are estimated.

[c] Launched from Tyuratam. All other "Cosmos" satellites have been launched from Kapustin Yar.

TABLE 2

POSSIBLE CHRONOLOGY OF A SOVIET LUNAR PROGRAM

We have estimated the chances as better than even that the Soviets will attempt to achieve a manned lunar landing ahead of or in close competition with the US, and we believe that with a strong national effort they could accomplish this feat in 1967–1969. The following table estimates approximate dates for specific accomplishments required for Soviet achievement of a manned lunar landing in 1967, which we regard as the earliest possible date. All of the dates estimated except those for astrophysical studies are predicated on the development and use of equipment specifically designed for the manned lunar landing mission.

	1962	1963	1964	1965	1966	1967
Astrophysical Studies						
Systematic radiation and meteoritic studies[a]	x					
Systematic lunar exploration[a]	x					
Flight Test of Propulsion Systems						
Large single engine (500,000 pounds thrust or better)[b]		x				
Large booster (cluster of single engines)			x			
High energy upper stage			x			
Development of propulsion for:						
change of trajectory				x		
earth landing retrosystem				x		
lunar landing retrosystem and takeoff					x	
Flight Test of Lunar Spacecraft in Earth Orbit			x			
Establishment of Long-Range Tracking System			x			
Rendezvous, Docking, and Transfer (Using Large Clustered Booster)						
Synchronous launch			x			
Rendezvous of vehicles			x			
Docking and transfer of men and equipment				x		
Flight Test of Guidance						
Ejection guidance			x			
Mid-course, terminal, and re-entry guidance				x		
Earth Re-entry At Lunar Return Speed				x		

	1962	1963	1964	1965	1966	1967
Final Preparatory Phase						
Manned circumlunar [c]				x	x	
Manned lunar satellite [c]					x	x
Manned Flight to Moon, Landing, and Return						x

[a] There is evidence of limited activities in these fields. Lunar exploration would include unmanned soft landings, unmanned circumlunar flights, and unmanned lunar satellites.

[b] There is some evidence suggesting static testing in 1961.

[c] These missions are not believed to be essential to accomplish a manned lunar landing, but might be undertaken as system tests or to achieve significant "firsts."

TABLE 3

OTHER POSSIBLE SOVIET SPACE MISSIONS

We have estimated that the chances are better than even that the Soviets will attempt a manned lunar landing ahead of or in close competition with the US. In addition, the Soviets will probably undertake other programs including scientific satellites, military support satellites, and interplanetary probes. This table lists space missions estimated to be within Soviet capabilities, but we do not believe that all these missions could be accomplished within the time periods indicated. If the Soviets are not committed to a lunar race with the US, other programs will probably receive greater emphasis.

PROGRAMS	POSSIBLE DATE
UNMANNED SATELLITES	
Space Science Operations [a]	
(1) Magnetic measurement	1962 on
(2) Radiation measurement	
(3) Study of electromagnetic propagation	
(4) Study of upper atmosphere	
(5) Study of meteorites	
(6) Orbital astronomical observatory	
Military Systems	
(1) Early warning satellite	1962 on
(2) Reconnaissance satellite	1962 on
(3) Defensive space weapons systems [b]	
(i) Inspection of single nonmaneuvering satellite	1964
(ii) More sophisticated satellite with inspection, neutralization, and damage assessment capability	Later in decade
(4) Offensive space weapons systems	
(i) Demonstration of orbital bombardment satellite [c]	1962 on
(ii) Developmental system of limited effectiveness	1965

PROGRAMS	POSSIBLE DATE
UNMANNED SATELLITES (*Continued*)	
Commercial or Military Application	
(1) Meteorological satellites	1962–1963
(2) Communications satellites	
(3) Geodetic satellites	
(4) Navigation satellites	
MAN–IN–SPACE	
Manned Earth Orbital Flights	
(1) Orbit of multimanned spacecraft	1962–1963
(2) Rendezvous and docking	1962–1963
(3) Demonstration of 10-day life support system	1962–1963
(4) Transfer of man from one space vehicle to another	1963–1964
Large Manned Space Station	1965–1966 [d]
Manned Lunar Flights	
(1) Circumlunar	1965–1966 [d]
(2) Lunar satellite	1966–1967
UNMANNED LUNAR AND PLANETARY EXPLORATION	
Circumlunar, Lunar Satellite, Lunar Soft Landing	1962 on
Probes to Mars and Venus	1962 on
Probes to More Distant Planets	1963 [e]
Solar Probe	1963
Ejection of Vehicle from Solar System	1963 [e]

[a] Collection of data is also performed by manned satellites.

[b] In this decade, the Soviets are most likely to use surface-launched missiles to neutralize enemy satellites. However, orbiting systems may be developed for inspection, damage assessment, and neutralization.

[c] Demonstration for propaganda or political reasons could occur at any time, but military effectiveness would be minimal.

[d] These estimates are based on the availability of a multimillion pound space booster. If the USSR uses a first-generation ICBM booster or if a military booster of about one and a half million pounds should become available in the next year or so, a small manned space station or a manned circumlunar flight could be achieved in 1963–1964.

[e] With present propulsion systems, payloads could not include necessary communications systems. These events are more likely to occur when more powerful boosters and upper stages become available, possibly in the next year or so.

Figure 1

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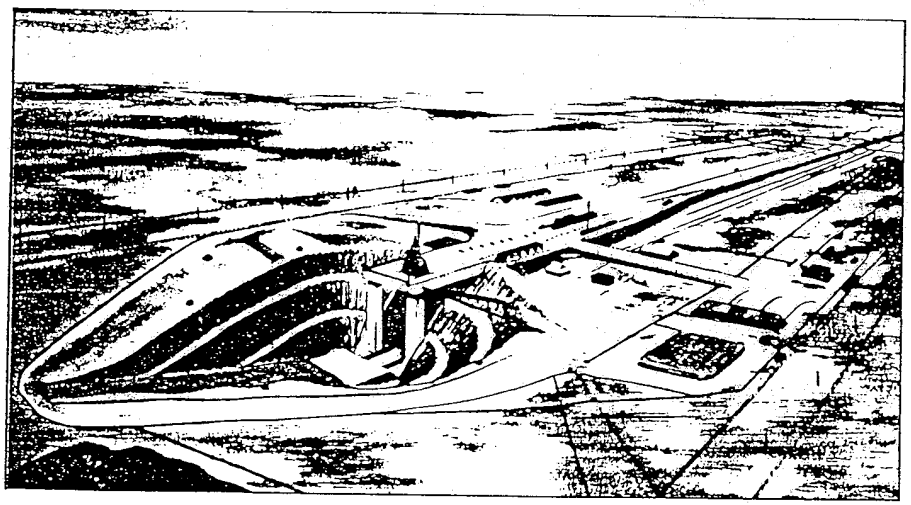
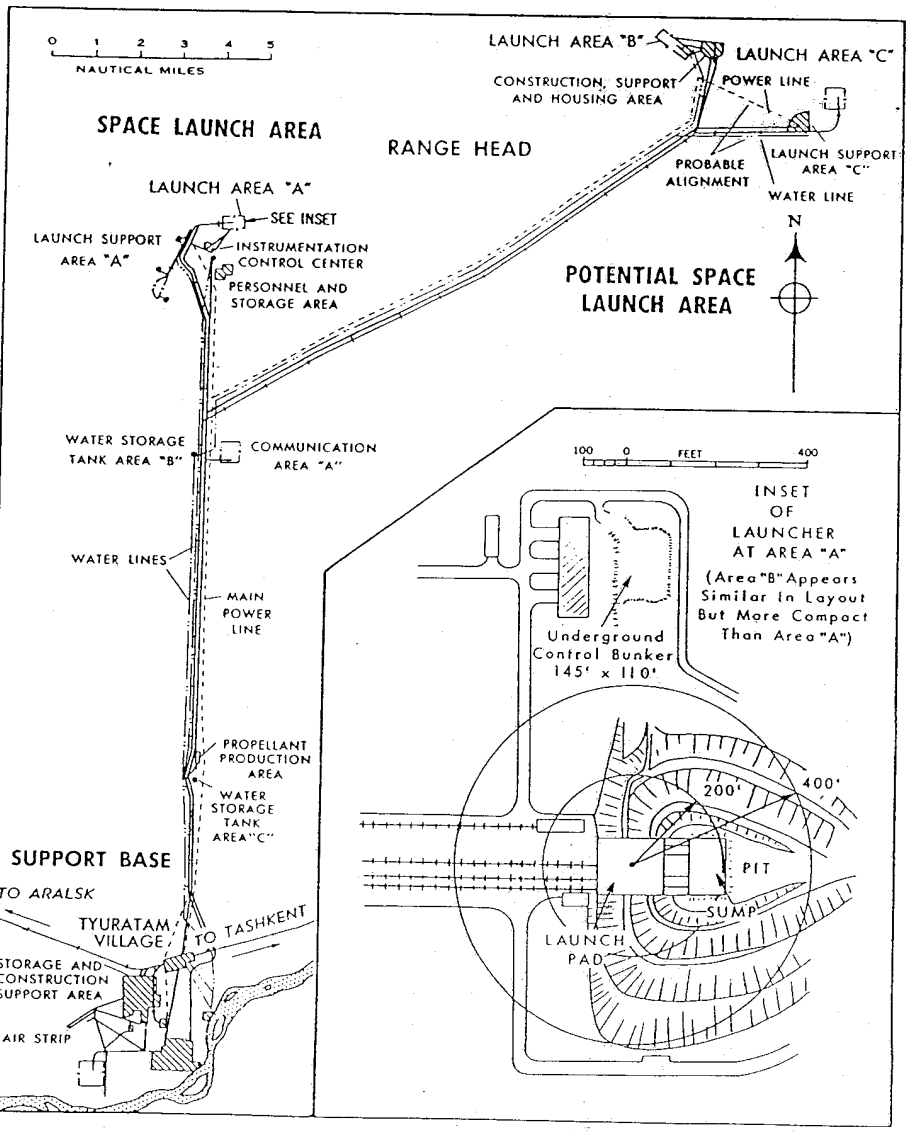
SPACE LAUNCH FACILITIES
TYURATAM MISSILE TEST RANGE





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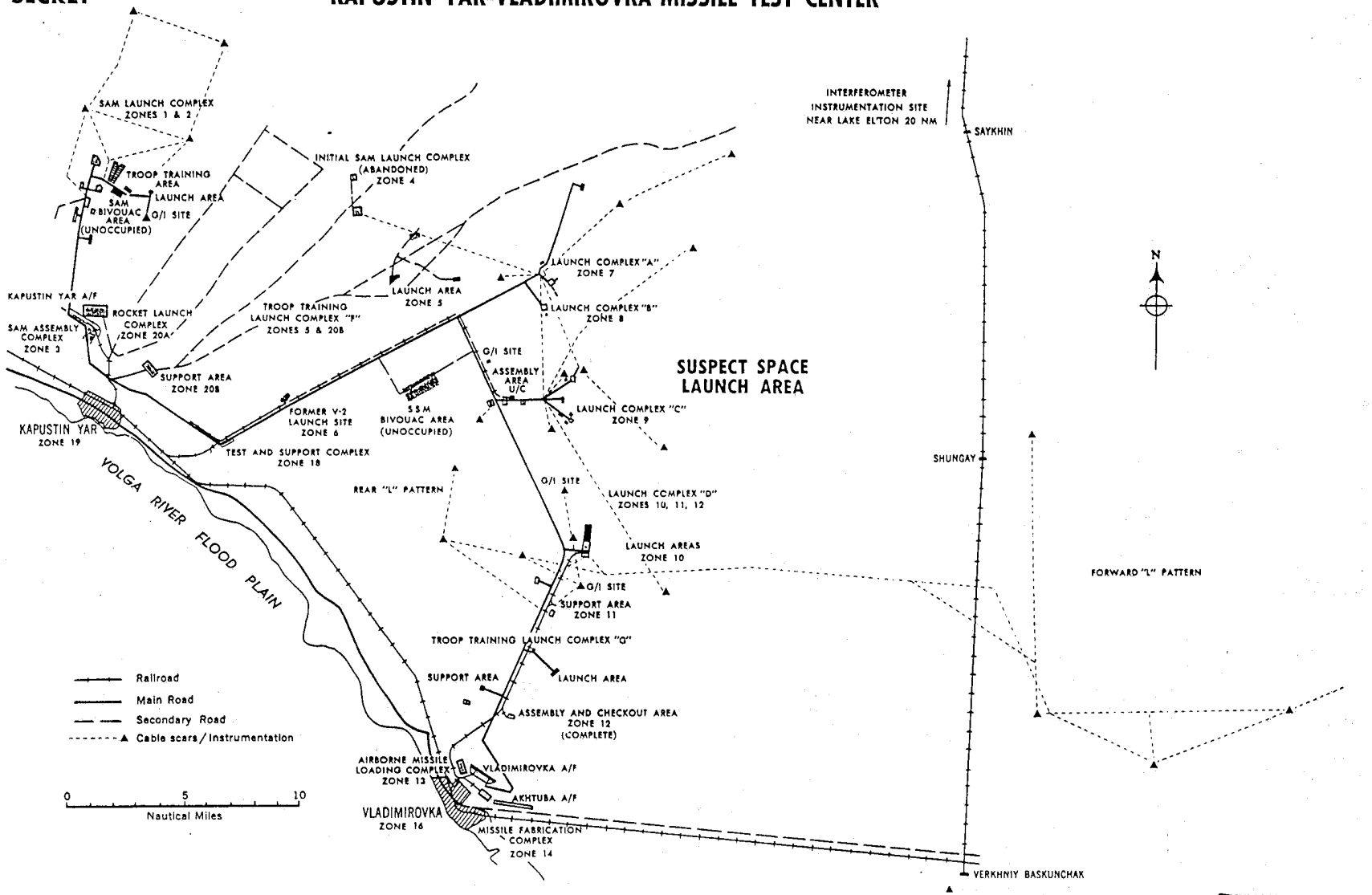
SUSPECT SPACE LAUNCH FACILITIES
KAPUSTIN YAR-VLADIMIROVKA MISSILE TEST CENTER

~~SECRET~~



~~SECRET~~

~~DOWNGRADING PROHIBITED~~

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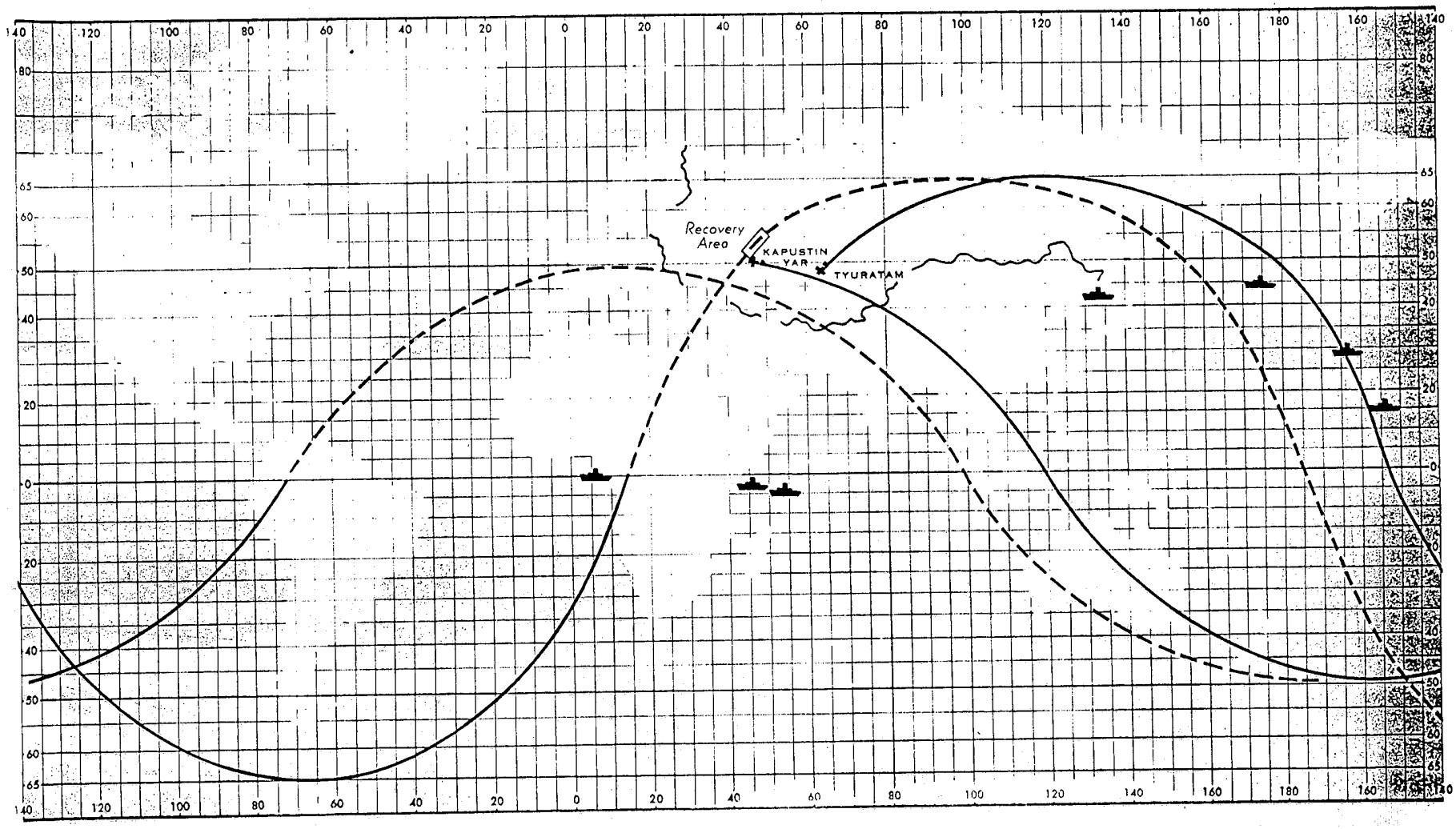
GROUP 1

Figure 2

~~SECRET~~

TYPICAL ORBITAL PATHS OF SOVIET EARTH SATELLITES



From TYURATAM — Zero Orbit
From TYURATAM - - - First Orbit

From KAPUSTIN YAR — Zero Orbit
From KAPUSTIN YAR - - - First Orbit

Typical positions of Instrumented Ships

36732 10-62

~~SECRET~~

GROUP 1
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Figure 3

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