[redacted]

TOP SECRET
Controlled Dissem

NATIONAL INTELLIGENCE ESTIMATE

The Soviet Space Program

ACCOUNTABLE DOCUMENT
RETURN TO O/DDI REGISTRY,
Rm 7E-47 Hqs.

TOP SECRET
NIE 11-1-71
1 July 1971
TCS-2032-71

№ 140

THIS ESTIMATE IS SUBMITTED BY THE DIRECTOR OF CENTRAL INTELLIGENCE AND CONCURRED IN BY THE UNITED STATES INTELLIGENCE BOARD.

The following intelligence organizations participated in the preparation of the estimate:

The Central Intelligence Agency and the intelligence organizations of the Departments of State and Defense, and the NSA.

Concurring:

The Deputy Director of Central Intelligence

The Director of Intelligence and Research, Department of State

The Director, Defense Intelligence Agency

The Director, National Security Agency

The Assistant General Manager, Atomic Energy Commission

Abstaining:

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

GROUP 1
Excluded from automatic downgrading and declassification

NIE 11-1-71

THE SOVIET SPACE PROGRAM

BLANK PAGE

CONTENTS

	Page
THE PROBLEM	1
SUMMARY OF KEY JUDGMENTS	1
DISCUSSION	5
I. SOVIET SPACE ACTIVITY DURING THE PAST TWO YEARS	5
II. POLITICAL AND ECONOMIC FACTORS AFFECTING FUTURE PROSPECTS	6
A. General	6
B. Organization and Management	6
C. Economics	8
III. SCIENTIFIC AND TECHNICAL FACTORS	9
A. General	9
B. Launch Vehicles	9
C. High-Energy Propellants	11
D. Manned Spacecraft	12
E. Life Support Systems	15
F. Non-Nuclear Power Sources for Spacecraft	16
G. Nuclear Power and Propulsion	16

	Page
H. Communications Systems for Space Operations	16
I. Command and Control for Space Operations	17
IV. FUTURE PROSPECTS	18
A. General	18
B. Manned Space Station	19
C. Planetary Exploration	19
D. Unmanned Lunar Exploration	21
E. Manned Lunar Landing	21
F. Applied Satellites	22
G. Scientific Satellites	24
V. INTERNATIONAL SPACE COOPERATION	24
A. USSR-European Nations	24
B. USSR-United States	25

ANNEX A. SOVIET SPACE ACTIVITY

ANNEX B. SOVIET SPACE LAUNCH VEHICLES

ANNEX C. SOVIET CHRONOLOGICAL SPACE LOG FOR THE PERIOD 24 June 1969 Through 27 June 1971

THE SOVIET SPACE PROGRAM

THE PROBLEM

To estimate Soviet capabilities and probable accomplishments in space over the next 5 to 10 years.[1]

SUMMARY OF KEY JUDGMENTS

A. The Soviet space program continues to rank high among national efforts and to be relied on as a principal instrument for projecting the image of the USSR as a leading technological power. While the highly successful US Apollo program blunted the international impact of their achievements in space over the past two years, the Soviets doggedly continue to propagandize their space ventures in an effort to improve their image. And they have achieved some noteworthy "firsts" during the period, one being their unmanned lunar vehicle, Lunokhod 1, which has been traversing the Sea of Rains area and transmitting data back to earth, and another being the Salyut/Soyuz manned space station operation.

B. We judge that Soviet expenditures on their space program peaked out about two years ago and, barring some unforeseen development, are unlikely to exceed $7 billion[2] per year for the next several years. This leveling off is due for the most part to the nearing of com-

[1] In this estimate we do not discuss those Soviet space programs which are assessed as directly related to weapon system development. Those are addressed in the 11-8 and 11-3 series of NIEs.

[2] The dollar value is an estimate of what the program would cost if conducted in the US.

pletion of two major launch vehicle development programs, and construction of their associated facilities, which have been underway for several years. These are the large SL-12 launch vehicle which was used recently to orbit the 40,000 pound Salyut craft, and the very large booster which we refer to as the "J-vehicle" which will, among other ventures, probably be used to place men on the moon. There are shortcomings in both of these programs, however—the SL-12 record of success has not been impressive, the "J-vehicle" has failed both times attempts were made to launch it, and the Salyut/Soyuz 11 mission ended in the death of three cosmonauts. To correct the problems encountered in these programs may require the diversion of resources from some other segments of the overall program. This, in turn, would result in a slowdown in some of the less important programs.

C. There is a growing body of evidence of budgetary pressures on the Soviet space program and disenchantment with the large sums being spent on that program. Further, the political leadership may in the wake of recent failures, especially that involving the death of three cosmonauts, be shaken in the confidence it extends to those managing the space program, and be disposed to delay new activities unless more solid guarantees of success are provided. At the same time, the Soviet leaders surely feel compelled to restore to their space program some of the prestige they enjoyed earlier. Thus, we judge that Soviet efforts in space over the coming years will have to be justified on the basis of either, or both, of two criteria: 1) are there demonstrable economic or military benefits to be derived; or, 2) can the venture be exploited to capture international imagination. At the same time, the technical feasibility of certain ventures must surely be questioned in light of the SL-12, "J-vehicle", and Salyut/Soyuz performance histories. We believe that the future of the Soviet space program is being reviewed by Soviet leaders with these factors in mind.

D. Early in their program the Soviets exploited launch vehicles which were developed originally as boosters for ballistic weapons systems. With these rugged, powerful, and reliable vehicles they were able to achieve a series of "firsts" with payloads that did not require a high degree of sophistication in their development. They have followed this course about as far as they can go and must now advance their technology to a higher level if they are to carry out the complicated missions they appear to be considering. This may not come easily. The poor success rate they have experienced over the last two years in missions using new launch vehicles and spacecraft systems suggests that the Soviets are pushing their present technology to its limit. Their awareness of shortcomings in their technology may account for their refusal to announce the purpose of any payload prior to its launch and their insistence that a particular payload in orbit is performing as expected even though we are well aware that it is not. Furthermore, the Soviet space program is so widely compartmented in its organization and lacking of any apparent centralized direction that those factors by themselves surely act as a bottleneck to significant and rapid technological advance. Nevertheless, we believe that the Soviets will press forward in space matters, using advanced technology when it is available or resorting to the "brute force" approach when it is not.

E. Up until recently, efforts by the US to induce the Soviets to cooperate in the exchange of space data or to participate in joint programs have met with limited success. Recently, however, some warming has been noted in the Soviet attitude and in the future they may become more cooperative. In doing so, they will likely seek to get the US to contribute in those areas where they feel they can gain some insight into US technology and management techniques that will work to their advantage without their having to admit to any shortcomings on their part.

F. Looking to the future, we estimate that one of the ventures of major importance that the Soviets will undertake will be the establishment of a long term, multimanned space station. We expect them to make steady progress in this program throughout the period. The recent Salyut/Soyuz operation may have been intended as a major step in this direction. The deaths of the cosmonauts on Soyuz 11, however, will have a serious effect on this program and a prolonged standdown may ensue. The emphasis on planetary exploration apparent since early in the program will continue and more sophisticated and venturesome missions will be launched to Venus and Mars. We also expect them to carry out a very ambitious unmanned lunar exploration program. As attractive as a "grand tour" [3] of the planets may be during the optimum period that will exist for such a mission in 1976-1979, we think it unlikely that Soviet technology will have advanced far

[3] A "grand tour" involves a fly-by of Jupiter, Saturn, Uranus, and Neptune by one spacecraft.

enough by that time for such a mission to have an acceptable chance of being successful.

G. In spite of the fact that a manned lunar landing mission would be anticlimactic in light of the US Apollo program, it is believed that such a mission remains on the books but that it has been delayed. It is unlikely that such a mission will be attempted before 1975-1976. When it is undertaken, it may be the precursor of a program aimed at the establishment of a manned lunar base, which we believe is one of the long-term goals of the Soviet program. Prior to the manned lunar landing, the Soviets will continue to use a variety of unmanned vehicles to explore the moon's surface and report or deliver data back to earth.

H. Throughout the period the emphasis now given to military-related photographic and electronic reconnaissance payloads will almost certainly continue. The Soviets obviously attach great importance to these systems. And they will almost certainly deploy a satellite navigation system for naval use. More advanced communications and meteorological payloads, capable of serving both military and civilian consumers, will be orbited and we expect that much attention will be given to the survey of earth resources by satellite means. This latter program is one wherein the benefits to the economy can be clearly demonstrated.

DISCUSSION

I. SOVIET SPACE ACTIVITY DURING THE PAST TWO YEARS

1. During the past 2 years the Soviet space program has retained the high priority among major national objectives that it has enjoyed since its initiation. The steady annual increase in the number of launches noted over past years continued during 1970 and into 1971. There was a total of 85 launches during 1970 compared to 82 in 1969 and 71 in 1968; thus far in 1971 there have been 43. The 173 launches that have occurred since NIE 11-1-69: "The Soviet Space Program", dated 19 June 1969, TOP SECRET, ALL SOURCE, was issued, can be grouped into the following general categories: Launches having a direct or indirect military application (categories 1, 2, and part of 6) continued to constitute a substantial majority of the launches over the past two years and the capability to perform military-related missions was considerably improved.

Category	Number of Launches
1. Reconnaissance (photographic and ELINT)	69
2. Applied (communications, navigation, and meteorological)	25
3. Manned flights (earth orbit)	7 (includes Salyut)
4. Scientific (earth orbit only)	12
5. Lunar and planetary probes	14
6. Offensive, defensive, possible radar calibration	39
7. Unknown	7

2. Some events can be classified as "firsts" of the type that capture world-wide interest: the Soviets landed an unmanned spacecraft on the moon, took a soil sample, and returned it to earth; they landed a lunar rover vehicle, Lunokhod-1, that has been transmitting data during lunar days; one of their spacecraft made the first and only transmission of data from the surface of another planet, Venus; and they orbited the first manned space station, the Salyut/Soyuz operation, which, even though it ended in the death of the cosmonauts, established a new record for the length of a manned orbital flight (over 23 days). The latter almost certainly was intended as a major step in the development of a truly long duration manned station. Though the Soviets have concentrated their public relations efforts on these events in attempting to improve their image in space matters, the overall international impact of these events has been diluted by US achievements during the same period.[4]

[4] See Annex A for a detailed discussion of Soviet space launches over the past two years.

II. POLITICAL AND ECONOMIC FACTORS AFFECTING FUTURE PROSPECTS

A. General

3. In deciding the future of their space program, Soviet leaders face a situation unlike any other since their program began. Up until the successful Apollo 11 moon mission in the summer of 1969 the Soviets had enjoyed a high degree of world prestige that stemmed directly from their series of successful space ventures. Since that event, however, Soviet accomplishments in space have not been accorded the esteem throughout the world that was the case earlier. This situation must be irritating the Soviet leadership and they probably are determined to alter it.

4. There is little doubt that the Soviets intend to continue a broad-based effort in space. Soviet leaders, including Brezhnev and the President of the Academy of Sciences, Keldysh, have repeatedly stressed the importance of their space program from both an economic and a scientific standpoint. The directives for the 1971-1975 five-year plan, published in April of this year, revealed no new space program but did reaffirm Soviet commitments in several areas of space activity. The directives call for:

> "the pursuance of scientific work in space so as to develop long-distance telephone and telegraph lines, television, meteorological forecasting, study of natural resources, geographical research, and the solution of other economic tasks with the use of satellites, automatic and manned devices, and the continuation of fundamental scientific research on the moon and planets of the solar system."

As in the past, no reference was made to military space programs, as such.

5. On the other hand, implications of budgetary pressures on the Soviet space program continue to appear. Further, there are signs of disenchantment on the part of a large segment of the Soviet populace with the sums being spent on space activities at the expense of consumer goods. This sentiment probably is growing. Several Soviet articles published during the past year seem to be defensive reactions to criticism of the space program. These articles try to assuage the complainants by stressing the practical economic benefits of space activities—particularly of surveying earth resources—and emphasizing the comparatively low cost of the Soviet unmanned lunar exploration program when compared to the US Apollo program.

6. Thus, Soviet leaders probably see a need to align their space program in the future so as to enhance national prestige and to give more emphasis to the economic value of the program. At the same time, they will continue to emphasize those military related space programs which they feel are essential to their security. In doing so, however, they probably realize that they cannot effect any basic changes in the overall nature of the program for the next few years but may be able to effect some realignment in the priorities assigned to various missions over the longer run. The number and types of missions that the Soviets will undertake in the near term will probably be limited as much by authorized priorities as by technical constraints.

B. Organization and Management

7. Due to the secrecy surrounding these programs, including the Soviets' wish to hide military space activity, we have limited knowledge about the precise structure of the USSR's organization of its overall space program and its management. So far as we have been able to determine, there is no single organizational entity that is totally in charge of the space effort and, for that matter, there is no single entity that is totally in charge

of any one specific program. We have identified, however, several organizations and individuals which play significant roles in one or more aspects of the overall program. Reflecting the nature of Soviet society, these entities and persons are situated throughout the upper echelons of the Communist Party, the national government, civilian industry, the Ministry of Defense, and the scientific community. Examples of this diversity and separation include the Politburo, Party Secretary D. F. Ustinov, the Military-Industrial Commission, the Ministry of General Machine Building (MOM), the Strategic Rocket Forces,[5] and the Academy of Sciences. These organizational features appear to reflect a separation in mission planning; hardware specification, design, production, and use; command and control; and postflight evaluation and adjustment.

8. The MOM was created in 1965 and was given the industrial controlling authority for space and missile production and almost all research and development (R&D) connected therewith. The MOM currently operates or oversees the principal design bureaus and production plants, and we believe that one of the primary objectives behind the establishment of the MOM was to upgrade industrial performance—for the space program—in terms of timeliness and adherence to specifications. Over the past six years the MOM probably has accomplished much of the desired upgrading, but long-standing problems in supply and management still exist and show no likelihood of disappearing completely. We attribute these difficulties in part both to the organization of the space effort, as well as to its management, and we suspect that this basic type of problem is repeated in other portions of the overall program outside the MOM.

9. The culmination of this type of problem is clear in the catastrophic performance record of the SL-12 launch vehicle, in the failure of the "J-vehicle" both times launches were attempted, and to some extent in the photoreconnaissance program. The SL-12—the first truly complicated space launch vehicle the USSR has employed—experienced an unprecedented series of failures between late 1967 and early 1970 (see paragraph 18). The random nature of these failures also is clear; they could not be attributed to any obvious or easily remediable cause, or to any one component of the system. They appeared to result from shortcomings in quality control during production and in test and checkout procedures, although we cannot eliminate faulty design as a cause.

10. We judge that if the MOM (and possibly other improvements in Soviet space organization and management since 1965) had not existed between 1968 and 1970, the problems with the SL-12 might have been worse and might have taken longer to correct. Similarly, the first failure of the "J-vehicle"—an

[redacted]

extremely complicated booster—occurred in the same time period. We do not know what caused it to explode. Furthermore, although it has been nine years since the photoreconnaissance program began, many of these spacecraft still experience various subsystem failures which almost certainly reduce payload performance significantly. We believe that these problems in the SL-12, in the "J-vehicle", and in the photoreconnaissance program imply serious organizational and managment difficulties.

11. Even though the SL-12 now appears to work properly most of the time, we doubt that these difficulties have been resolved completely. We have no evidence of any recent major changes in the organizational and personnel structure of the space program and we judge that in the near term, despite the apparent shortcomings, the USSR will keep its space effort organized and managed in about the same manner as in the past few years. Our limited knowledge precludes a meaningful assessment as to whether or not the present organization and management structure is adequate, to build, operate, and evaluate the more complicated spacecraft that will be required for the missions we believe they are considering for the future. Should it prove to be inadequate, it almost certainly will be a limiting factor in the USSR's space program.

C. Economics

12. Soviet expenditures for space rose rapidly from an estimated 180 million rubles ($360 million) [6] in 1959 to an estimated high of about 3.5 billion rubles ($7 billion) in 1969, although the increase between 1965 and 1969 was not as rapid as it was in earlier years.

[6] The dollar values are estimates of what the Soviet space program would cost if conducted in the US. If the official rate of change—.91R: $1.00—were used, it would understate considerably the magnitude of the Soviet space effort expressed in dollars.

13. Based on a cost analysis of the hardware used in the various programs which the Soviets have already initiated as well as those they are likely to pursue in the near future, and taking account of the pressures to reduce the spending on space, we estimate that the Soviets are unlikely to exceed the current annual level of spending of 3.5 billion rubles over the next few years. We think it equally unlikely, however, that expenditures will drop significantly during the same period in view of the nature of the present and oncoming programs which will probably keep the number of launches required at about the level established over the past few years. Total space spending tends to vary in proportion to the number of launches involved but the correlation is not exact. For example, there was a slight increase in launches in 1970 over 1969 but launch costs decreased slightly because fewer large, expensive vehicles were used.

14. Costs associated with the launch of a space vehicle can be estimated with a fair degree of confidence but costs of R&D of new systems are more difficult to assess. [redacted] Based on US analogy, however, R&D probably accounts for a significant part of Soviet expenditures for space.

15. We believe that the Soviet space program is entering a period of a smaller development effort than has been underway for about the past 5 years. The SL-12, after a lengthy period of failures, now appears to be more reliable and should not require further funds for its development. The "J-vehicle" and its associated facilities have been under development for so long that that program must be considered as having passed the three-quarter mark in funding—unless, of course, the "J-vehicle" experiences an extended period of several years of flight test failures, as did the

SL-12. Consequently, expenditures on the order required to develop those two vehicles—about 400 million rubles ($800 million) annually during 1965-1970—may be released for other space purposes, e.g., more advanced payloads. This situation would allow for either an increase in launch operations without an increase in spending, or a slight decrease in spending if launch activity remains at about the present level. We do not expect the Soviets to undertake another similar program for development of a new space booster. We are unable to make a confident prediction of expenditures after about 1975 [ ]

III. SCIENTIFIC AND TECHNICAL FACTORS

A. General

16. As in the past, the Soviet space program continues to rely heavily on boosters that were developed initially for weapon systems. These launch vehicles have proven useful for a variety of space ventures, principally because of their rugged nature and their reliability. Early in the program, these boosters allowed the Soviets to orbit payloads which were heavy by standards of those days. This capability helped the Soviets to achieve a number of "firsts" with a series of payloads that did not require pushing the state-of-the-art in the development of components and subsystems that were simultaneously small, lightweight, and highly reliable. By now, however, the Soviets have about exploited this engineering philosophy to the limits of its utility. If they intend to press forward in space exploration, as we think they do, many missions will require far more sophistication in the hardware elements of the program than has been required to date.

B. Launch Vehicles

17. The space launch vehicles which have been developed from missile systems and used in the Soviet space program in the past are discussed in Annex B. In this part of the paper we will discuss only the two launch vehicles which have been built in the past decade exclusively for the space program—the SL-12 and the "J-vehicle". Both of these systems are quite large and complex, and could be used in a variety of missions, but both have experienced serious developmental problems.

18. *SL-12*. The SL-12 has failed in 14 of 27 launch attempts. The failures were not restricted to any one stage or component of the system. Seven of the last nine launches of the SL-12 have been successful, suggesting that the problems are nearing solution. Considering the cost of the vehicle and the number of tests involved, the SL-12 program has been very costly.[7]

19. With its estimated lift-off weight of about 1.8 million pounds, the SL-12 is the largest booster the Soviets have used. Conventional propellants are used in all stages of the vehicle. It has been used in a three-stage version to place the 37,000 pound "Proton 4" scientific satellite into a low-earth orbit and to orbit the 40,000 pound Salyut craft. In a four-stage configuration, it has placed about 45,000 pounds in a low-earth orbit. The fourth-stage engine has demonstrated a restart capability that has enabled the Soviets to put about 14,000 pounds on a trajectory to the moon. This capability will also allow them to put 6,000 pounds into a synchronous orbit.[8] Based on recent successes, we judge that the SL-12 is now ready for use in a variety of unmanned space ventures.

20. *"J-Vehicle"*. This vehicle is a different case. It exploded during its first launch at-

---

[7] We estimate that each launch of the SL-12 costs the equivalent of $45 million.

[8] A circular orbit 19,300 n.m. above the earth, in the plane of the Equator. At this altitude, the orbital speed of the spacecraft would be equal to the rotation of the earth and the spacecraft would be essentially stationary over a given point on the earth.

tempt, either before or shortly after lift-off, and caused extensive damage to the launch pad, which has not been completely repaired after nearly two years. On 26 June 1971 it was tested again, probably from the adjacent launch pad, and again it failed. This time, however, the failure occurred well after lift-off and it is highly unlikely that any damage was done to the launch pad. This vehicle is much larger and more complex than the SL-12. Based on our knowledge of the level of technology used in developing the US Saturn vehicle, the problems encountered, and the nature of the solutions, it would not be too surprising if the Soviets find the "J-vehicle" problems very difficult to correct.

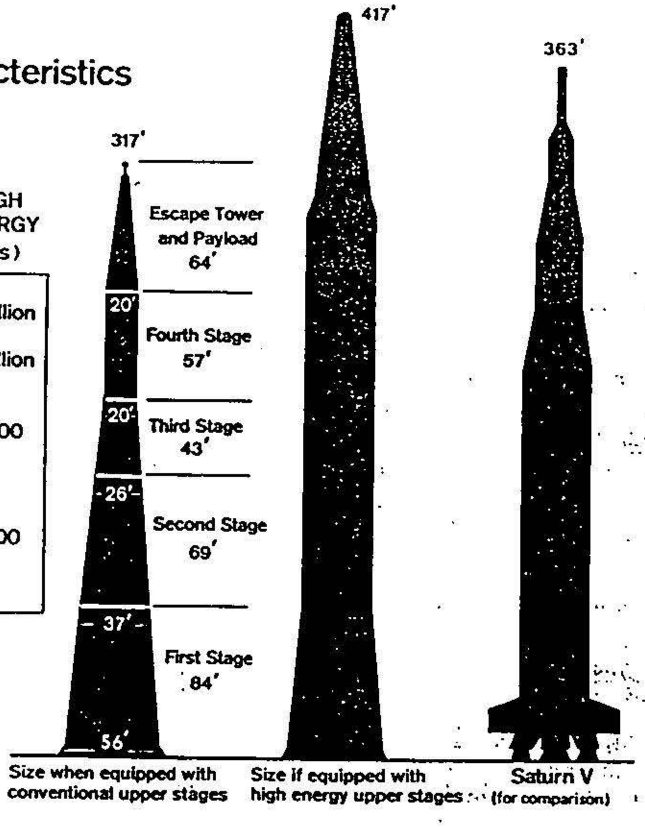
21. The "J-vehicle" was first observed in December 1967 at Area J at Tyuratam, hence its nickname. All estimates of its capabilities [ ] have assumed conventional propellants in all stages and current state-of-the-art in engine technology.

22. The booster consists of 4 stages and is estimated to be capable of placing about 275,000 pounds in low-earth orbit or 75,000 pounds on a trajectory to, or beyond, the moon. We estimate that the first stage develops 13 million to 14 million pounds of thrust, the second stage about 3.5 million pounds, and the third stage about 1.2 million pounds. The final stage probably develops about 440,000 pounds. The gross lift-off weight of the vehicle is probably on the order of 10 million pounds. (See Figure 1.)

Figure. 1

Estimated J Vehicle Characteristics

TYPE OF PROPELLANTS	CONVENTIONAL (lbs)	HIGH ENERGY (lbs)
LIFT OFF WEIGHT	10 Million	10.4 Million
LIFT OFF THRUST	13-14 Million	13-14 Million
PAYLOAD WEIGHT IN EARTH ORBIT	275,000	550,000
PAYLOAD WEIGHT TO THE MOON		
without rendezvous	75,000	225,000
with rendezvous	175,000	



23. When its problems are solved, a vehicle of this size and capability will enable the Soviets to carry out a wide variety of manned or unmanned missions which require very large payloads. These could include a manned lunar landing mission, orbiting a very large manned space station, and unmanned exploration of distant planets. Even more impressive missions could be flown if this vehicle were to utilize high-energy propellants in its upper stages. We cannot make a confident forecast as to when the vehicle will be ready for use.

C. High-Energy Propellants

24. Soviet development of high-energy upper stages, such as used by the US, would increase greatly the payloads that could be launched by the SL-12 and the J-vehicle. Recognizing this, the Soviets have for the last decade been progressing slowly with several approaches to high-energy rocket engine development. We believe the major developmental efforts are underway at Plant 456 at Khimki and at the rocket-engine test facility at Zagorsk. These are considerably behind the schedule we estimated for them in NIE 11-1-69. Lesser efforts are probably underway at test facilities at Zelenogorsk and Nizhnaya Salda.

25. *Toxic Propellants.* Facilities for test firing engines using high-energy toxic propellants, probably fluorine compounds, have been available at Khimki for several years. The test facilities appear to be capable of accommodating engines with thrusts between 35,000 and 150,000 pounds.

Since the first try for an operational fluorine engine probably would involve a relatively small one, the Khimki engine probably has a thrust of 50,000 pounds or less.

26. Had development proceeded smoothly, the Soviets might have had a fluorine engine ready for flight testing by now. In August 1969, however, a well known Soviet propellants expert stated that they were having "big problems" with fluorine, and it is likely that the program is well behind schedule. We do not know the extent of the problems, and we have no basis for estimating when a fluorine engine will be ready for flight tests.

27. The facility at Zelenogorsk was equipped in 1964 to test small rocket engines using toxic propellants. Fluorine propellant tests have probably been underway there for several years. It is also a likely test-site for propellants containing beryllium.

28. *Liquid Hydrogen.* Hydrogen engine R&D activity has been underway at Zagorsk for several years and static testing is believed to have begun about two years ago. The engine is estimated to generate somewhere between 40,000 and 90,000 pounds of thrust. Engines generating such thrust would be particularly useful in upper stages for the SL-12 and the J-vehicle. A smaller engine with about 7,000 to 15,000 pounds of thrust is also believed to be under development. If the test program proceeds smoothly, either or both of those engines could be ready for flight testing this year.

29. Another hydrogen engine development program probably got underway at Nizhnaya Salda sometime last year. Evidence of progress at the test stand there suggests that the engine will develop a thrust betwen 30,000 and 60,000 pounds. Assuming a smooth development program, it could begin flight testing as early as 1972, but a year or so later is more likely.

30. An indication of the emphasis being put on a high-energy propellant that utilizes liquid hydrogen is the growing evidence of an intent to produce and transport liquid

hydrogen on a large scale. Construction of large plants, probably to produce liquid hydrogen, is underway at the three known chemical centers in the USSR: Chirchik, Navoi, and Tolyatti. The Chirchik and Navoi plants are within 350 n.m. of Tyuratam and Tolyatti is near the Kuromoch test facility where much of the static testing of engines for space vehicles takes place. Of these, Chirchik appears to be ready for production; Navoi and Tolyatti are at least two years away from completion. A fourth plant, similar but not identical to the other three, is located about 12 n.m. from the Dnepropetrovsk missile development facility. It has probably been producing liquid hydrogen for several years.

31. [

] there is some construction activity going on at the SL-12 launch area at Tyuratam which could be interpreted as indicating the installation of facilities for handling high-energy propellants.

32. All things considered, however, we think it is unlikely that development of high-energy upper stages has progressed far enough for the Soviets to begin flight testing them on the SL-12 or the J-vehicle in the near future. If the Soviets develop high-energy upper stages for the J-vehicle, we estimate that the less dense fuel would require greater volume in the tankage than the present version and the resulting vehicle would be considerably taller than the present one. In order to service such a vehicle, the service platforms on the gantry at Area J would have to be repositioned since the service-entry points into the vehicle would be at different heights than on the present one. Such changes have not occurred. (See Figure 2.)

D. Manned Spacecraft

33. Soviet spacecraft design clearly differs from that in the US. Whereas US designs are lightweight and sophisticated, using multiple alternate subsystems redundant to one another to achieve reliability, the Soviets have built spacecraft that are heavy, clearly not up to US standards, and that rely on system redundancy by duplication to achieve reliability. This approach has been valuable in several ways. It has enabled the Soviets to accomplish many "firsts" in space. It has, however, limited their activities in other ways. For example, flights requiring a deviation from the pre-set program have not worked well. In general, the Soviet philosophy in spacecraft design restricts the extent to which the cosmonaut can control the spacecraft.

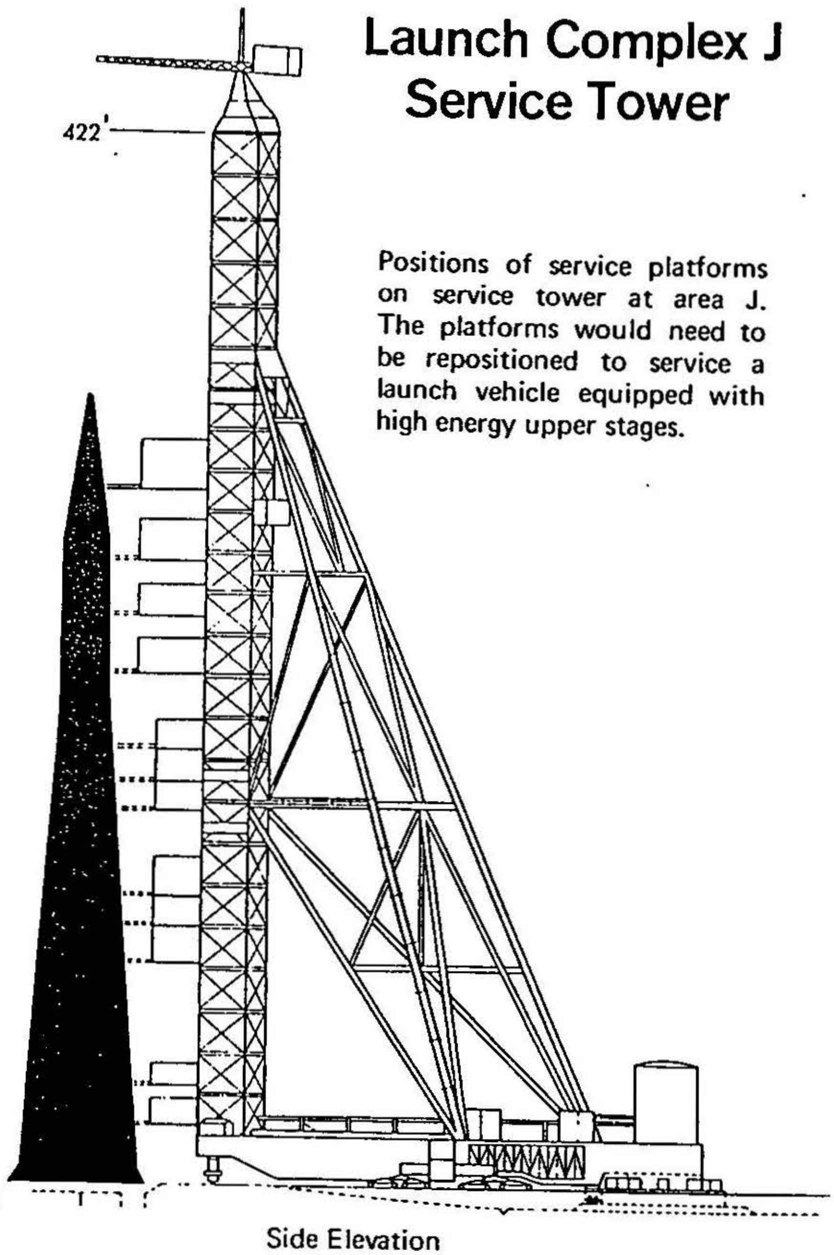
34. *Soyuz.* Since 1967 the Soviets have been using the Soyuz spacecraft in their manned space flights. (See Figure 3.) This vehicle has proven to be quite reliable and, in comparison to its predecessors (the Vostok and the Voskhod), it has many advanced capabilities:

a. Its shape provides it with some degree of aerodynamic lift, allowing it to be maneuvered during re-entry to a more accurate landing than was possible with Vostok and Voskhod whose shapes provided no degree of lift.

b. It has an on-board propulsion system which enables it to perform maneuvers while in orbit, including those necessary for rendezvous and docking.

c. It has the radar and other equipment required for rendezvous and docking.

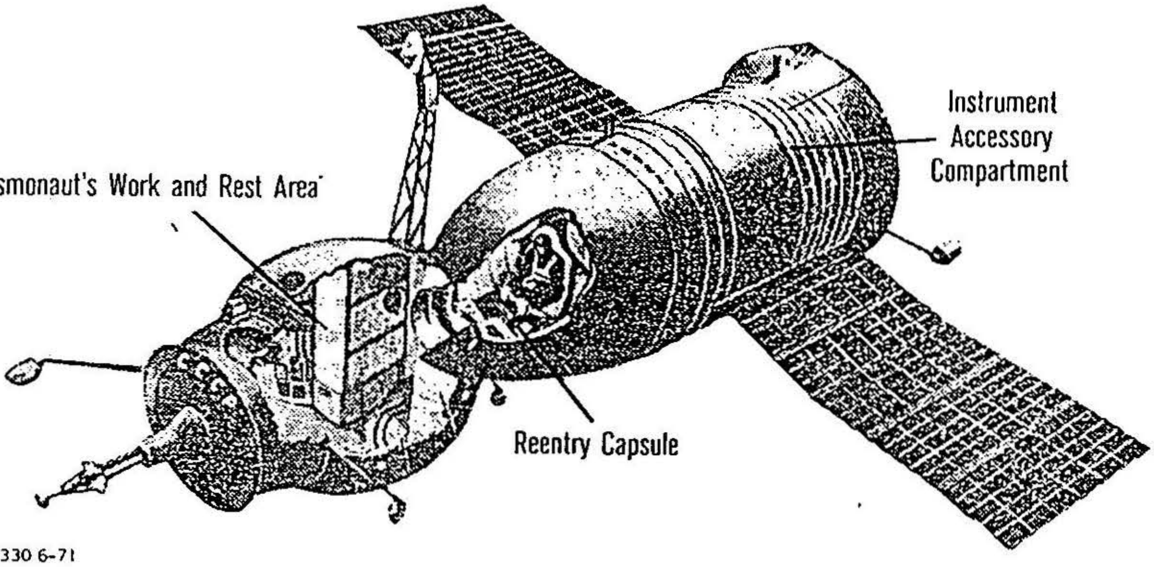
Figure. 2



560329 6-71 CIA
TCS 886182/71

Figure. 3

Soyuz Configuration



560330 6-71

d. It has a more commodious "living" or "experiment" compartment; Voskhod was rather cramped.

e. It has more provision for control by the cosmonauts than its predecessors. Cosmonauts in the Vostok and Voskhod had virtually no control over the operation of the spacecraft.

f. It uses solar panels for power supply. Batteries were used in the other spacecraft.

g. Its life support system has a considerably greater capacity than did earlier ones.

35. These improvements have enabled the Soviets to undertake more sophisticated missions than were possible with the Vostok and Voskhod, including rendezvous and docking, crew transfer, and orbit adjustment maneuvering, as well as longer missions that were clearly impossible in the past.

36. The spacecraft does, however, suffer from several deficiencies which will limit its usefulness if the Soviets intend to use it in more ambitious undertakings. Among these are:

a. *Poor Visibility.* This problem is so acute that manual rendezvous and docking is a difficult operation.

b. *Size.* Whereas the overall volume of the vehicle is adequate, the "command module" is quite cramped when occupied by three men. Furthermore, the Soyuz basic life support system appears to be limited to about 30 man-days. To stretch the flight beyond that point, various spacecraft subsystems must be removed and replaced with added life support equipment. During the Soyuz-9 flight (36 man-days), for example, both the docking equipment and the rendezvous radar system were removed.

c. *Attitude Control.* The spacecraft uses a type of attitude control system which is rather simple to build but is far more difficult to use for docking than the system used in the US Gemini program. The system is adequate for automatic docking but is very exacting when operated by a cosmonaut and may account for the difficulty the Soviets have had in docking manually.

37. Despite its shortcomings, the Soviets show every indication of continuing to use the Soyuz for manned flights. The Salyut/Soyuz operation suggests that one of its main uses will be as a "ferry" vehicle to resupply or man orbital space stations. We do not rule out the possibility that the Soviets may rendezvous and dock two Soyuz craft to test subsystems intended for use in space stations. We have no evidence that a "recoverable" spacecraft as a follow-on to the Soyuz is being developed.

38. *Salyut.* The Salyut craft which is now in orbit is estimated to weigh about 40,000 pounds. It is reported to be 40 feet long, 14 feet in diameter in its largest section, to have a working space of 1,300 cubic feet, and to use solar cells and batteries for power. The crew of Soyuz 11 was able to move directly into the Salyut craft through the docking collar rather than having to go outside to make the transfer. The vehicle is reported to have various types of life-support systems aboard and to be comprised of several compartments, including airtight working and habitation areas. Other areas are provided for instrumentation, actuator systems, and scientific equipment. The major life support systems probably include a superoxide environmental control system (ECS), stored food (dehydrated and refrigerated), and stored water. The vehicle may incorporate the atmospheric-condensation and urine-reclamation water recovery systems like those tested in the one year ground trial conducted in the Soviet Union three years ago. If the vehicle does use the superoxide ECS, it may have the capability to maintain a crew of 6 to 8 men for a period of several months.

E. Life Support Systems

39. The superoxide atmosphere revitalization system used in all Soviet-manned missions to date has been tested for 36 man-days in continuous flight and for 546 man-days in a continuous ground trial. The ground test data demonstrated that three men could be maintained in cabin environment conditions, similar to that found in the Soyuz spacecraft, for a six-month period. Furthermore, the Soviets have developed a method for packing superoxide compounds more densely than heretofore; we believe they are using this methodology in back-up systems for environmental control in submarines. We estimate that this more efficient packing could allow three to four times as much chemical to be stored in a given volume. This means that greater quantities of superoxide can be stored aboard a spacecraft, subject to the limitations of available expendable weight at launch. As a result, Soviet use of higher density life support expendables would significantly extend the mission lifetime of those Soviet manned spacecraft which employ a superoxide environmental control system.

40. Atmospheric condensation and urine water recovery systems have been tested for a 12-month period on the ground. The results of this trial demonstrated that when used in combination with the superoxide environmental control system in a spacecraft, such as the single or double Soyuz configuration, these water recovery systems could provide nominal potable water requirements for three men. The first operational flight test of the atmospheric condensation system, during the Soyuz 9 mission, was only partially successful and was not the major source of drinking water during

that flight. Fixed weight of hardware and power requirements would not be limiting factors for inclusion of these water reclamation systems in the Salyut spacecraft.

41. The Soviets have conducted a three-man six-month ground test of a physical/chemical life support system which regenerates water and atmosphere. The weight and power requirements of this system rules it out for use in the Soyuz program and make it impractical for operational use in the Salyut. We doubt that this system is ready for operational use, but it could be in about two years. The most likely use of this system would be in long-duration multimanned space stations large enough to provide the power such a system requires.

F. Non-nuclear Power Sources for Spacecraft

42. We expect the Soviets to continue to use solar cells, backed up by chemical batteries, as the principal source of electrical power for spacecraft for several years. Improvements are expected in both elements. We have no evidence on any developmental work being done in the USSR on fuel cells of the type used on US spacecraft.

G. Nuclear Power and Propulsion

43. Considerably greater payloads could be sent to interplanetary distances if the Soviets were to develop nuclear power and propulsion systems. We do not know whether or not the Soviets are developing a nuclear rocket engine. Prototype nuclear engines would have to be tested in a remote location and would require large amounts of liquid hydrogen as the fuel.

44. A large facility, nicknamed "PNUTS", at the Semipalatinsk Nuclear Weapons Proving Ground has been under observation for more than seven years. One of several postulated functions for the facility is that it will serve as a test stand for nuclear rocket engines. A possible liquid hydrogen production plant has been observed at the proving ground's Main Support Area some 35 n.m. away. However, many features of PNUTS have not been identified and the relationship between various buildings is unclear. The facility is much more complex than the test stands in Nevada where the US tested nuclear rocket engines.

45. Based on available evidence, no firm projection can be made regarding flight readiness dates for a nuclear rocket. If such a system is being developed, we doubt that it could be ready for use before the mid-1980s.

46. Although there is very little direct evidence of such a development, we believe the Soviets have a considerable interest in electrical propulsion systems which would require a nuclear power source for interplanetary travel. The Soviets have recently announced the operation of a thermionic installation which generates several kilowatts of electric power. We believe that this is a prototype thermionic reactor. Although probably conservatively designed, it is nevertheless the first complete thermionic reactor to operate. We estimate that if the Soviets choose to do so, they could have a 10 kilowatt thermionic reactor in space by the late 1970s. A reactor with this output would be adequate as a source of electrical power for a large space station or as power for electrical propulsion for planetary probes. A nuclear electric system employing a radioisotope power supply could be available in the mid- to late-1970s.

H. Communications Systems for Space Operations

47. The USSR's space communications systems have remained relatively unchanged since 1968. They include a wide variety of different

space communications systems, covering numerous frequencies. As a group they seem sufficient, with minor upgradings, to handle Soviet command and control requirements for space operations well into the 1970s.

48. The unified UHF space communications system which was introduced in the mid-1960s continues to be the most flexible one in use. [redacted]

49. [redacted] The system's flexibility allows it to be used at earth orbit distances and beyond. The Soviets employ the system on payloads such as the Soyuz vehicles, Molniya satellites, lunar probes, and interplanetary probes. Such use almost certainly will continue for the first half of the decade at least.

50. [redacted]

I. Command and Control for Space Operations

51. The USSR's capability to command and control its spacecraft has improved dramatically over the past several years and will almost certainly continue to improve. A new mission control center, referred to in Soviet press reports either as the "Flight Control Center" or as the "Manned Flight Control Center", has been identified. This center controls only flights which are manned or man-related and appears to be coequal to the much older Coordination-Computation Center which handles unmanned missions.

52. The network of space tracking stations for near-earth missions has continued to grow over the past several years. In addition to the construction of new stations, antennas, and ships [redacted]

53. The two new space event support ships (SSESS), Gagarin and Korolev, will provide the Soviets considerably more mission support flexibility and capability. Both vessels probably will have significant improvements over other similar vessels in the Soviet fleet in technology and mission capability. The Gagarin recently began sea trials and may be ready for deployment by late summer. The number and size of the Gagarin's parabolic antennas, together with the absence of a Soviet land-based tracking station in the Western Hemisphere, are a very strong indication that the vessel is intended to support lunar missions. The most likely area for this support activity is the Western Hemisphere, near Cuba. The Korolev has been deployed, going first to Havana and then to a position off Nova Scotia where it supported the Salyut/Soyuz operations.

54. No major improvements have been noted at the installations which support interplanetary vehicles. Based on the reports on Venus 7, however, the Soviets apparently are now capable of analyzing a space probe's very weak signal, and their processing capability apparently has been upgraded. There is no evidence the USSR is planning to construct a space communications antenna larger than those at Yevpatoriya used for interplanetary missions. A noted Soviet expert on deep-space communications recently stated that such an antenna might not be needed since increased power and more directional antennas on the spacecraft, reduced data requirements, and the introduction of better data-coding techniques could make the present system adequate.

IV. FUTURE PROSPECTS

A. General

55. Our near term projections are based, when possible, on the extension of trends which are now evident. We can make some confident projections based on the characteristics and capabilities of hardware that is now available or is in late stages of development. Other projections stem from our analysis of indirect evidence on studies or experiments being conducted in the USSR that have some application to the space program. In other instances, we project on the basis of our appreciation of the Soviet state-of-the-art in various hardware areas and its application to space ventures which we believe the Soviets would like to undertake, but on which no direct evidence is available.

56. In the long term, however, the future of the Soviet space effort is a political decision. Given the pressure on the leadership to make programs demonstrate their "cost effectiveness", we think it unlikely that the aggregate expenditures on the space effort will increase. Expenditures are now at such a high level, however, that a wide variety of ventures could be undertaken without any cutbacks. An orderly development of individual programs as herein set forth could probably be accomplished with no increase in expenditures, and might be supported with decreased annual resource allocation. A stretchout of the various programs would, in fact, lead to substantial annual savings over the current level of expenditures. Central to these judgments is our belief that the Soviets will not over the next decade undertake the development of a new large space booster, and that the pacing item for some of the missions we postulate as possibilities will be the development of highly reliable and durable spacecraft subsystems.

57. We think it is likely that the Soviet space program is being reviewed critically by the leadership and that some rearrangement in priority has been, or will be, made. Although we believe that military-related missions will continue to receive major emphasis, we have no good evidence on how other more

spectacular ventures will be arranged in any priority listing, or what criteria will determine the priorities. In the following, therefore, we discuss the various ventures the Soviets are likely to undertake and estimate the dates when they *could* be attempted; we do not, as a matter of course, attempt to determine what priority the Soviets have assigned to any particular one in relation to others. In making these projections, we have assumed a high level of success in activities leading up to a particular mission. Delays and failures can, of course, occur at any time, especially when new hardware is involved. These could delay a mission by a year or so.

B. Manned Space Station

58. For several years the Soviets have been discussing the advantages to be gained by orbiting manned space stations. They state that such stations will have extensive applications in the areas of agriculture, forestry, weather prediction, oceanography, geography, geology, astronomy, and studies of the atmosphere. In our view, a space station which could serve these purposes would be a highly desirable venture for the Soviets to undertake as soon as feasible; it would serve to restore some luster to their space program and could offer some pay-off in terms of the economic benefits derived. And a manned space station will almost certainly be used to augment certain aspects of the Soviet military space program.

59. *Long-Duration Station (SL-12 Launched).* In its three-stage configuration, the SL-12 has demonstrated the capability to place about 40,000 pounds in low-earth orbit. This weight would be adequate for the habitable "core" of a long-term space station. It is conceivable that the cosmonauts would be aboard this main element when it was first launched but, as was the case in the Salyut/Soyuz operation, it is more likely that the crew would be sent up in ferry vehicles to rendezvous and dock with the main element after it had been determined that it was in orbit and functioning properly. A station of this size could probably support a six to eight man crew for four to six months, using present life support systems and equipment. The mission could be extended somewhat if the new water recycling systems were used or if Soyuz vehicles were used to resupply the station. A smaller crew would also permit a longer mission. The Salyut/Soyuz operation was probably intended to be the first step in such a program.

60. *Very Large Space Station.* There is no evidence, direct or indirect, suggesting that the Soviets plan to use the J-vehicle in a space station program. Using conventional propellants, that vehicle could be used to put a platform in orbit that would weigh about 275,000 pounds; with high-energy upper stages, it would weigh on the order of 550,000 pounds. Considering the costs involved in the J-vehicle program and the advances that could be made in a station put up by the SL-12, we estimate that if the Soviets do plan to use the J-vehicle to place a space station in orbit, they will wait until the subsystems required for a truly long-duration manned station, capable of sustaining crews for many months or even years, are available. These would include a closed water, air, and food regenerative life support system which we estimate will not be available until the late 1970s at the earliest.

61. In pursuing either of the above programs, the Soviets may see the need to develop a more advanced "ferry" vehicle than the Soyuz.

C. Planetary Exploration

62. We believe that the Soviets will try to use every available "window"[9] during the period of this estimate to send probes of one

[9] A period of time during which conditions are most favorable for launching on a particular mission.

type or another to Mars and Venus. A variety of missions are possible, and we cannot judge which will be undertaken.

63. *Mars*. Two modes of exploration of Mars are currently within Soviet capability: an orbiter and a lander. A vehicle placed in orbit around Mars could provide a variety of scientific data such as measurements of the atmosphere, photography of the surface, and other data valuable to planning for further exploration of the planet. A soft lander could carry out scientific experiments, photograph the terrain, relay data to earth, and provide data valuable to the planning of even more ambitious missions. Either of these missions could be attempted during the 1973 "window". The Mars II and III vehicles, now on their way after having been launched by SL-12, may be intended to carry out either or both of these missions.

64. A more ambitious venture, which could be within Soviet capabilities by the time the 1975 "window" opens, would be a rover mission. Much of the information gained either by an orbiter or a lander mission as well as the hardware developed and the experience gained in the Lunokhod mission would be applicable to a Mars rover. A rover could carry out a variety of experiments, including environmental measurements and analysis of soil from separate areas, that would not be possible with either an orbiter or simple lander mission. The journeys that the rover could take would be restricted, however, because of the delay in round trip communications time resulting from the distances involved. This delay ranges from 6 to 46 minutes, depending upon the position of Mars relative to the earth. Thus, the exact position of the rover must be known at all times, the distances and timing of any travels must be carefully programmed, and the "stop-go-stop" signals must be passed at precise instances, taking into account the delays involved.

65. Perhaps the most ambitious mission to explore Mars that could be undertaken during the period, would be one that collected a sample of the planet's soil and returned it to earth. This would require major, across-the-board advances in all aspects of Soviet spacecraft technology, especially those affecting reliability; the payload would have to remain viable for a period of 1,000 days. Moreover, for a capsule weighing, say, 200 pounds to be returned to earth, the mission would require a spacecraft weighing on the order of 117,000 pounds at the time it landed on Mars. The thrust required to deliver such a payload would require a J-vehicle equipped with high-energy upper stages. For these reasons, we estimate that such a mission will almost certainly not be feasible before the 1975 Mars "window", and probably not until later in the decade.

66. *Venus*. There seems to be little incentive for the Soviets to repeat the Venus 7 mission, principally because the data it transmitted correlated closely with that sent by their earlier Venus probes as well as the US Mariner V mission. The next logical step in their Venus program would appear to be a more sophisticated lander mission. The SL-12 could be used to deliver a payload designed to survive within the hostile environment for at least several hours and having more power for transmission of data than Venus 7. The lander could relay qualitative and quantitative data on the composition of the planet's surface not yet obtained by either the US or the USSR. This mission could be attempted when the next window to Venus occurs in March-April 1972.

67. We have considered the possibility that the Soviets will undertake a "grand tour" [10] of the planets during the 1976-1979 period

[10] A "grand tour" involves a fly-by of Jupiter, Saturn, Uranus, and Neptune by one spacecraft. Such a mission would take 8 to 10 years to complete.

when the planets are in the relative positions required for such a venture. We think it is unlikely that they will have advanced far enough in the development of the long-life, highly reliable spacecraft subsystems required to assure that a mission of this duration and scope would have an acceptable chance of being successful.

D. Unmanned Lunar Exploration

68. The Soviets have discussed the value of a threefold approach to unmanned lunar exploration and, based on their activities to date, we believe they will follow essentially that program. The first objective they discussed was putting a vehicle on the moon that could take a sample of the soil and return it to earth; the Luna 16 mission did this. The second objective was exploration of the lunar surface by a mobile vehicle; Lunokhod 1 is doing this. The third objective is the landing of a large, stationary experimental platform that could serve as a base for larger, more sophisticated experimental apparatus; this remains to be done.

69. The design of Luna 16 and the flight profile it followed limit the areas on the moon to which the vehicle can be sent. Future missions in this category will probably involve more advanced payloads which can be landed to take soil samples from virtually any place on the moon's surface that is visible from earth.

70. The Lunokhod 1 experiment has demonstrated that the rover can travel at least five miles and has a useful lifetime of at least six months. Another mission of this type probably will be attempted this year to investigate a different area of the moon than the Sea of Rains now being explored.

71. A much more sophisticated and complex mission which probably would satisfy the first two objectives of the program as well as going far to fulfill the third would be one that involved features of both Luna 16 and Lunokhod 1. In such a mission, two payloads would be sent to the moon; one being a lander/return vehicle, the other a rover. The rover could extract soil samples from relatively distant areas, carry out certain measurements or other experiments, and deliver a package to the stationary payload which would then return to earth. Because of the weights involved, this mission would require two SL-12s to deliver the two payloads or one J-vehicle. It is unlikely that a mission of this type would be attempted before the mid-1970s.

E. Manned Lunar Landing

72. Evidence of a Soviet manned lunar landing program has been accumulating for several years. From that evidence we could assess the progress being made in the program and estimated several years ago that the Soviets were not competing with the US Apollo program.

73. It is possible, however, that they may have hoped to take advantage of any major setback the Apollo program might have experienced that would have allowed them to be the first to put a man on the moon without pushing their program beyond acceptable limits. The success of the Apollo program has ruled out that eventuality. Further, whatever their timetable for such a mission, it has certainly been delayed by the failures of the J-vehicle. There is little doubt that they intend to carry out the mission; the evidence on the J-vehicle and the obvious intent to use it for manned missions, the construction of large, sophisticated tracking facilities, and the improvements observed in their communications capability are all directly applicable to a manned lunar landing and are quite persuasive. The major remaining question is its timing.

74. Repair work at area J where damage resulted from the explosion during the first attempt to launch the vehicle does not appear to

be proceeding at a pace commensurate with an urgent, high priority program. Further, the long interval between the first and second launch attempts, and the fact that the second effort was also a failure, suggest that inherent booster design problems may be involved which will necessitate changes to the basic design. Despite these problems, the Soviets will almost certainly feel obliged to continue the development of this type of launch vehicle. Abandonment of the program would seriously curtail the types of missions they could perform. For example, without a vehicle of this type, they would be unable to carry out a manned lunar landing mission.

75. Whatever the case, these failures have almost certainly delayed any missions requiring this launch vehicle for at least two years and have delayed for an undeterminable length of time any plans the Soviets may have for a manned lunar landing. We think it is highly unlikely that any attempt to carry out a manned lunar landing would be made before 1975-1976.

76. The Soviets could attempt such a mission either by the rendezvous and docking of two vehicles placed in orbit by two conventional propellant versions of the J-vehicle which would then be ejected from orbit on a lunar trajectory, or by the use of a single J-vehicle with high energy propellant upper stages. The launch date will not be significantly affected by whichever version is used. We believe the Soviets would precede the actual launch by a series of launches intended to test system reliability and to man-rate the system, including the spacecraft. During this time they might attempt a manned circumlunar flight or a manned mission to orbit the moon for a period of time and then return to earth. Data acquired on these preliminary flights would allow us to make a more precise estimate as to the likely timing of the lunar landing mission.

77. The Soviets have been discussing the scientific benefits that could be derived from a permanent or semi-permanent manned lunar base. They visualize a lunar base as being useful for advanced studies in such areas as astronomy, solar radiation, and the effects on man of extended activity in a unique environment. We believe that toward the end of the decade the Soviets will have progressed far enough in the various scientific and technical disciplines related to such a venture to allow them to carry out the first launches aimed at establishing such a facility on the moon.

F. Applied Satellites

78. *General.* In the field of applied satellites, photoreconnaissance and ELINT systems will continue to enjoy the highest priority. We expect however that increasing emphasis will be given to other applied satellites, especially those for communications, meteorology, and earth resources survey, during the decade. This latter group represents one area of the space program where the tangible and beneficial results to be obtained can be used to counter complaints about the resources being devoted to the space program.

79. *Photoreconnaissance.* During the coming years we expect the Soviets to continue launching photoreconnaissance satellites at about the same annual rate as that observed over the past two years. We also expect the trend toward longer duration missions to continue, in both the high- and low-resolution programs. Minor improvements in the efficiency and flexibility of the program will probably result from more flights having the capability to vary their orbits and from minor adjustments in on-board telemetry and camera systems. There are no indications that any major program changes, such as multiple-bucket spacecraft or signif-

icant improvement in ground resolution, are imminent.

80. Improvements of these types would require a new spacecraft with significant improvements in instrumentation; it could probably not become available until the mid-1970s. By the late 1970s, the Soviets could have the technology to develop a system to relay collected data to ground stations on a near-real-time basis.

81. *ELINT.* We believe the Soviets will continue an energetic ELINT program throughout the decade. Late in the period a follow-on ELINT collector may be developed to supplement the third generation system now being deployed.

82. *Comsats.* Two years ago the Soviets filed a notice with the International Frequency Registration Board for two new comsats with supporting ground stations. Both programs will employ the same payload, which will be a vehicle somewhat improved over Molniya 1 and using higher frequencies. Neither of these systems will have the broad capabilities of Western comsat systems now in use. One system, Statsionar-1, reportedly will involve one vehicle placed in a synchronous orbit over the Indian Ocean. The other, Molniya 2, reportedly will use three vehicles in highly elliptical orbits. We had expected the first launches or precursors for both these systems to get underway last year but they did not. We now expect them to be launched later this year but further delays would not be surprising.

83. The higher frequencies will enable Molniya 2 to handle a greater number of channels than its predecessor and increase its capacity for common-carrier and television-relay traffic. The number of subscribers to the Molniya system, both civilian and military, is expected to expand over the period.

84. Statsionar's electronics are expected to be similar to those of Molniya 2. Its announced orbit, however, will preclude complete coverage of the northern latitudes of the USSR. Thus, Statsionar may be intended for international rather than national service and as a competitor to Intelsat.

85.

86. *Metsats.* We believe that the large investment being made in the Soviet meteorological satellite program will result in continued growth and improvement in that program over the coming years. New and improved sensors will be employed and data collection and analysis will become more efficient, particularly as new computers are more extensively used. Satellite data will be exploited more effectively to meet the broad scale weather requirements of the military forces.

87. Improvements in the near term will probably include better systems for transmission of data and a near-real-time capability to relay collected data to Soviet military units and ships, as well as to civilian consumers, on a global basis. Late in the decade the Soviets probably will place a meteorological payload in synchronous orbit.

88. *Earth Resources Survey Satellites.* The Soviets are giving serious consideration to the benefits that can be derived from an earth resources survey (ERS) satellite program. The types of experiments being considered by them for such a system appear to parallel those suggested for similar US systems. Photography and spectrophotometry would be used for hydrological, glaciological, geological, oceanographic, agricultural and mineralogical surveys, as well as botanical studies. Satellites capable of performing an adequate ERS mission may also have the capability to perform military related missions, such as technical intelligence, camouflage detection and discrimination, or ocean surveillance.

89. We believe that the Soviets will launch their first ERS satellite within the next five years, possibly by the end of this year. One way they could accomplish this would be by including an ERS package on one of their present metsats; this would be the simplest approach and could be used for a launch late this year. Another way they could do it would be to adapt one of the metsat payloads to a pure ERS function; some of the equipment already developed for use in the metsat program lends itself to use in an earth survey role. This type of payload probably could be orbited at any time. Finally, the Soviets may elect to develop a completely new spacecraft for this role; in that event we would not expect the first launch until 1973-1974.

90. A considerable number of earth resource experiments and observations will probably be conducted by manned space stations when they become fully operational.

91. *Other Applied Systems.* Throughout the period we expect the Soviets to continue to improve many of the other applied systems now in use. They will almost certainly bring a navigation satellite system to operational status and they will probably try to broaden the use of such systems; toward the end of the period they could orbit a non-doppler type navigation satellite system for use by aircraft. During the period they may investigate the use satellites for monitoring such things as: missile launches in foreign countries, atmospheric nuclear detonations wherever they may occur, and the movement of ships and submarines at sea.

G. Scientific Satellites

92. The scientific exploration of near-earth space has always occupied a position of low priority relative to other activities in the Soviet space program. We do not expect it to be given any increased priority during the next decade. There will probably be some improvements, however, in such things as satellite instrumentation, experiment design, and data handling capacity of the systems.

V. INTERNATIONAL SPACE COOPERATION

A. USSR-European Nations

93. The USSR and France have been cooperating, not too successfully, in certain space ventures for a number of years. The French reason for cooperation probably is one of prestige, while the Soviets probably hope to gain from French technology. Some of the difficulties encountered stem from a reluctance on the part of the Soviets to supply much useful design data to the French, others from a shortage of French funds. The latter has led to slippages in some joint programs and cancellation of others.

94. The most notable joint experiment conducted by these two countries is the laser experiment on Lunokhod 1 (see paragraph 20 of Annex A).

95. There has been some cooperation in the meteorological field. It has consisted of

a vertical rocket program, using French instrumentation, for studies of the upper atmosphere, and a program of balloon observations by the French which has been used by the Soviets to correlate with some of the data collected by their metsats. These programs have been successful.

96. The French and Soviets have also cooperated in television transmission via the Soviet Molniya system. The program has been of little importance and has probably not progressed beyond the test stage.

97. One of the more venturesome joint programs was to be a Soviet-launched probe to Venus which would deploy a series of balloon-like objects intended to float in the Venutian atmosphere and transmit data back to earth. This program probably has been cancelled.

98. Some French equipment is being carried by one of the Mars probes now on its way to that planet. The Soviets also plan to launch a series of satellites this year and next which will carry French instrumentation. These are intended to study the space environment as well as the effects of space on components of the spacecraft. No specific dates have been announced for these experiments.

99. We expect USSR-French cooperative ventures to be continued over the next several years at about the same level of activity and degree of technical sophistication as represented by the joint missions undertaken thus far.

100. Except for limited collaboration with Poland and Czechoslovakia in background research on space physiology, there has been little true cooperation until recently between the USSR and the East European nations. East European scientists have often stated that they received more information from the US space program than from the Soviet program. This dissatisfaction among the East Europeans may have accounted for a Soviet relaxation which became apparent with the first launchings of the "InterKosmos" satellites in 1969 and the "Vertikal" rockets in 1970.

101. The most recent Soviet initiative for space cooperation has been with West Germany. An agreement has been proposed for a cooperative effort to collect data on ground-based observations of space-related phenomena, such as trying to determine the effects the earth's magnetic field has on the space environment.

B. USSR-United States

102. Nearly all past efforts by the US to induce the Soviets to engage in cooperative or joint space programs have met with limited success. US proposals have encompassed a variety of areas, including the exchange of data on biomedical problems, planetary science, and solar and cosmic physics experiments. The Soviets agreed in 1962 to the exchange of satellite-acquired weather data but they still do not support fully their part of the agreement. This delay was probably caused by technical difficulties in their Metsat program and their reluctance to admit it.

103. There has been some warming, however, in the Soviet attitude toward cooperating with the US on the exchange of space related data. At the request of the US, talks between US and Soviet delegations were held in October 1970 to discuss the desirability of compatible Soviet and US rendezvous and docking systems for manned spacecraft and space stations. This initial meeting considered the general areas in which compatibility was required and it was agreed that the precise details should be handled later at a working group level. An initial agreement along these lines was confirmed in December by an exchange of notes between Dr. Low, Acting Administrator of NASA, and M. V. Keldysh, President

of the Soviet Academy of Sciences. In a subsequent meeting between Dr. Low and Keldysh, broader areas for cooperation were discussed.

104. This more cooperative attitude was most recently manifested in the spring of this year when the Soviets began contributing biomedical data for use in a jointly prepared monograph on bioastronautics. This was proposed about three years ago but the Soviets had not been forthcoming until now. Thus, there is the possibility that the Soviets will prove to be more cooperative in the future than they have in the past.

105. There are, however, at least two factors which tend to justify continued skepticism. First, the Soviets have used their successes in space as evidence of their technological parity with the West—an important "public relations" factor to them. A fully cooperative agreement would require an admission on their part of technological shortcomings.

106. Secondly, the Soviets have yet to provide details on the specific objectives of any one of their space launches until the mission is successfully underway. In many instances, the extent of the intended function of a spacecraft has not been announced until after all applicable data have been collected and analyzed. The Soviets are most reluctant to admit that any mission may have failed to achieve its objectives, claiming that virtually every launch fulfilled its mission "as planned" even though it is clear to us that many of their missions have been only partially successful or have failed completely. This practice suggests that the Soviets would be reluctant to enter into any cooperative space activities which required them to declare the objectives of a mission prior to launch.

107. For these reasons, we believe that if a cooperative program is implemented between the US and the USSR, the Soviets will restrict their contributions to areas which do not reveal their shortcomings. They will probably ask that the US inputs be in those areas where they feel they can gain some insight into US technology and techniques of management that will work to their advantage.

ANNEX A

BLANK PAGE

SOVIET SPACE ACTIVITY

19 JUNE 1969 THROUGH 27 JUNE 1971

A. Manned Space Flight

1. *Soyuz 6-7-8*. In October 1969, the most complex manned space mission ever undertaken by the USSR was attempted when Soyuz 6, 7, and 8 were launched on consecutive days. Soyuz 6 and 8 each had two cosmonauts aboard while Soyuz 7 carried three. A significant portion of the mission was to involve the automatic rendezvous and docking of Soyuz 7 and 8, the observation of this procedure by the crew of Soyuz 6, and the cosmonaut-controlled rendezvous of Soyuz 6 with the other two.

2. The five rendezvous attempts made during the mission all were unsuccessful for several different reasons. The first failed because the automatic rendezvous system would not indicate radar lock-on between Soyuz 7 and 8. Two orbits later the first manual rendezvous attempt was made but it was broken off after Soyuz 8 used more than the authorized amount of attitude-control propellant. A second manual attempt, made the next day, failed because Soyuz 8 did not properly control its lateral velocity relative to Soyuz 7. The attempt by Soyuz 6 to carry out a cosmonaut-controlled rendezvous with the other two spacecraft failed because of insufficient time to correct for a three kilometer out-of-plane separation between it and the other vehicles. The final manual attempt at rendezvous and docking between Soyuz 7 and 8 was poorly timed and the vehicles could not establish the correct interval and relative velocity between them required for a docking operation before they entered the earth's shadow.

3. While not engaged in these non-productive efforts, crew members of all three spacecraft were busy with a variety of other tasks. These activities included scientific observations, space technology tests, and tests of various spacecraft systems. The most interesting scientific experiments were geological-geophysical observations coordinated between spaceborne and ground observations. Space technology tests included navigational experiments and the much-publicized welding-in-space experiment. The latter was performed automatically in the living compartment of the Soyuz 6 spacecraft which had been vented for the operation; the only function of the crew was to retrieve the experimental samples.

4. On three occasions during this mission an SS-7 intercontinental ballistic missile (ICBM) was launched from Tyuratam as the Soyuz 6 spacecraft was passing over that area [redacted] If this were a missile-launch-detection experiment it would appear to have limited applicability since in each instance the launch occurred at night; it is doubtful that the missiles could have been detected had the launch taken place in daylight.

5. *Soyuz 9*. This mission, with a crew of two, was launched in June 1970. The flight was one of the truly "working" missions that the Soviets have attempted, despite the many

"firsts" that they achieved during past flights. Many experiments observed were related directly to space station applications and requirements, with emphasis on determining the effects of long-duration flight on man; the flight lasted for 425 hours (850 man-hours).

6. Other experiments involved the collection of some earth resources data,[1] evaluation of star tracking and on-board navigation techniques, and testing various operational modes of the spacecraft. Considering the many experiments that had to be rescheduled or cancelled, the list of undertakings set for this mission appears to have been overambitious—a characteristic of many Soviet manned flights in the past. This could result from inadequate preflight simulation of the mission or unrealistic mission planning.

7. The Soyuz 9 flight raised some serious biomedical problems. The cosmonauts had no major problems while in orbit, but did experience serious aftereffects which lasted for several weeks. These included disorientation, fatigue, pain in the extremities, difficulty in movement, and an imbalance in their blood chemistry.

8. *Salyut/Soyuz 10.* This event was carried out between 19 and 25 April, this year. (See Figure 4.) This operation, although not completely successful, appears to have been the initial step in establishing a large manned platform in space. On 19 April, the unmanned Salyut vehicle was put into a very low orbit by an SL-12 booster. The altitude of the orbit was so low that the vehicle could stay in orbit only about two weeks.

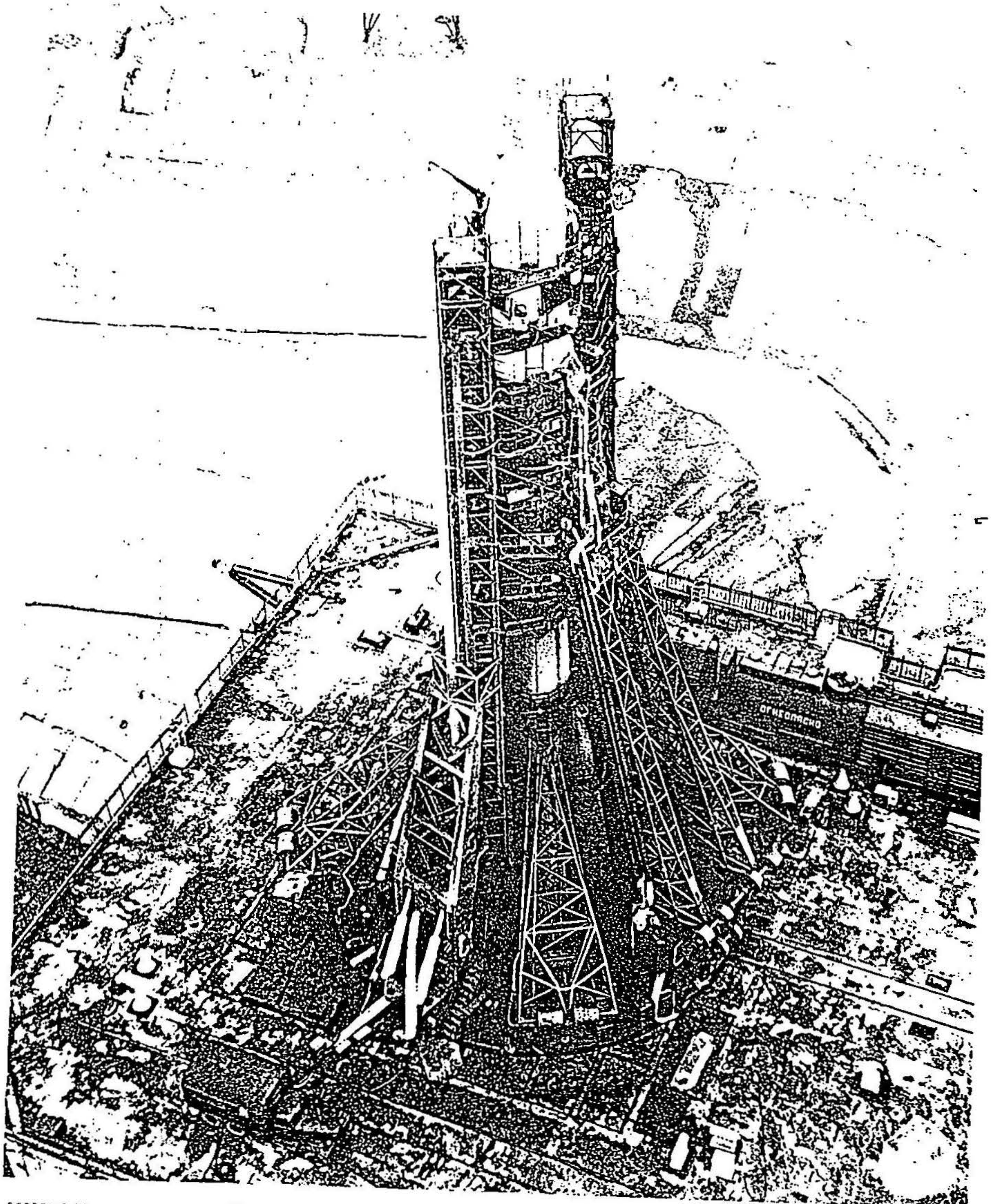
9. Soyuz 10, carrying a crew of three, was launched on 22 April into a slightly higher orbit than that of Salyut. After some adjustments in the orbits of both vehicles, an attempt to dock the two spacecraft was made on 24 April. Some misalignment of the two craft prevented completion of the final phase of docking [redacted] Further difficulties were encountered in attempting to disengage the two craft and after release had finally been effected there were no further attempts at docking. This operation covered a period of two days and Soyuz 10 was recovered late on 24 April.

10. It appears that the mission was to involve the transfer of a crew member, or members, from Soyuz 10 to Salyut, using a new docking device that would allow the personnel to move directly from one vehicle into the other without having to go outside to make the transfer as was the case earlier in the Soyuz program. Had the docking effort been successful, the mission would probably have lasted somewhat longer. After Soyuz 10 was recovered, the Salyut was maneuvered into a higher orbit.

11. *Salyut/Soyuz 11.* Soyuz 11, also with a crew of three, was launched on 6 June. The vehicle was placed into an orbit coplanar with that of the Salyut. Soyuz 11 successfully completed a rendezvous and docking sequence with Salyut on 7 June and a crew transfer was reported completed via a new crawl-through docking adapter.

12. While they were aboard the Salyut, the crew carried out a variety of scientific and technical experiments and activities related to the operation and use of a manned space station. And, in spite of difficulties encountered, [redacted] they established a new manned orbital spaceflight endurance record of over 23 days (69 man-days). The overall mission, however, ended in disaster. While attempting to undock the Soyuz craft from the Salyut vehicle on 29 June, the cosmonauts had trouble [redacted]

[1] Limited data was collected relating to meteorology, geology, hydrology, oceanography, and geography.



560331 6-71

Figure. 4 Soyuz 10 erected on launch pad at Tyuratam

Prior to beginning their re-entry procedure, the cosmonauts depressurized the living compartment of the Soyuz to check whether or not the hatch between it and the re-entry capsule was effectively sealed and it appears that they were satisfied that it was.

Retrofire occurred almost an hour later and the re-entry capsule separated from the living compartment of the Soyuz at 2247 GMT. The re-entry capsule landed in the Soviet Union at about 2315 GMT and TASS has announced that all three crew members were dead when the capsule was opened and that the deaths were caused by depressurization of the re-entry capsule. The Salyut vehicle is still in orbit.

B. The Zond Circumlunar Program

13. Since late 1967 the Soviets have carried out a series of unmanned launches which we believe to be directly related to a manned circumlunar flight. So far the tests have involved checkout of the spacecraft and its systems, mission control procedures, and re-entry and recovery techniques. Throughout its history the program has been plagued by problems with the SL-12 launch vehicle.

14. On 7 August 1969, Zond-7 was launched on a free-return circumlunar trajectory and the spacecraft was recovered in the Soviet Union after performing a controlled skip-out after first encountering the earth's atmosphere upon return and then truly re-entering on the second encounter. This event appeared to be a full-scale precursor to a manned event; the support for this mission (including an early-abort capability) was much more extensive than for previous Zond launches.

15. Over a year later, on 20 October 1970, Zond 8 was launched on essentially the same type of mission. This mission may have been scheduled to have a crew aboard but the chronic problems with the SL-12 booster probably prevented such a flight. In this instance, the Soviets chose to test the re-entry of the spacecraft on a ballistic trajectory rather than to use the skip-glide technique. The vehicle re-entered the atmosphere from the Northern Hemisphere instead of from the south, followed a normal ballistic trajectory, and splashed down in the Indian Ocean. This re-entry mode is less desirable than one which allows recovery in the Soviet Union but is an alternative that has been proven feasible in the event something goes wrong during a flight that requires that the spacecraft be tracked from within the USSR during the final stages of the flight just prior to re-entry.

16. The Zond circumlunar program was probably originally undertaken (along with the unmanned lunar exploration program) to blunt somewhat the world-wide impact of the US Apollo program. Because of the delay it has suffered, however, it appears that very little public relations value could be derived from a manned circumlunar flight at this time, although such a flight may be undertaken as a precursor to a manned lunar landing mission.

C. Unmanned Lunar Exploration

17. Since our last estimate, the Soviet unmanned lunar exploration program has entered a new phase, involving the use of the SL-12 booster and more sophisticated payloads. The prime objectives of this series of lunar probes are to develop techniques for maneuvering in lunar orbit, to conduct surface experiments and, in some instances, to bring back samples of lunar soil.

18. Luna 15 was launched on 13 July 1969 and was successful up to the attempt at soft landing. On 17 July it was inserted into lunar orbit and four days later it crashed in the Sea of Crisis after initiation of the final descent program. We believe that the objective of this mission was to return a soil sample and it probably was intended to compete with the Apollo 11 flight.

19. Three consecutive attempts to launch lunar orbiters or lunar landers were made over the next year, but all failed for one reason or another. Despite these failures, the Soviets tried again on 12 September 1970 and Luna 16 was successfully placed on a lunar trajectory. The vehicle was inserted into lunar orbit and successfully soft-landed in the Sea of Fertility on 20 September. After landing, a drill extracted a soil sample weighing about seven ounces and placed it in a recoverable capsule. Other minor experiments were also performed including radiation and temperature measurements and surface observations. On 21 September, about 26 hours after landing, the Luna 16 ascent stage was launched and the payload capsule followed a simple ballistic trajectory to earth, landing in the USSR.

20. Luna 17, carrying the self-propelled roving vehicle Lunokhod 1 (see Figure 5), was launched on 10 November 1970 and successfully soft-landed in the Sea of Rains a week later. The vehicle contains equipment for measuring the properties of the soil, for measuring extragalatic sources of radiation, and for taking television pictures. A French-built laser reflector on the vehicle has been successfully located by the Soviets. The vehicle has operated successfully during eight lunar days[2] and could have a lifetime of several more months. This venture has produced some valuable scientific and engineering data and has given the Soviets a significant payoff in the public interest it has generated.

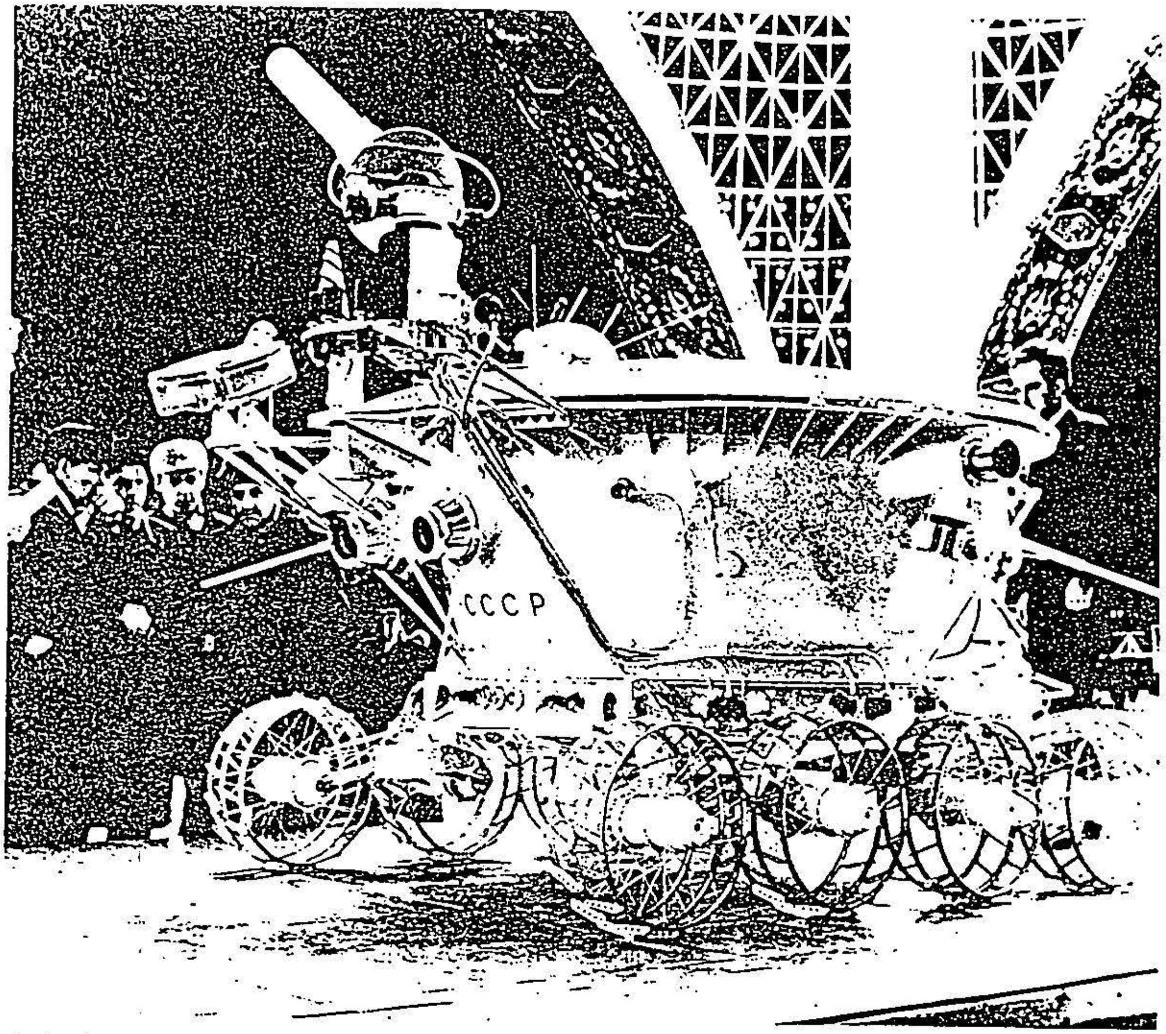
D. Planetary

21. Five planetary-probe launches were attempted by the Soviets during the past two years. Two attempts were directed at Venus and were launched within five days of each other in August 1970. Venus 7, launched on the 17th, appears to have been very similar to previous Venus probes but the entry capsule appears to have been more durable than the others, probably so that it could withstand the surface pressure on Venus. Earlier probes had carried out temperature and pressure measurements as well as chemical analysis of the upper portions of the Venutian atmosphere. However, the added weight of the strengthened Venus 7 capsule did not permit the Soviets to incorporate the equipment into the capsule for analyzing the chemistry of the atmosphere and still keep within the payload weight limitations of the SL-6 booster. We believe that the Soviets intended to transmit data on both pressure and temperature but because of a malfunction of some equipment in the capsule, only gross temperature measurements were transmitted. The data collected, however, agreed with earlier findings. The second attempt was made on 22 August but the probe failed to get out of earth parking orbit.[3] We believe the payload was identical to that of Venus 7.

---

[2] A lunar day is equal to approximately 14 earth days.

[3] An orbit of a spacecraft that is used for assembly of components or to wait for conditions favorable for departure from the orbit toward its objective.



560333 6-71

Figure. 5 LUNOKHOD-1

22. Three attempts to launch Mars probes with the SL-12 were conducted during the 1971 launch window. The first attempt was on 10 May 1971 and resulted in a failure when the 4th stage failed to reignite and take the vehicle out of parking orbit. A second launch was conducted on 19 May and Mars 2 was successfully ejected from parking orbit. Likewise, the third attempt on 28 May (Mars 3) has been successful so far. Mars 2 and 3 are expected to reach the planet late in November or early in December. These probes are reported to weigh 10,250 pounds and could be orbiters or landers, although we feel that the latter is more likely. The two probes will probably perform similar experiments of a very basic nature (i.e., surface photography, surface and environmental measurements, etc.).

E. Photographic Reconnaissance Satellite

23. Over the past two years, photoreconnaissance satellites have accounted for nearly 40 percent of all Soviet space launches. Prior

to 1969, about the same number of high-resolution and low-resolution missions were flown each year. Since that time, however, the preponderance of missions have been of the high-resolution type, indicating an increased Soviet interest in detailed data on various targets with lesser emphasis on searching broad areas for "gross" information. The Soviet high-resolution or "spotting" photography system is believed to achieve ground resolutions on the order of 5 feet and is probably capable of resolutions down to 2 to 3 feet under optimum conditions. [redacted] swath width [redacted] could be on the order of 25 n.m. or could be as great as 60 n.m. The Soviet low-resolution or "search" system is credited with a ground-resolution of 10 to 30 feet; its swath width is on the order of 150 n.m.

24. The Soviets are also leaving their photoreconnaissance systems in orbit longer than they did earlier in the program (10 to 13 days as opposed to 8). This allows them to obtain more coverage while maintaining about the same annual launch rate as in earlier years.

25. We continue to believe that the objectives of the photoreconnaisance program are:

a. To precisely target US strategic forces and to check their status.

b. To map areas of ground military interest, especially those bordering the USSR.

c. To monitor the development and testing of military systems, especially in the US and in Communist China.

d. To monitor large-scale military and naval activity, wherever it occurs.

26. [redacted]

27. Neither of the photoreconnaissance systems has the capability of relaying photographs to ground stations during its mission. The film is recovered for processing after the payload is deorbited and processing of the film and read-out of data almost certainly requires several days.

F. ELINT Satellites

28. The USSR has flown three ELINT reconnaissance systems. The oldest of these consists of a "piggyback" ELINT package that is flown as part of the low-resolution photoreconnaissance vehicle. The second system is a non-recoverable payload which operates in a 300 n.m. circular orbit and is launched solely for an ELINT mission. The third and newest system also is devoted solely to the ELINT mission and operates at about 375 n.m. but employs a heavier payload than either of the earlier systems.

29. The USSR's two older ELINT reconnaissance systems continue to be used at about the same level that has been noted over the past several years. There do not appear to have been any noteworthy changes made in the payload of the low-altitude program (orbits having apogees on the order of 180 n.m. and perigees of about 110 n.m.) since it was first orbited in 1962. [redacted]

33. Six launches of the non-recoverable system were conducted during the past two years; five payloads were successful. The launch activity noted to date suggests that the Soviets intend to have 4 satellites of this type in operation concurrently. The satellites are deployed in space in such a manner that a four-satellite net could collect data from any point in the world at least once every 95 minutes.

34. The program represents a considerable improvement over the older, low-altitude system.

35.

G. Applied Satellites

36. *Communications.* The Molniya 1 communications satellite relay program has continued at about the same level over the past two years as that established early in the program. No significant changes to either the Molniya 1 spacecraft or the system as a whole were detected during the period. The major use of the Molniya system is television distribution to the network of "Orbita" receiving stations throughout the USSR. [

]

37. The typical useful lifetime of a Molniya 1 vehicle is 18 months although one has continued operating for as long as 27 months. Because of the highly elliptical orbit the system flies, a minimum of four vehicles (properly phased to each other) is required to provide 24-hour coverage to all areas of the USSR. Replacement vehicles are launched as older payloads become inoperative.

38. The Molniya 1 program continues to suffer in almost every comparison with the Intelsat system. [

]

39. *Navigation.* The Soviet navigation satellite (Navsat) program [

] One group of satellites has been placed in a near-circular orbit at about 400 n.m. A second group has employed a near-circular orbit at about 650 n.m. while the most recent satellite to be launched (December 1970) which we assess as being part of the Navsat program was placed in a near-circular orbit at about 550 n.m. [

]

40. Several things point toward the low-altitude group being a civil system. Satellites at about 400 n.m. have a natural limitation on their potential accuracy. At that altitude, drag induced by solar activity can cause a vehicle to deviate from its intended orbit, resulting in navigation error. The magnitude of the error would be acceptable for most civil applications, but would almost certainly be too great for most military uses. Vehicles in the higher altitude groups would be less subject to this type of disturbance. [

]

41. [

]

The primary users of an accurate Navsat system would probably be Y-class ballistic missile submarines.

42. One bonus that the Soviets could gain from their present Navsat activities would be the refinement of their geodetic data. The satellite's orbital characteristics would be adequate for refinement of geodetic data with the best coverage above 40 degrees north latitude and below 40 degrees south latitude.

43. *Meteorological Satellites.* The past two years have seen an increase in the launch rate of Soviet meteorological satellites (Metsats) but little change in the system itself. During 1970, five satellites were placed in orbit as opposed to 3 and 2 for 1969 and 1968, respectively. The vehicles currently used in the program are viritually the same as those orbited early in the program and the program continues to suffer the deficiencies that have been evident since its inception: a relatively low (400 n.m.) orbital altitude, an optical system with a narrow field of view, and an orbital path that causes the vehicle to view selected areas under slightly different lighting conditions from day to day (the desired situation is for a metsat to view a specific area of interest under the same lighting conditions each pass).

44. The Soviets have stated many times that their Metsat program is directed and operated by the Hydrometeorological Service. There is good evidence, however, that other agencies are directly involved in the program, especially the Strategic Rocket Forces (SRF) which has its own need for the data

45. *Possible Radar Calibration.*

To date some 40 have been launched.

Some of these satellites serve as targets for calibrating phased-array and other large radars.

H. Scientific Satellites

46. The Soviet near-earth scientific satellite program has had little priority for the last five years. This lack of priority is reflected in the unsophisticated payloads used, the low launch rate, and the poor processing of the collected data. In general, these satellites perform investigations in one or more of the following areas:

a. Terestrial and atmospheric radiation studies.

b. Atmospheric composition and structural studies.

c. Ionospheric studies.

d. Magnetospheric studies.

e. Meteoroid studies.

47. Satellites in this category can be lumped into three general groups:

a. *The SL-7 Payloads.* The total number of launches of scientific payloads using the

SL-7 as a booster has dropped off in the last two years. In 1970 there were five attempts in this series and in 1969 there were none. In constrast, there were seven in 1967 and eight in 1968. The spacecraft used in this program are small and unsophisticated. The data the Soviets have reported collecting by their satellites have contributed little that is new to the understanding of the space environment.

b. *INTERCOSMOS*. In 1969 the Soviets started a program of scientific satellites with the label of INTERCOSMOS. Some of the instruments in these payloads have been designed by scientists in the Communist Bloc countries. There have been two launchings in this series in 1969 and two in 1970.

c. *The SL-8 Payloads*. The Soviets launched two satellites in 1970 and one so far in 1971 with the SL-8 booster system which are believed to be part of the scientific program. These are the first satellites of this type launched by the SL-8 which can place greater payloads in orbit than can the SL-7. [redacted]

I. Satellite Interceptor Program

48. The Soviet satellite interceptor program, which we discussed in the last estimate on the Soviet space program under the heading "maneuverable satellites", is continuing apace. The program over the past two years has involved 13 launches. Since this is now accepted as a purely military program, it is treated in detail in NIE 11-3-71, "Soviet Strategic Defenses", dated 25 February 1971, TOP SECRET ALL SOURCE,

J. Uncategorized Satellites

49. The Soviets have on several occasions since the beginning of their space program, orbited satellites whose characteristics or functioning did not allow them to be placed in any of the categories discussed above. Some of the programs, whatever their intent, were short-lived, comprising only a few vehicles. Others have continued for several years. Some of these launches almost certainly were related to later developments whose purpose became clear after a period. Some were probably related to programs which never came to fruition for one reason or another. Some are continuing but we still cannot fit them into any known or suspect program.

50. Eleven such launches occurred during the past two years. Two involved groups of eight satellites orbited by a single launch vehicle. The orbital altitude was about 900 n.m. These exhibited some characteristics of a system intended to serve as relay link for communications which were not so urgent as to require real-time transmission. [redacted] Two launches involved only a single satellite which had different characteristics than the multiples. Both of these programs may relate to a communications system intended to relay command and control data which does not need to be passed on a real-time basis. [redacted]

51. Two launches involved a payload which used an injection engine to place it in a near-circular orbit 500 n.m. above the earth. [redacted] Since

the SL-11 that launched the vehicle is normally used for military-related programs, this launch may have some military-related role but we cannot at this time determine what it would be.

52. Two vehicles were launched that carried a variable thrust engine that was used to effect two in-plane changes in the orbit. This is the only objective of the flight that we can identify. The operation of the engine is comparable to that used in soft-lunar-landing missions. However, we cannot yet determine how the engine will ultimately be used.

53. One payload was orbited which appears to have included the fourth stage of the SL-12 launch vehicle. This composite spacecraft performed six maneuvers. Five involved in-plane changes in the orbit while the sixth changed the plane of the orbit, a maneuver which requires considerably more energy than an in-plane change. Aside from testing the restart capability of the engine, the ultimate use of this payload is not clear.

ANNEX B

BLANK PAGE

SOVIET SPACE LAUNCH VEHICLES

(See Figure 6.)

1. *SS-6 Family*. The SS-6 surface-to-surface missile, first launched in August 1957 and subsequently deployed as the Soviets first-generation intercontinental ballistic missile, has been used in numerous space events with a variety of payloads and is still used extensively as the first and second stages of the SL-3, SL-4, and SL-6 launch vehicles.[1]

2. The SL-3 uses the SS-6 booster and has a third stage referred to as the "Lunik" stage. This launch vehicle has been used for direct-ascent launch attempts to the moon, in manned missions (Vostoks 1 through 6), and in early photoreconnaissance flights. These missions were subsequently taken over by higher performance boosters. Since mid-1967 the SL-3 has been used only for meteorological satellite launches from Plesetsk. However, Cosmos 389 (launched on 18 December 1970) is the first of a new series of payloads launched by this system. The SL-3 is capable of placing about 5,000 pounds in a 400 n.m. circular orbit from Plesetsk.

3. The SL-4 uses the SS-6 booster plus a third stage named the "Venik" stage. Its first successful launch was from Tyuratam in November 1963, carrying a photoreconnaissance satellite. It has since been employed extensively at Tyuratam to orbit the manned Voskhod and Soyuz vehicles and their unmanned precursors, and at both Tyuratam and Plesetsk to orbit photoreconnaissance satellites. The SL-4 was also used to orbit the unmanned Soyuz-class vehicles which performed the automatic rendezvous and docking experiments (Cosmos 186 and 188 in 1967 and Cosmos 212 and 213 in 1968). The SL-4 can put up to 15,000 pounds into low-earth orbit.

4. The SL-6 is an SL-4 with the addition of a fourth stage capable of delivering about 15,000 pounds of thrust. This fourth stage, with the payload, is placed in a near-earth parking orbit. Following a coast period, this stage is ignited and injects the payload into a highly elliptical orbit or on a lunar or planetary trajectory. The system was first launched in October 1960 and resulted in a failure of a Mars mission. This vehicle has been used for interplanetary and lunar probes and to place Molniya communications satellites in orbit. Until 19 February 1970, when a Molniya was launched from Plesetsk, all the launches had come from Tyuratam. The role of the SL-6 in interplanetary and lunar missions probably has ended, with the SL-12 assuming that role.

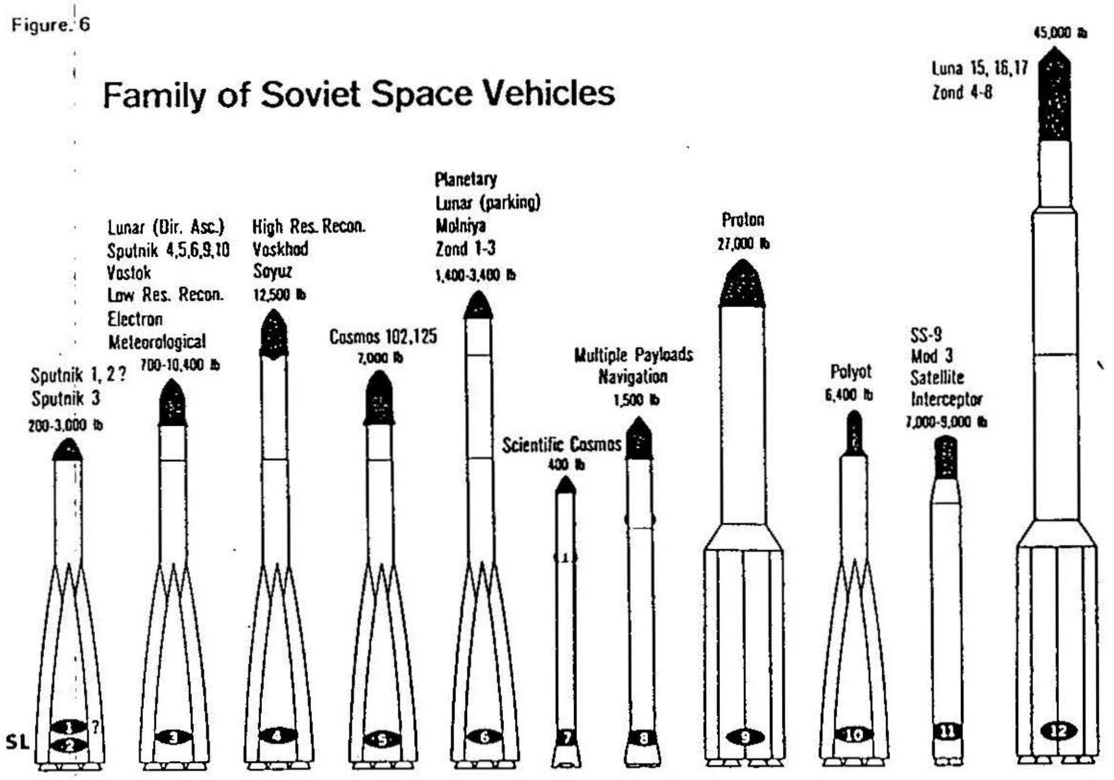
5. *SL-7*. The SL-7 is a two-stage launch vehicle that uses a modified SS-4 medium-range ballistic missile as its first stage plus a new second stage. The second stage develops a thrust of 24,000 pounds. The launch vehicle

---

[1] The SL-1, 2, 5, and 10, all members of the SS-6 family, are no longer used. The SL-1 probably was used to orbit Sputniks 1 and 2. The SL-2 was used to orbit Sputnik 3. The SL-5 was essentially an SL-3 with a restartable fourth stage and was associated with only two launches. The SL-10 was the SS-6 with a restartable third stage and was used to orbit Polyots 1 and 2.

Figure. 6

Family of Soviet Space Vehicles



560332 6-71 CIA

was first tested in October 1961 but was not successful until March 1962, when Cosmos 1 was orbited from Kapustin Yar. Since then, the SL-7 has been used to orbit non-recoverable non-scientific satellites from Plesetsk and scientific satellites from both Plesetsk and Kapustin Yar. The SL-7 can place about 1,000 pound in a low-earth orbit.

6. *SL-8.* The SL-8 is a two-stage launch vehicle that uses a modified SS-5 intermediate-range ballistic missile as its first stage and a new second stage having a multiple restart capability. This vehicle was first launched in August 1964 and has been used from both Tyuratam and Plesetsk for vertical probes, navigation satellites, scientific satellites, and ELINT reconnaissance missions. The SL-8 is capable of placing about 3,000 pounds into near-earth orbit when launched from Tyuratam.

7. *SL-9.* The SL-9 was launched only four times in what were believed to be feasibility tests of components and subsystems that were later incorporated into the SL-12 vehicle.

8. *SL-11.* The SL-11 is used to orbit spacecraft associated with the satellite interceptor program. It consists of the same two stages as on the SS-9 intercontinental range ballistic missile.

9. *SL-12.* The SL-12 launch vehicle—the largest the Soviets have used—has a lift-off weight of about 1.8 million pounds. It was used in a three-stage configuration to place the 37,000 pound Proton 4 scientific satellite

into a low-earth orbit. In a four-stage configuration, it has placed about 45,000 pounds in a low-earth orbit. The fourth-stage engine has demonstrated a restart capability that enables the Soviets to put about 14,000 pounds on a trajectory to the moon and will allow them to put about 6,000 pounds into a synchronous orbit.

10. The payload capability of the SL-12 is adequate for a variety of earth-orbital, lunar, and planetary missions. It has been used in the Zond program, for the Luna 15/16 and Lunokhod 1 missions, for probes to Mars, and to put the Salyut vehicle in orbit. The SL-12's development and use have been slowed significantly by repeated failures (14 in the first 27 launches). However, seven of the nine latest launches have been successful, indicating that the problems have been solved. This launch system is expected to be used for future lunar and planetary missions, for earth-orbital missions such as large space stations, and to place satellites in geosynchronous earth orbit.

12. *J-Vehicle*. The Soviet's largest space booster was first observed in December 1967 at the J complex at Tyuratam. This launch system has been designated the J-vehicle. All estimates of the vehicle's capabilities have [ ] assumed conventional propellants and probable state-of-the-art engine technology.

13. The booster consists of four stages and is estimated to be capable of putting about 275,000 pounds into low-earth orbit or 75,000 pounds on a lunar trajectory. We estimate that the first stage develops a thrust of 13 to 14 million pounds, the second stage 3.5 million pounds, and the third stage 1.2 million pounds. The fourth stage probably develops about 440,000 pounds of thrust. The total length of the four-stage booster is 253 feet. When the payload (including escape tower) is added, the length reaches 317 feet. The lift-off weight probably is about 10 million pounds.

14. [ ] The first actual launch attempt was undertaken on 3 July 1969 and resulted in an explosion which demolished the vehicle and heavily damaged the launch pad and immediate area. This launch apparently was intended to be an unmanned circumlunar flight with re-entry over the Indian Ocean and recovery in the Soviet Union. On 26 June 1971, another effort to launch a "J-vehicle" also ended in failure when the booster malfunctioned some 50 seconds after lift-off. This latest attempt appeared to be intended primarily as a propulsion test rather than some type of space mission.

15. Although there is no evidence of high-energy propellant facilities at Complex J at Tyuratam, we continue to believe that the J-vehicle will eventually be fitted with high-energy upper stages which will permit it to put about 550,000 pounds into earth orbit or about 175,000 pounds on a lunar trajectory.

BLANK PAGE

ANNEX C

BLANK PAGE

SOVIET CHRONOLOGICAL SPACE LOG FOR THE PERIOD

24 June 1969 Through 27 June 1971

Date	Soviet Designation	Mission	Launch Vehicle	Outcome
24 June 1969	Cosmos 287	Photoreconnaissance	SL-4	Success
27 June 1969	Cosmos 288	Photoreconnaissance	SL-4	Success
3 July 1969	None	Possible Lunar Probe	"J-Vehicle"	Failure
10 July 1969	Cosmos 289	Photoreconnaissance	SL-4	Partial Success
13 July 1969	Luna 15	Lunar Lander	SL-12	Partial Success
22 July 1969	Cosmos 290	Photoreconnaissance	SL-4	Success
22 July 1969	Molniya 1/12	Communications	SL-6	Success
23 July 1969	None	Possible Calibration	SL-7	Failure
6 August 1969	Cosmos 291	Engineering Test	SL-11	Unknown
7 August 1969	Zond 7	Circumlunar	SL-12	Success
13 August 1969	Cosmos 292	Navigation	SL-8	Success
16 August 1969	Cosmos 293	Photoreconnaissance	SL-4	Success
19 August 1969	Cosmos 294	Photoreconnaissance	SL-4	Success
22 August 1969	Cosmos 295	Possible Calibration	SL-7	Failure
29 August 1969	Cosmos 296	Photoreconnaissance	SL-4	Success
2 September 1969	Cosmos 297	Photoreconnaissance	SL-4	Success
15 September 1969	Cosmos 298	SS-9 Mod 3*	SS-9 ICBM	Success
18 September 1969	Cosmos 299	Photoreconnaissance	SL-4	Success
23 September 1969	Cosmos 300	Lunar Probe	SL-12	Failure
24 September 1969	Cosmos 301	Photoreconnaissance	SL-4	Success
6 October 1969	Meteor 2	Meteorological	SL-3	Success
11 October 1969	Soyuz 6	Manned Flight	SL-4	Success
12 October 1969	Soyuz 7	Manned Flight	SL-4	Success
13 October 1969	Soyuz 8	Manned Flight	SL-4	Success
14 October 1969	Intercosmos 1	Scientific	SL-7	Success
17 October 1969	Cosmos 302	Photoreconnaissance	SL-4	Success
18 October 1969	Cosmos 303	Possible Calibration	SL-7	Success
21 October 1969	Cosmos 304	Navigation	SL-8	Failure
22 October 1969	Cosmos 305	Lunar Probe	SL-12	Failure
24 October 1969	Cosmos 306	Photoreconnaissance	SL-4	Success
24 October 1969	Cosmos 307	Possible Calibration	SL-7	Success
1 November 1969	None	Undetermined	SL-11	Failure
4 November 1969	Cosmos 308	Possible Calibration	SL-7	Success
12 November 1969	Cosmos 309	Photoreconnaissance	SL-4	Success
15 November 1969	Cosmos 310	Photoreconnaissance	SL-4	Success
24 November 1969	Cosmos 311	Possible Calibration	SL-7	Success

Footnote at end of table.

Date	Soviet Designation	Mission	Launch Vehicle	Outcome
24 November 1969	Cosmos 312	Navigation	SL-8	Success
28 November 1969	None	Engineering Test	SL-12	Failure
3 December 1969	Cosmos 313	Photoreconnaissance	SL-4	Success
11 December 1969	Cosmos 314	Possible Calibration	SL-7	Success
20 December 1969	Cosmos 315	ELINT Collection	SL-8	Success
23 December 1969	Cosmos 316	Possible Engineering Test	SL-11	Unknown
23 December 1969	Cosmos 317	Photoreconnaissance	SL-4	Success
25 December 1969	Intercosmos 2	Scientific	SL-7	Success
27 December 1969	None	ELINT	SL-8	Failure
9 January 1970	Cosmos 318	Photoreconnaissance	SL-4	Success
15 January 1970	Cosmos 319	Possible Calibration	SL-7	Success
16 January 1970	Cosmos 320	Scientific	SL-7	Success
20 January 1970	Cosmos 321	Scientific	SL-7	Success
21 January 1970	Cosmos 322	Photoreconnaissance	SL-4	Success
30 January 1970	None	Possible Scientific	SL-7	Failure
6 February 1970	None	Lunar Probe	SL-12	Failure
10 February 1970	Cosmos 323	Photoreconnaissance	SL-4	Success
19 February 1970	Molniya 1/13	Communications	SL-6	Success
27 February 1970	Cosmos 324	Possible Calibration	SL-7	Success
4 March 1970	Cosmos 325	Photoreconnaissance	SL-4	Success
13 March 1970	Cosmos 326	Photoreconnaissance	SL-4	Success
17 March 1970	Meteor 3	Meteorological	SL-3	Success
18 March 1970	Cosmos 327	Possible Calibration	SL-7	Success
27 March 1970	Cosmos 328	Photoreconnaissance	SL-4	Success
3 April 1970	Cosmos 329	Photoreconnaissance	SL-4	Success
7 April 1970	Cosmos 330	ELINT	SL-8	Success
8 April 1970	Cosmos 331	Photoreconnaissance	SL-4	Success
11 April 1970	Cosmos 332	Navigation	SL-8	Success
15 April 1970	Cosmos 333	Photoreconnaissance	SL-4	Success
23 April 1970	Cosmos 334	Possible Calibration	SL-7	Success
24 April 1970	Cosmos 335	Scientific	SL-7	Success
25 April 1970	Cosmos 336-343	Multipayload, Possibly Communications Related	SL-8	Success
28 April 1970	Meteor 4	Meteorological	SL-3	Success
12 May 1970	Cosmos 344	Photoreconnaissance	SL-4	Success
20 May 1970	Cosmos 345	Photoreconnaissance	SL-4	Success
1 June 1970	Soyuz 9	Manned Flight	SL-4	Success
10 June 1970	Cosmos 346	Photoreconnaissance	SL-4	Success
12 June 1970	Cosmos 347	Possible Calibration	SL-7	Success
13 June 1970	Cosmos 348	Scientific	SL-7	Success
17 June 1970	Cosmos 349	Photoreconnaissance	SL-4	Success
23 June 1970	Meteor 5	Meteorological	SL-3	Success
26 June 1970	Molniya 1/14	Communications	SL-6	Success
26 June 1970	Cosmos 350	Photoreconnaissance	SL-4	Success
27 June 1970	Cosmos 351	Possible Calibration	SL-7	Success
7 July 1970	Cosmos 352	Photoreconnaissance	SL-4	Success
9 July 1970	Cosmos 353	Photoreconnaissance	SL-4	Success
21 July 1970	None	Photoreconnaissance	SL-4	Failure
28 July 1970	Cosmos 354	SS-9 Mod 3	SS-9 ICBM	Success
7 August 1970	Cosmos 355	Photoreconnaissance	SL-4	Success

Date	Soviet Designation	Mission	Launch Vehicle	Outcome
7 August 1970	Intercosmos 3	Scientific	SL-7	Success
10 August 1970	Cosmos 356	Scientific	SL-7	Success
17 August 1970	Venus 7	Venus Lander	SL-6	Success
18 August 1970	None	SL-12 Propulsion Test	SL-12	Failure
19 August 1970	Cosmos 357	Possible Calibration	SL-7	Success
20 August 1970	Cosmos 358	ELINT	SL-8	Success
22 August 1970	Cosmos 359	Venus Lander	SL-6	Failure
29 August 1970	Cosmos 360	Photoreconnaissance	SL-4	Success
8 September 1970	Cosmos 361	Photoreconnaissance	SL-4	Success
12 September 1970	Luna 16	Lunar Lander	SL-12	Success
16 September 1970	Cosmos 362	Possible Calibration	SL-7	Success
17 September 1970	Cosmos 363	Photoreconnaissance	SL-4	Success
22 September 1970	Cosmos 364	Photoreconnaissance	SL-4	Success
25 September 1970	Cosmos 365	SS-9 Mod 3	SS-9 ICBM	Success
29 September 1970	Molniya 1/15	Communications	SL-6	Success
1 October 1970	Cosmos 366	Photoreconnaissance	SL-4	Success
3 October 1970	Cosmos 367	Undetermined	SL-11	Unknown
8 October 1970	Cosmos 368	Photoreconnaissance	SL-4	Success
8 October 1970	Cosmos 369	Possible Calibration	SL-7	Success
9 October 1970	Cosmos 370	Photoreconnaissance	SL-4	Success
12 October 1970	Cosmos 371	Navigation	SL-8	Success
13 October 1970	Intercosmos 4	Scientific	SL-7	Success
15 October 1970	Meteor 6	Meteorological	SL-3	Success
16 October 1970	Cosmos 372	Possibly Communications Related	SL-8	Success
20 October 1970	Cosmos 373	Satellite Intercept Target	SL-11	Success
20 October 1970	Zond 8	Circumlunar	SL-12	Success
23 October 1970	Cosmos 374	Satellite Interceptor	SL-11	Partial Success
30 October 1970	Cosmos 375	Satellite Interceptor	SL-11	Success
30 October 1970	Cosmos 376	Photoreconnaissance	SL-4	Success
10 November 1970	Luna 17	Lunar Lander	SL-12	Success
11 November 1970	Cosmos 377	Photoreconnaissance	SL-4	Success
17 November 1970	Cosmos 378	Scientific	SL-8	Success
24 November 1970	Cosmos 379	Maneuvering Engine Test	SL-4	Success
24 November 1970	Cosmos 380	Possible Calibration	SL-7	Success
27 November 1970	Molniya 1/16	Communications	SL-6	Success
2 December 1970	Cosmos 381	Scientific	SL-8	Success
2 December 1970	Cosmos 382	Maneuvering Engine Test	SL-12	Success
3 December 1970	Cosmos 383	Photoreconnaissance	SL-4	Success
10 December 1970	Cosmos 384	Photoreconnaissance	SL-4	Success
12 December 1970	Cosmos 385	Navigation	SL-8	Success
15 December 1970	Cosmos 386	Photoreconnaissance	SL-4	Success
16 December 1970	Cosmos 387	ELINT	SL-8	Success
18 December 1970	Cosmos 388	Scientific	SL-7	Success
18 December 1970	Cosmos 389	Probable ELINT	SL-3	Success
25 December 1970	Molniya 1/17	Communications	SL-6	Success
12 January 1971	Cosmos 390	Photoreconnaissance	SL-4	Success
14 January 1971	Cosmos 391	Possible Calibration	SL-7	Success
20 January 1971	Meteor 7	Meteorological	SL-3	Success

Date	Soviet Designation	Mission	Launch Vehicle	Outcome
21 January 1971	Cosmos 392	Photoreconnaissance	SL-4	Success
26 January 1971	Cosmos 393	Possible Calibration	SL-7	Success
9 February 1971	Cosmos 394	Satellite Intercept Target	SL-8	Success
17 February 1971	Cosmos 395	ELINT	SL-8	Success
18 February 1971	Cosmos 396	Photoreconnaissance	SL-4	Success
25 February 1971	Cosmos 397	Satellite Interceptor	SL-11	Unknown
26 February 1971	Cosmos 398	Maneuvering Engine Test	SL-4	Success
3 March 1971	Cosmos 399	Photoreconnaissance	SL-4	Success
5 March 1971	None	Photoreconnaissance	SL-4	Failure
5 March 1971	None	Unknown	SL-7	Failure
18 March 1971	Cosmos 400	Satellite Intercepter Target	SL-8	Success
27 March 1971	Cosmos 401	Photoreconnaissance	SL-4	Success
1 April 1971	Cosmos 402	Undetermined	SL-11	Unknown
2 April 1971	Cosmos 403	Photoreconnaissance	SL-4	Success
4 April 1971	Cosmos 404	Satellite Interceptor	SL-11	Unknown
7 April 1971	Cosmos 405	Probable ELINT	SL-3	Success
14 April 1971	Cosmos 406	Photoreconnaissance	SL-4	Success
17 April 1971	Meteor 8	Meteorological	SL-3	Success
19 April 1971	Salyut	Manned Station	SL-12	Success
22 April 1971	Soyuz 10	Manned Flight	SL-4	Failure
23 April 1971	Cosmos 407	Possibly Communications Related	SL-8	Success
24 April 1971	Cosmos 408	Possible Calibration	SL-7	Success
28 April 1971	Cosmos 409	Navigation	SL-8	Success
6 May 1971	Cosmos 410	Photoreconnaissance	SL-4	Success
7 May 1971	Cosmos 411-418	Multiple Satellites	SL-8	Success
10 May 1971	Cosmos 419	Mars Probe	SL-12	Failure
18 May 1971	Cosmos 420	Photoreconnaissance	SL-4	Success
19 May 1971	Cosmos 421	Possible Calibration	SL-7	Success
19 May 1971	Mars 2	Mars Probe	SL-12	Success
22 May 1971	Cosmos 422	Navigation	SL-8	Success
27 May 1971	Cosmos 423	Possible Calibration	SL-7	Success
28 May 1971	Cosmos 424	Photoreconnaissance	SL-4	Success
28 May 1971	Mars 3	Mars Probe	SL-12	Success
29 May 1971	Cosmos 425	ELINT	SL-8	Success
4 June 1971	Cosmos 426	Probable Scientific	SL-8	Success
6 June 1971	Soyuz 11	Manned Flight	SL-4	Ended in the death of 3 cosmonauts
11 June 1971	Cosmos 327	Photoreconnaissance	SL-4	Success
24 June 1971	Cosmos 428	Photoreconnaissance	SL-4	Success
25 June 1971	None	Photoreconnaissance	SL-4	Failure
26 June 1971	None	Propulsion Test	"J-Vehicle"	Failure

*For details of the SS-9 Mod 3 program, see NIE 11-8-70: "Soviet Intercontinental Attack Forces", dated 24 November 1970, TOP SECRET, ALL SOURCE.

CENTRAL INTELLIGENCE AGENCY

DISSEMINATION NOTICE

1. This document was disseminated by the Central Intelligence Agency. This copy is for the information and use of the recipient and of persons under his jurisdiction on a need-to-know basis. Additional essential dissemination may be authorized by the following officials within their respective departments:

a. Director of Intelligence and Research, for the Department of State
b. Director, Defense Intelligence Agency, for the Office of the Secretary of Defense and the organization of the Joint Chiefs of Staff
c. Assistant Chief of Staff for Intelligence, Department of the Army, for the Department of the Army
d. Assistant Chief of Naval Operations (Intelligence), for the Department of the Navy
e. Assistant Chief of Staff, Intelligence, USAF, for the Department of the Air Force
f. Director of Intelligence, AEC, for the Atomic Energy Commission
g. Assistant Director, FBI, for the Federal Bureau of Investigation
h. Director of NSA, for the National Security Agency
i. Director of National Estimates, CIA for any other Department or Agency

2. This document may be retained, or destroyed by burning in accordance with applicable security regulations, or returned to the Central Intelligence Agency by arrangement with the Office of National Estimates, CIA.

3. When this document is disseminated overseas, the overseas recipients may retain it for a period not in excess of one year. At the end of this period, the document should either be destroyed, returned to the forwarding agency, or permission should be requested of the forwarding agency to retain it in accordance with IAC-D-69/2, 22 June 1953.

4. The title of this document when used separately from the text should be classified: ~~SECRET~~

DISTRIBUTION:
White House
National Security Council
Department of State
Department of Defense
Atomic Energy Commission
Federal Bureau of Investigation

TOP SECRET

Controlled Dissem

TOP SECRET