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NATIONAL INTELLIGENCE ESTIMATE

Soviet Space Programs

(Supporting Analysis)

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

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Concurring:

The Deputy Director of Central Intelligence

The Director of Intelligence and Research, Department of State

The Director, Defense Intelligence Agency

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SOVIET SPACE PROGRAMS
(Supporting Analysis)

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SOVIET SPACE PROGRAMS

(Supporting Analysis)

I. LAUNCH SUMMARY

1. The number of Soviet space launches declined slightly from a high of 90 in 1971 to 79 in 1972. A continuation of the rate in the first 354 days of 1973 will result in about 90 launches in 1973. A decline has occurred in many programs, but the largest relative drop was in the [redacted] program. As has been the case since about the mid-1960s, the majority of Soviet space launches have been for satellites with military and intelligence-related missions. The following table shows the numbers of launches by year and by program. The Annex lists Soviet space launches from 1 July 1971 through 20 December 1973.

II. MILITARY AND INTELLIGENCE-RELATED SPACE PROGRAMS

Photoreconnaissance Satellites

2. The Soviets have been conducting a photoreconnaissance program since 1961, and the gathering of photographic data is now the single most active Soviet use of space.

3. There are two broad categories of photoreconnaissance satellites. The first is a low resolution satellite with a "search" mission. This satellite probably is used to look for new targets and to perform broad background studies. The second is a high resolution satellite used in "spotting" missions. Its primary use is for photographing targets whose existence and location is known. This type of satellite also has been used in a search role when the resolution of the other system was not adequate.

4. *Systems.* The low resolution satellites were first launched in late-1961, and there have been no revolutionary design changes since then. In 1968, the film capacity was increased, and the nominal mission duration grew from 8 to 12 days. About 7 million square miles of coverage is achieved with each mis-

SUMMARY OF SOVIET SPACE LAUNCHES 1968-1973

Program	Year 1968	1969	1970	1971	1972	1973 [a]	Results (1968-1973) Launches	Successes	Failures	Unknowns
Military and Intelligence-Related Programs										
Photographic Reconnaissance	29	32	30	30	28	33	182	174	4	4
ELINT Reconnaissance	2	3	4	7	5	5	26	23	2	1
Radar Reconnaissance	1	2	1	2	1	1	8	5	3	0
Photographic-Related	0	0	0	1	2	2	5	5	0	0
Surveillance and Early Warning	0	0	0	0	1	1	2	0	0	2
Communications [b]	4	2	6	7	11	11	41	38	3	0
Meteorological [b]	2	3	4	4	3	2	18	17	1	0
Navigation [b]	1	2	3	2	3	2	13	12	1	0
Geodetic [b]	2	2	0	2	2	1	9	9	0	0
Ground Site Calibration/Checkout [b]	9	13	12	12	11	9	66	60	5	1
Satellite Interceptor	4	2	3	6	1	0	16	14	2	0
Fractional Orbital Bombardment System	2 [c]	1	2	1	0	0	6	6	0	0
Sub-Total	56	62	65	74	68	67	392	363	21	8
Prestige Programs										
Manned and Manned Related	5	5	1	3	2	6	22	19	3	0
Lunar	6	7	4	2	2	1	22	11	11	0
Planetary	0	4	2	3	2	4	15	6	5	4
Scientific	9	2	9	5	5	4	34	32	2	0
Sub-Total	20	18	16	13	11	15	93	68	21	4
R&D and Uncategorized	2	1	4	3	0	1	11	8	3	0
TOTAL	78	81	85	90	70	83 [a]	496	439	45	12

[a] Up to and including Cosmos 624 on 19 December 1973; no launches occurred 20 December 1973. There were five space launches in the remainder of 1973, making a total of 88 in 1973.

[b] These programs, or portions of them, also serve civilian or scientific functions.

[c] Two additional tests occurred in a depressed ICBM mode.

sion. The resolution of the camera system is currently assessed at 7-15 ft. The number of launches of the low resolution system has declined recently from a high of 15 per year to about 10 per year. The increase in mission duration, however, has kept the total days of coverage per year just about the same.

5. The high resolution system also has undergone gradual improvement, but with no revolutionary design changes. When first launched in 1963, it had a nominal 8-day life. Modifications introduced in 1968 included more film, extension to 13-day flights, and the addition of an in-orbit-adjust engine. In 1971, further changes included an improvement to the roll pointing subsystem and more accurate vehicle attitude control. These changes resulted in considerable mission flexibility.

6. The high resolution camera system has an estimated resolution of 3-5 feet and can obtain up to 200,000 square miles of stereo coverage per mission. The roll capability permits it to photograph targets up to about 50 nm either side of its ground trace. The launch rate and days of high-resolution coverage peaked in 1971 (at 22 launches and 250 satellite days respectively). The steady launch rate of about 20 each year shows a heavy emphasis continues to be placed on this program.

7. Both low and high resolution satellites employ a similar low resolution index camera in addition to the primary cameras. The index camera has an estimated resolution of 80-120 feet and a swath width of about 120 nm and yields a total coverage of about 15 million square miles per mission. The index camera operates independently of the main camera and is used to provide coverage primarily over tropical and other remote areas that are not routinely photographed by the primary camera systems. The low resolution is adequate for small scale mapping purposes.

8. *Use.* The programming of the high resolution satellites clearly reflects their strategic purposes. About one-fourth of the known coverage during 1972 and 1973 has been of the strategic facilities of the US, such as Minuteman, Titan, or Safeguard complexes. Washington, D.C., is another favorite target. China now receives coverage equal to the US. About half the coverage is scattered throughout the world, with the Soviet Bloc and Africa (excluding the Middle East) getting very little coverage.

9. Activity by several satellites in the summer of 1972 provides an example of high resolution photo satellite usage for Strategic Arms Limitation (SAL) purposes. Forty-five known camera operations were conducted over US Minuteman silos, by six satellites launched from May through August. This was far more than the normal degree of observed coverage. Nearly 20 of these operations occurred in May, prior to and during President Nixon's visit to Russia and the signing of the initial SAL agreements. Significant activity occurred over Grand Forks, Malmstrom, and Ellsworth Air Force Bases. During this period, ABM construction projects were underway at both Grand Forks and Malmstrom, while Minuteman upgrading was underway at Ellsworth. We believe that the current photoreconnaissance systems can, in general, locate and categorize deployment of land-based strategic systems sufficiently well to verify numerical aspects of strategic arms agreements. However, we are uncertain whether the Soviets currently have the photographic resolution to verify technical agreements on system changes.

10. The coverage from mission to mission is highly variable. In addition, the Soviets ap-

parently have the capability to launch, or reprogram, photoreconnaissance satellites on relatively short notice should an event of importance occur, such as during the Middle East crisis in 1967, the India-Pakistani war in 1971 and the NATO "Strong Express" naval exercise during September 1972. During the Arab-Israeli war in 1973, a succession of 7 satellites were used, 6 of which were launched in 17 days. These special missions had short lifetimes, generally about 6 to 9 days. This presumably was the result of a desire to recover the data rapidly.

11. The Soviets carry out search activity in the PRC with the high resolution camera systems, probably to detect and identify strategic targets, especially nuclear production facilities and missile deployment. The target patterning suggests that the Soviets consider this search important, and find the capabilities of the low resolution system inadequate.

12. *Future Developments.* While the Soviets appear to be generally satisfied with these satellites launched by the SL-4, and we expect them to remain in operation for several years, we also expect several advances.

13. The Soviets have continued their practice of retrieving the entire photographic package. The use of multiple film packages reentered separately would increase operational flexibility. The new spacecraft Salyut-2 (launched in April 1973) may have been related to the development of a man-related reconnaissance system. Such a system, or one involving deorbit of capsules to the USSR, might be operational in the latter part of the 1970s. (If the Soviets chose to orbit multiple recoverable photographic packages, they probably would have to use the SL-13 launch vehicle.)

14. By the early 1980s, a new system (or a radical improvement of a current system) could be developed to cover selected targets on a daily basis, with on-board data processing of the imagery and transmission of the image in near real-time to the USSR.

15. We believe that the Soviets consider targeting objectives world-wide, and balance target priorities, to carry out their satellite photoreconnaissance program. At present, the Soviets probably can obtain yearly coverage of 50 percent or more of the earth's land mass with low resolution photography. More frequent coverage is obtained of high interest targets, such as US ABM construction. By the late 1970s, coverage could improve to once every four to six months. This could continue in the 1980s with slight improvements in resolution. High resolution coverage of the top 100 or so complexes probably is now obtained at least once every three months. The Soviets probably cover about 1,500 complexes per year with high resolution photography. By the late 1970s the number of areas covered could double, and it could double again by the early 1980s. This could be accomplished by using more film and longer lifetimes.

16. The current and mid-term high resolution system(s) will perform general identification of most military targets and yield some technical characteristics that can be based on dimensional measurements of 3-5 foot resolution. These include the strategic weapons of the PRC and US. It will also identify tactical forces that are not interpretable with the 7-15-foot resolution of the low resolution photoreconnaissance system. By the 1980's resolution probably will be improved to the 1-2 feet required for detailed identification and technical assessment of strategic military equipment.

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Radar Reconnaissance

25. In late 1967 the Soviets first used the SL-11 launch vehicle (SS-9) to launch a 9,000 pound satellite possessing a considerable maneuver capability to maintain a precise orbit. Since then, a total of nine of these satellites have been launched from Tyuratam. Three failed to reach orbit, including the most recent launched in April 1973.

26. The objectives of this program include, as a major goal, the development of a space-

borne radar system for the reliable detection of surface ships. The system's present capability probably permits the detection of large ships—such as aircraft carriers—even under adverse sea-state conditions, and may allow the detection of medium- and a few small-sized ships—such as cruisers and destroyers—under certain favorable conditions. There remain some unexplained features in the overall test series, however, indicating it may have objectives in addition to the development of a spaceborne radar system.

27. The facts that the system uses the same command system and the same command and control site as the satellite interceptor spacecraft strongly suggest the program belongs to the PVO. The PVO can better fulfill its mission to protect the USSR if it knows where US aircraft carriers are located. The Soviet Navy would also have an interest in the satellite's data.

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30. After spending a period in low earth orbit, the satellite separates into three major pieces. This appears to mark the end of the satellite's radar reconnaissance role. One object maneuvers to an orbit about 525 nm high, using its own propulsion and attitude control systems. This object has provided little evidence of its purpose, and we do not know why this sequence always occurs.

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31. Successful development of an ocean reconnaissance spacecraft will mean the USSR, if it desires to place a system of these satellites in orbit, would have a capability to detect and locate large surface ships—such as aircraft carriers, even when the vessels are in periods of electromagnetic emission control and in overcast weather. Combined with other data, this capability would significantly expand the USSR's overall capability to locate and monitor the movements of such ships. Further, position accuracies on the order of that required for targeting certain Soviet antiship missiles appear possible. It is doubtful, however, if the Soviets would commit these weapons solely on the basis of these satellites' data, as they could provide little, if any, target identification. The data from such a satellite could be either collated in the USSR or provided to a Soviet ship directly.

32. The overall program appears to be in a mid- to late-stage of R&D. The launch rate implies that the program is not being conducted with any particular sense of urgency. [redacted]

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More R&D tests are likely, and major changes may be incorporated—such as larger swath widths and/or an improved radar—to improve the satellite's capability to detect ships. Thus, although the nature of and the requirement for the system is clear, it is not clear at what point the Soviets would consider their developmental goals are achieved and deployed an operational system. But we believe the Soviets will attempt to develop an operational version of this spacecraft that could be used to obtain information on small ocean areas, and may be able to do so by the 1975-1977 time period. If the Soviets choose to develop a more capable radar reconnaissance satellite, or a radar surveillance satellite, for broad continuing ocean coverage, it probably could not appear until later.

Photographic-Related Satellites

33. The Soviets have in the past two years launched a series of satellites that apparently collect basic mapping and/or geophysical data on world-wide ocean and land surfaces. They carry a low resolution camera that provides extensive coverage of mountain, jungle, and desert land areas and of polar ice fields. What may be another sensor—more than likely sensitive to infrared and/or microwave—records images on film of ocean areas; this could permit determination of ocean temperature gradients and current patterns. [redacted]

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34. These satellites share many technical characteristics with photoreconnaissance satellites. The weight (13,000 pounds), configuration, attitude control system, orbits, and recoverable capability are all similar to the regular Soviet photoreconnaissance programs. There is either only one camera, probably mounted to view vertically, or a system of cameras which always operate simultaneously.

35. The first launch in this series occurred in December 1971, and five have occurred thus far, near the winter or summer solstices (times of maximum or minimum daylight). This results in an optimal opportunity to photograph polar areas at the onset of the ice

navigation season and to photograph land areas at opposite extremes of the vegetation cycle. We expect at least one or two more sets of two launches (winter and summer), but spring and fall launches may be used eventually.

36. The exact purpose and rationale of this satellite program is unclear. Conspicuous is the minimal coverage of the US, the Soviet Union, and large areas of the Northern Hemispheric oceans. [redacted] the satellites may represent the beginning of a separate Soviet economic earth resources survey program, or they may be concentrating on less important areas and represent a continuation of a longstanding effort that has used both manned flights and unmanned satellites. If the satellites do represent just a beginning, we would expect to see the coverage and life duration considerably improved. There is one report that the Soviets intend to modify a Meteor satellite for use as an earth resources satellite in 1974; a specially designed earth resources survey satellite (possibly similar to the US ERTS satellite) could be available by about 1976. On the other hand, it is possible that these satellites represent a continuation of a longstanding program in which aircraft and low resolution reconnaissance satellites have already been employed to photograph high priority areas. Most of the index camera photography by Soviet reconnaissance satellites is expended over non-strategic, particularly equatorial areas, probably reflecting the current areas of emphasis of Soviet foreign mapping programs.

Surveillance and Early Warning

37. The Soviets have no satellites in high altitude orbits that can provide effective strategic surveillance of ballistic missile launches and nuclear detonations, of surface ships and high altitude aircraft, or of electronic emissions or communications. They have, however, indicated interest in such missions with a few of their recent satellites. Two of these, Cosmos 520 and 606, may be prototypes of a future system.

38. Soviet requirements for such satellites exist in varying degrees.

- The PVO Strany does not currently possess a satellite system that could detect launches of strategic missiles. A high altitude system, presumably employing infrared sensors, could overcome this shortcoming and would fill a significant gap in their missile warning.
- A satellite capable of detecting nuclear detonations would be useful for monitoring nuclear testing agreements and in a battle management role in a nuclear war.
- The radar reconnaissance system now being tested does not have the mission life or area coverage to be useful in a surveillance role. A Soviet requirement thus might continue to exist for development of a satellite system that would keep track of the locations of medium- and large-sized ships.

[redacted]

39. The most attractive way in general to perform these missions is with high altitude orbits. These orbits include the semi-syn-

chronous[1] 12-hour orbit used by Molniya communications satellites, the four-day orbits used by Prognoz satellites,[2] and the synchronous (or stationary) orbit used by US-launched Defense Support Program satellites. No Soviet satellites, however, of any kind have thus far been placed in synchronous orbits.

40. We believe the Soviets now have the basic technology for some of these missions and may be capable of the technology for most of them. Sensor development for a missile launch detection mission may have been the purpose of Soyuz 6 and Salyut 1 observations of SS-7 and SS-9 launches in 1968 and 1971. These observations included lock-on, tracking, and data collection of the missiles' exhaust plumes. Although an exact definition of the sensor(s) used for these observations still is unknown, it is probable that a combined visual and IR capability was used.

41. In the area of nuclear detonations, the Soviets have shown an interest in the early 1960s in satellite data collection against Soviet atmospheric tests, and against the effects on the ionosphere of French and Chinese tests in the late 1960s. It is possible that the Prognoz satellites, by virtue of their mission to observe solar radiation and its effects, and by virtue of the satellites' very high orbits, could be applied to the mission of nuclear detonation detection.

42. The characteristics of Cosmos 520 and 606, launched in late 1972 and late 1973, respectively, suggest they may be the first satellites in a high altitude strategic surveillance program. The spacecraft were launched into highly elliptical semi-synchronous Molniya-type orbits, with apogee over the Northern Hemisphere.

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The mission of Cosmos 520 and 606 is undetermined, but we believe that a missile detection role is the most likely. ELINT collection and nuclear detection roles are considered less likely unless they play a secondary role on a common spacecraft.

43. The Soviets are estimated to be capable of placing at least 4,000-6,000 pounds into synchronous orbit with the current version of the SL-12 booster, and could place even more into a semi-synchronous orbit. These weights should be sufficient to deploy a relatively sophisticated surveillance system. The sensor and processing sophistication required to utilize a truly effective early warning or intelligence collection satellite would tax Soviet capabilities, especially in the area of computers.

44. It is likely that PVO facilities in the Moscow area would serve as a ground terminal for any surveillance/early warning type satellite.

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[1] A satellite in semi-synchronous orbit repeats its earth trace every other revolution and has an orbital period of slightly less than 12 hours.

[2] Three spacecraft placed in highly elliptical 4-day orbits.

45. Considering their strategic requirements and level of technology, if Cosmos 520 and 606 do not already represent a prototype series of satellites in semi-synchronous orbits for early warning/surveillance purposes, we expect the Soviets will introduce such a program in the next one to three years. The program might be operational by 1976-1977. Synchronous orbits, while technically possible, are considered much less likely for an operational system until later in the 1970s.

46. In order for an early warning satellite—with infrared sensors—to work optimally, the area of interest has to be looked at from a high elevation angle. But it would not be easy for a USSR-based ground station to control a synchronous satellite with a good viewing angle to the ICBM complexes in the US. Alternative solutions include use of satellite-to-satellite relay, a Cuban ground station, or more likely, semi-synchronous orbits. Inter-satellite relay is technically difficult for such a mission, and we have no evidence that it is being considered for the 1975-1980 period. A Cuban station is unlikely because of the high degree of vulnerability from US intelligence collection and strategic attack forces. There are, nonetheless, areas of the world—such as China and the Indian Ocean—that could be observed optimally by a synchronous satellite which could be easily controlled from the USSR. The Soviets might wish to introduce such a satellite and orbit combination later in the 1970s.

Calibration/Checkout Satellites

47. Another Soviet satellite program supports the PVO Strany by orbiting targets to calibrate ABM ground radars and to check out command and control equipment for interceptor satellites. There are two types of these satellites, generally referred to as Type 5 and Type 10, both launched by a small booster—the SL-7. The program began in 1964 at Kapustin Yar, and moved to Plesetsk shortly after it began. In the past several years there has been no significant change in the launch rate of these satellites, in their orbits, or in their apparent missons. The Soviets launch about 10 of these satellites each year. Use of these satellites is expected to continue at the present level for the next several years.

48. The Type 5 satellites apparently are used as targets for Soviet ABM class radars—most likely small and large Try Add radars—located at ABM sites around Moscow and at R&D sites at the Sary Shagan Missile Test Center. A few radars for other purposes, such as a tracker of RVs on Kamchatka, also may be involved. In addition, these satellites play a role in observations of the atmosphere's density in the ionosphere. The satellites appear relatively unsophisticated.

49. The Type 10 satellites appear to be used for the checkout of gear at monitoring sites involved in the satellite interceptor program. One site also is used in the radar reconnaissance program, and may be involved in the program to develop a Soviet satellite for surveillance and early warning.

Navigation Satellites

50. The first Soviet navigation satellite flight was Cosmos 192, launched in November 1967. Since then payloads have been launched from Plesetsk by the SL-8 launch vehicle into near circular orbits of 400 and 530 nm altitude, with orbital inclinations of 74 and 83 degrees. It appears now that in December 1970 a nominal orbit of about 530 nm altitude was selected as standard. This altitude provides a more stable orbit than the lower one—a highly desirable quality for such satellites. Two naviga-

tion satellite groups, of three satellites each, are now in use—one at 74 degrees inclination, and one at 83 degrees.

51. These satellites transmit ephemeris data (which describe the satellite's position and velocity) and have two beacons for Doppler tracking. These data, collected passively, allow the determination of the user's position. The accuracy of the ephemeris data, however, limits the positional accuracy that can be achieved. Thus far, the Soviets have used data that are inaccurate to the degree that a user could determine position only to about one mile. This feature, on seemingly operational satellites, has been somewhat puzzling.

52. The data do not appear good enough for all military users and have been interpreted as evidence that the program is intended for civil use only. Moreover, the satellites are not programmed on Sundays. It is possible, though, that in a situation of tension, the satellites could be programmed with highly accurate ephemeris data and be available continually. And in that context a user, such as an SSBN, might be able to achieve positional accuracies as good as 300-600 feet.

53. One purpose of these satellites is to provide positional data to Soviet ships. Known examples are Soviet missile range instrumentation ships, oceanographic research ships, tankers, and Z-class submarines (used in scientific expeditions). 25X1, E.O.13526 But even if they are not current users, submarines and surface ships are likely users in the future. It is quite possible, moreover, that other users exist. Examples include mobile land-based ballistic missile elements, geodetic survey elements, and ionospheric propagation researchers. The satellites transmit on a limited basis over and near North America, other non-Soviet areas around the world, and some ocean areas.

54. 25X1, E.O.13526 it is clear that a second subsystem exists on the navigation satellites, and it has been on them since the first one in 1967. It is independent of the navigation subsystem, and is programmed separately. This subsystem operates frequently both over and away from the USSR.

55. Improvements in the accuracy of the satellite-transmitted ephemeris almost certainly will be made eventually, if improved accuracy does not already exist. The Soviets are reducing their geodetic uncertainties through geodetic satellites that are associated with the navigation satellites, as well as by other means. The Soviets also may investigate eventually the use of other concepts (such as triangulation or direct ranging) for improved navigation capabilities. Deployment of sets of satellites at higher altitudes than 550 nm may occur, and they might provide improved position and velocity information for moving users.

Geodetic Satellites

56. The Soviets have gathered rudimentary, indirect world-wide geodetic data since the early 1960s using their photographic reconnaissance satellites. The emphasis was on collecting data over the US. The Soviets have also engaged in optical tracking of non-Soviet satellites—in part under international cooperative programs. The launching of a specific Soviet geodetic satellite system in early 1968 was a natural follow-on and complement to their overall effort in geodesy. The satellite system indicates an intent to provide improved world-wide geodetic ties, and to improve

gravimetric and geodetic models to the extent that they can support very high accuracy targeting of strategic ballistic missiles. It is believed that the satellite system might be able [redacted]

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57. The Soviets have launched nine of these satellites since the program began in early 1968. Light flashes were first observed emanating from these vehicles in late 1971. Subsequently, these flashes were correlated with [redacted] These satellites are launched from Plesetsk by SL-8 boosters. Until recently, the satellites used a near-circular orbit about 650 nm high, with an inclination of about 74 degrees. The two most recent of these satellites use a near-circular orbit about 750 nm high, but still with a 74 degree inclination. This higher orbit provides even better earth coverage, and both types of orbits allow extensive tracking from the Northern Hemisphere, where the Soviet ICBM launch sites and targets are both located. Several kinds of orbits also permit more accurate determination of the earth's gravity field. The orbit also provides several opportunities each day for observations in both the USSR and North America to be made on the same revolution.

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58. The geodetic satellites appear to be very similar to the Soviet navigation satellites. [redacted]

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The satellites have some form of attitude control, probably passive. The details of the spacecraft are not clear; there are [redacted]

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Thus, additional missions or functions are possible. In fact, one [redacted]

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into the Soviet navigational spacecraft. Although no ephemeris data has been intercepted being either loaded into, or transmitted from, the geodetic satellites, it is judged that these vehicles may have the capability to perform a navigational mission.

59. The flashing lights on the geodetic spacecraft permit the Soviets to take measurements without relying on solar illumination. The light pulse sessions, and the beacon transmissions, are programmed to occur over selected areas around the world. In conjunction with this, the Soviets [redacted]

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60. This program probably will continue for several years at about two launches per year, but new inclinations and additional high altitudes may be used. The introduction is expected in the next year or so of laser ranging to further improve the data's quality. Along that line, a Soviet physicist announced the development of a laser to photograph and determine the exact distance of earth satellites. In the future, therefore, geodetic satellites may contain retroreflectors in addition to, or instead of, the active optical system.

Meteorological

61. Only minor changes have been detected in Soviet meteorological satellites since the Soviets began their series of operational weather spacecraft in 1969. The program and the satellites still have certain limitations, in-

cluding a relatively low altitude orbit (now at about 500 nm) and an optical system with a relatively narrow field of view. This has required multiple satellites to provide worldwide coverage. And unlike US weather satellites, which use higher altitude orbits, Soviet weather satellites do not use orbits which are sun-synchronous.[3] Thus, the vehicle observes continually changing lighting conditions around the world, a situation which is overcome in part by a television system which can account for variations in light intensity and particularly by a large network of spacecraft in different orbital planes. (A sun-synchronous orbit for a Soviet weather satellite would require a retrograde launch to the northwest or southeast from Plesetsk, which the Soviets have never done.) [redacted]

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62. Some improvement in the satellites' subsystem reliability has been noted. The lifetime of the video transmission system, for example, appears to have been doubled to about 11 months. The Soviets introduced a real-time photographic transmission capability in 1971 which was probably preprogrammed. This technique, if linked with ground and satellite communications networks, could give the Soviets the capability for providing nearly real-time meteorological data to Soviet military units and ships on a global basis.

63. Soviet developments in the meteorological satellite field are expected to proceed along several fronts. We believe an automatic photographic transmission system will continue to be developed, and may be used in a continuously transmitting mode by 1974. This will increase significantly the utility of the system, particularly for users located in remote areas and for ships at sea. It will also allow many of the developing nations that have receiving equipment for US satellites to receive cloud pictures from Soviet satellites as well. This will enhance Soviet prestige, particularly since the quality of the pictures seems excellent.

64. The Soviets also seem to be working on new subsystems. They reported that they were using ocean buoy-mounted stations for at least the relay of meteorological data; the Meteor satellites could be used for data relay from such stations. In February 1972 two types of electric jet engines were tested on Meteor 10; one was referred to as a plasma engine and the other as an ion engine. The orbital period of Meteor 10 was lowered by 0.3 minutes during a one-week test period; such tests may lead to an operational station keeping and attitude control capability on future meteorological systems. The microwave sensors tested on several Cosmos satellites may appear in future Soviet meteorological satellites.

65. Moreover, we believe that infrared temperature sounders could become standard equipment on meteorological satellites before 1976 or so. These instruments provide very important data on the vertical distribution of temperature through the atmosphere, which must be known to produce accurate weather forecasts. Satellite data of this type are particularly important over remote regions of the globe that are not covered by ground-based observations. The Soviets reportedly also are designing second-generation satellite microwave radiometers for measuring sea

[3] Such orbits compensate naturally for daily changes in the sun's illumination of the earth; these changes occur because of the earth's own rotation and its motion around the sun.

temperatures and for ice reconnaissance, probably for meteorological and oceanographic uses. Sea temperature data could be used in the future as a data base to support a water differential-temperature system for ship or submarine wake detection.

66. It is expected that the current Soviet weather satellites will continue at their present level of activity until 1974-1976 period, when a follow-on spacecraft is expected. It probably will have improved subsystems (video and infrared) and will be placed at somewhat higher altitude—perhaps 800 nm or so. The Soviets have talked about a three-tier meteorological system, using a manned satellite in a near-earth orbit, an improved unmanned meteor at about 550-800 nm, and a geostationary satellite. They also have mentioned a geostationary satellite for the Global Atmospheric Research Program in 1976-1977. Major developments in the 1980s could include a multipurpose vehicle, perhaps combining advanced sensors—such as radars and lasers—with current subsystems.

Communications

67. Soviet use of space systems for communications relay has expanded during the last few years. Not only are new satellite systems emerging, but the older systems are being used in several new ways. Both instantaneous real-time relay and delayed repeater store/dump techniques are now used by Soviet satellites. The real-time satellites are identified by Molniya designators; two types have been launched so far—Molniya 1 and 2—using 12 hour, eccentric, inclined orbits. A follow-on system to Molniya, called Statsionar, using a synchronous orbit, has been announced by the Soviets, but no tests of the system have taken place. The store/dump satellites are given names in the Cosmos series; again, two types have been launched, using 440 and 800 mile circular orbits. Unlike the two versions of Molniya, which have some similarities, the characteristics of the two store/dump types are very different.

68. *Molniya.* The first satellite named in the Molniya 1 Series was launched in spring 1965, although several developmental satellites in the Cosmos series preceded this. Launches using the SL-6 booster have continued regularly, from both Plesetsk and Tyuratam, and 26 satellites have been announced so far. The first of a new series of communications relay satellites—called Molniya 2—was launched in November 1971. Seven of these satellites have been launched, and all have come from Plesetsk. Molniya 1 has used a two-way carrier, capable of 60 voice channels or a single television channel. This low capacity forces the USSR to have many satellites active as well as many ground stations. Molniya 2 reportedly will have a substantial improvement in flexibility over Molniya 1, and a 10-fold increase in relay capacity. This has yet to be demonstrated. The Soviets have continued to launch Molniya 1 type satellites since the first Molniya 2. It thus appears that the USSR will use both programs, at least for a few years. However, the 10 to 1 capacity advantage of Molniya 2 satellites will likely allow Molniya 1 replacement by the 1975-1977 time period.

69. The Soviets' original Molniya system of communications terminals consisted of dual (transmit/receive) antenna sets at five space mission control sites. During the late 1960s and early 1970s, there has been considerable expansion of ground terminals for two-way communications at space mission control sites

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Small dish antennas that might be usable with Molniya satellites have also been seen on several Y-class submarines.

70. There are currently over 45 Orbita receive-only stations to provide distribution of television signals relayed by the Molniya 1 satellites. The Soviets have indicated they will supply a number of these sites with a transmitting capability, thereby allowing them to function in a two-way mode.

71. An Orbita 2 ground terminal network has been announced as being intended for use with Molniya 2 and eventually with the geostationary satellite called Statsionar. This network apparently is still in the early phases of

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The Soviets probably plan 30 or so new Orbita 2 facilities and eventually intend to add Orbita 1 terminals to the network by converting the electronics to the 4-6 GHz frequencies used by Molniya 2.

72. There are several additional sites in the USSR that have medium to large size dish antennas. These steerable antennas may be related to satellite communications relay activity, but the full nature and scope of their involvement has not been resolved.

73. The present Molniya 1 system provides

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74. When the first Molniya 1 was launched in April 1965, the Soviets announced that the Molniya COMSAT system was to provide for the relay of civil communications signals, i.e., television, telegraph, and telephone. However, in June 1965

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SL-8 launch vehicles to orbit two types of store/dump communications satellites from Plesetsk.

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77. In one of these series, a single store/dump satellite is launched at a time. The current orbits are about 440 miles high. Seven have been launched in the current phase; four of them are generally active at one time. Each spacecraft has at least two subsystems for receiving, recording, and retransmitting low-data-rate communications. One communications subsystem is probably used for transmission from the USSR to users and the other subsystem for transmissions from the users back to the USSR.

78. The second store/dump communications series of satellites are launched eight at a time on a single booster and placed in an orbit 800 miles high. There have been eight launches since the first one in 1970, and the Soviets maintain 16, 24, or more, of these satellites active at one time.

79. *Statsionar.* Frequency registration applications for the Molniya 2 and Statsionar 1 satellites originally suggested they would be deployed at about the same time. It now appears the Soviets will deploy a Statsionar in 1975-1976, as they develop ground terminals. The Statsionar 1 satellite probably will be orbited into a geostationary orbit over the Indian Ocean. As they have yet to use such orbits, the Soviets probably will demonstrate their ability to place payloads in geostationary orbit before they are ready to launch Statsionar. Three Statsionar 1 satellites deployed 120 degrees apart would give the Soviets full earth communications coverage. Once in orbit, the satellite will allow military forces in the Indian Ocean to communicate with the USSR using other than HF or VLF means. Moreover, potential international deployment of Orbita sites for use by Statsionar will improve communications with friendly nations and also provide propaganda opportunities.

80. The operational frequencies of Statsionar reportedly will be in the same bands as Molniya 2. Statsionar, like Molniya 2, also will have two operating modes—one for civil communications and one for official users. In addition, the two spacecraft reportedly will have the same electrical characteristics. If so, it seems probable that the Soviets will continue deployment of Molniya 2 ground terminals, and evaluate the communications capacity and capabilities of Molniya 2 before Statsionar is launched.

81. Near the end of 1971, the Soviets entered into an Intersputnik agreement with Warsaw Pact countries, Mongolia and Cuba. This agreement established a Soviet Bloc satellite communications network that is independent of the Intelsat consortium. The Soviets plan to use the Statsionar satellite for Intersputnik with the exception of Cuba, which will work through Molniya 2. A terminal in Cuba announced as being for Intersputnik is nearly complete, whereas there is no evidence of comparable European sites. The Cuba site has some of the characteristics of sites in the USSR and in Mongolia (at Soviet military installations).

82. *New Systems.* The Soviets will likely continue the expansion of the Molniya systems, with increased use by military forces and higher capacity. Moreover, a communications relay capability may be introduced on other types of satellites. Logical candidates are high altitude vehicles—such as Prognoz—or satellites already serving a support role to military forces. Appropriate new users include lower

echelons of the Soviet Armed Forces, official and intelligence related installations abroad, airborne command posts, ballistic missile submarines, and naval command and control ships. We expect that new signal frequencies and modulation techniques will appear with these advances.

III. CIVILIAN AND SCIENTIFIC PROGRAMS

Manned Earth-Orbital Flights

83. Manned Soviet space programs for the 1970s will be primarily space station oriented. The groundwork for the Soviet space station program began with the Soyuz program in 1967. At that time there were at least two primary objectives for the Soyuz craft. One was to serve as a circumlunar vehicle that would upstage the Apollo manned lunar program. Another was as a ferry vehicle for the manned space station program, Salyut.

84. The circumlunar program never proved fruitful due to delays resulting from the Soyuz 1 cosmonaut death and due to the poor flight record of the required booster, the SL-12. It was finally postponed indefinitely when the US succeeded with its manned circumlunar flight, Apollo 8, in December 1968. As a result, progress on the manned lunar landing program slowed. Due to repeated failures of the booster for that purpose, the TT-05, a landing is still not a reasonable possibility for at least five years.

85. Between the Soyuz 1 flight in 1967 and the Salyut 1 launch in 1971, 13 Soyuz craft were launched. During this phase of the program, Soyuz demonstrated only a very limited capability to conduct the critical operations required for maintaining a manned orbital station. Three pairs of Soyuz vehicles completed successful rendezvous and docking operations. Of these, only the Soyuz 4/5 mission was manned, and its personnel transfer was carried out by extra vehicular activity (EVA) instead of through an internal transfer module as on Salyut.

86. The Soviets thus entered their first Salyut mission in 1971 without a single flight test of the docking transfer system. Further, they had conducted only one long duration flight, the 18-day Soyuz 9 mission. And Soyuz 1, Soyuz 2/3 and Soyuz 6/7/8 all experienced equipment failures that prevented the completion of many mission objectives. Thus, while on at least one occasion the Soviets did accomplish some of the key operations required for a space station, the Soyuz spacecraft did not appear reliable enough, by US standards, to warrant its use as an operational ferry. Nevertheless, apparently desiring a space first and the prestige they expected from such an accomplishment, the Soviets proceeded with Salyut 1.

87. The first launch of a Salyut type vehicle occurred in April 1971. It was labeled Salyut 1 by the Soviets, and the term now takes on the meaning of an orbital station which is manned by Soyuz ferry vehicles. Soyuz 10 attempted, but failed, to accomplish a successful dock with Salyut 1. Soyuz 11 docked and personnel transferred, but a Soyuz malfunction led to their death on reentry. Two additional launches of Salyut 1 type vehicles have taken place since. Both were failures. The first, in July 1972, suffered a booster malfunction and did not achieve orbit. The second, Cosmos 557[4] in May 1973, did achieve orbit, but failed very early in flight and was assigned a Cosmos designator.

[4] This vehicle was larger than the Salyut 1 and had a somewhat different configuration.

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88. The purpose of identifying the Salyut 1 type designator is that a second and different Salyut class vehicle, designated Salyut 2 by the Soviets, was launched in April 1973. Although launched by the same booster as Salyut 1, and given the name Salyut, it was noticeably different in its configuration. The most significant difference was its [redacted] mission. At this point the intended mission of Salyut 2 still is not clear. An open source Soviet article suggested a second space station program would parallel the manned station program (presumably the civilian Salyut 1 program). It further suggested that the parallel program would occasionally include "manned visits" to service scientific experiments, but that its primary mission was not manned. It is too early to determine whether Salyut 2 represents the first flight in the parallel program.

89. In addition to the Salyut missions since the summer of 1971, there have been five other man-related launches. The unmanned Cosmos 496, in June 1972, was an apparently sufficient checkout of Soyuz 11 problems prior to the July 1972 Salyut failure. The more recent flights of Cosmos 573, Soyuz 12, Cosmos 613, and Soyuz 13 had similar flight profiles and are believed to be for checkout and use of new or modified spacecraft subsystems rather than for specific corrections to problems which caused the Soyuz 11 disaster. Some of the subsystems may be related to the ASTP. Part of the motivation for the Soyuz 12 and 13 flights probably was to restore US confidence in Soviet manned flight in light of the many manned failures.

The 1971 Salyut 1 Mission

90. The April 1971 Salyut 1 launch marked the beginning of a new phase in the Soviet manned program, being the initial version of a Soviet earth orbiting laboratory. Although the beginning of a new program, it was totally dependent upon Soyuz. Many of the subsystems on Salyut were the same as on Soyuz. And the Salyut was dependent upon the Soyuz for ferrying men to it.

91. The first Salyut mission began with the Salyut 1 launch, followed three days later by the Soyuz 10 launch. One of the critical phases of the mission was to be a successful docking. An indicator of the importance the Soviets placed on the rendezvous and docking was their selection of Cosmonaut Shatalov as Soyuz 10 Commander. Shatalov had gained more experience than his fellow cosmonauts as the commander of the active spacecraft in the only other manned rendezvous mission—the successful Soyuz 5 rendezvous, dock, and EVA crew transfer to Soyuz 4 and the unsuccessful Soyuz 8 rendezvous with Soyuz 7. As pilot of Soyuz 10 Shatalov was unable to perform a rigid dock with Salyut. Although the specific cause of the Soyuz 10 failure is not known with certainty, there was evidence to suggest it was the fault of ground control. [redacted]

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Shortly after the unsuccessful docking attempt, the mission of Soyuz 10 was ended and the spacecraft deorbited. Although the Soviets did not say so explicitly, available evidence suggested that Soyuz 10 was to have involved a crew transfer for a mission of two to four weeks.

92. Seven weeks passed before Soyuz 11 rendezvoused and docked, and the crew performed the internal transfer to Salyut. But almost from the moment the crew boarded Salyut they were beset by numerous equip-

ment malfunctions that interfered with the program of experiments and routine on-board operations. The experiment schedule began to slip two days after the transfer to Salyut. Several times at the end of the first week the crew complained of the heavy work load and insufficient time to conduct experiments. Soon after these complaints a reduced work schedule was initiated. All schedules were discarded a few days later when an electrical fire broke out in one of the equipment panels.

93. The final sequence of the flight began with the undocking and ended with the fatal reentry. The undocking took only 8 minutes, but once again revealed the ground crew inability to react effectively to non-scheduled events. The crew announced that a warning light indicated an internal Soyuz hatch, the one between the reentry capsule and the working compartment, was not sealed. After seven attempts to open and reclose the hatch in a period of about 6 minutes, and apparently satisfied that the light was malfunctioning rather than the hatch, ground control recommended compromising the contact switch on the latch to enable the automatic undocking sequence to proceed.

94. Ground control, aware that the communication session for the undocking was only 10 minutes long and that if they delayed much longer the mission would have to be extended again if recovery were to be made in the intended area, decided to proceed with the undocking. In retrospect, one would have thought the problem deserved more consideration. A potential hatch seal problem deserves more than 8 minutes when the crew is without the added protection of space suits. (Volumetric limitations in the Soyuz capsule did not permit three fully-suited crewmen.) As a result of the deaths, future Soyuz crews will reportedly be limited to two men with suits. This configuration was demonstrated on the September 1973 flight of Soyuz 12.

Soyuz 12

95. When the Soviets began their Salyut 1 flight program in 1971, they probably felt it would permit them to achieve a multitude of manned spaceflight objectives—including increased prestige for the country as a technologically advanced power, economic benefits from scientific experimentation, and development of technology for other Soviet space programs such as Salyut 2.

96. Had it not been for the pressures from the US in ASTP for a successful Soviet manned test, the Soviets may not have had another Soyuz test until the fourth Salyut 1 attempt, expected in early- to mid-1974. However, the pressures were mounting: the Soviets had had no manned tests, their publicized man-related space tests had resulted in failure, and the ASTP test date was nearing. Thus far this Soyuz checkout series has consisted of three tests—the unmanned Cosmos 573 and 613, and the manned Soyuz 12. All appear to have been successful.

97. The primary purpose of the Soyuz 12 flight, [redacted] 25X1, E.O.13526 [redacted] was a thorough engineering checkout of a modified Soyuz spacecraft. Significant aspects of the mission, as determined in preliminary analysis, are:

- The cosmonauts wore pressure suits during both launch and reentry (expected as a result of the Soyuz 11 deaths).
- A possibly new type of docking assembly was checked out and expelled at the end of the flight.

— Particular attention was paid to ambient air pressure in the descent module throughout the flight.

— All experiments appeared to be spacecraft-systems-oriented, with the exception of four photography sessions during revolutions 13-16.

— Tenuous evidence that the Soyuz may now have rotatable solar panels.

The combination of these aspects suggests that possibly both ASTP-related hardware and general Soyuz improvements were tested. The docking assembly may be ASTP related, but the Soviets have stated they have no plans for flight testing of the required ASTP mechanism. More likely it was a test of an improved mechanism for the Salyut/Soyuz interface—one which needed work based on the difficulties encountered during Salyut 1/Soyuz 10. The rotatable solar panels were an apparent effort to solve their spacecraft electrical problems. The use of solar panels on low-altitude spacecraft (such as Salyut/Soyuz) presents a complex attitude control problem. In the past the whole Soyuz spacecraft has had to continually be reoriented toward the sun. With rotatable panels the Soviets may have eliminated this requirement and thus reduced a potential source of control problems.

98. All of the identified aspects of Soyuz 12 could easily have been tested in conjunction with a Salyut flight, and it is likely they would have been, had there been a successful 1972 or 1973 Salyut mission.

General Evaluation of Technical Limitations

99. While the Soviets have conducted numerous space flights which have been fully successful or at least generally so, in moving forward in their manned program they have encountered many problems which they have not foreseen or which have resulted from deficiencies in such areas as planning, designing, construction, or the conduct of the mission. The purpose of this section is to examine the shortcomings we have noted in their manned space flight program that may have an impact on the ASTP mission.

100. *Subsystems.* Chronic failures in the manned program have occurred in both procedures and hardware. This has in part been due to the continued use of outmoded technology. The increasing complexity of the missions attempted has become too much for their technology, with its limited techniques and materials. They frequently have used oversimplified design approaches and have not provided sufficient redundancy or alternatives for inflight emergencies. Failures of Soviet man-related hardware and propulsion and vehicle components demonstrate poor quality control procedures. Production items frequently seem to lack the quality of original single-piece hardware, and changes following operational problems frequently have caused more problems.

101. Soviet man-related onboard systems have demonstrated a high incidence of malfunction—particularly in environmental control components, electrical system units, mechanical elements, and biomedical experimentation apparatus. Questions have arisen concerning the integrity and compatibility of interface seals, connections and latches in Soviet spacecraft, and the flammability of Soviet materials. Major medical and biotechnological limitations were demonstrated during the 24-day mission of the Salyut 1/Soyuz 11 station, quite apart from the decompression problem which caused the death of the crew during the descent phase. The electrical fire onboard,

which probably was caused by overtaxed electrical systems, generated harmful gases and almost caused the station to be abandoned. The crew was exposed to atmospheric contaminants whose toxic effects probably affected their physical and mental stamina. There were recurrent breakdowns of the atmospheric control ventilation system, deficiencies in humidity control units, and potentially dangerous over-heating of the oxygen-producing superoxide chemical beds.

102. Poor human engineering and outmoded cockpit display technology have been noted on Soyuz capsules. Such configurations explain some of their problems and at the least increase the risk of instrumentation reading error during docking operations as well as of potential injury to the crew. Another hardware and potential biological effects problem area is electromagnetic interference due to high power emissions which can create problems for the effective operation of personnel and instruments. Difficulties have been encountered on many manned flights involving HF interference with VHF channels. In general, deficient technology and low reliability of major man-related subsystems, as well as poor design approaches, have added to the stress of Soviet cosmonauts and elevated the operational risks.

POTENTIAL SOVIET ASTP PROBLEM AREAS

DESIGN AREAS

Increased risk of personal injury or spacesuit damage. Human engineering of Soyuz interior is poor. Unguarded power control switches; sharp corners and edges on consoles, hatch passageways and junction boxes; and unsecured cables and hoses could cause problems.

Malfunctions in Soyuz hardware for environmental control system, for docking, and for spacecraft interface because of changes for mission. Previous changes to Soyuz have fixed deficiencies from specific flights, but the hardware has later failed under other flight conditions.

Difficulty in docking. Soyuz uses outmoded technology in cockpit displays; equipment has presented highly erroneous readings and, in addition, contributed to some crews' disorientation early inflight.

Electromagnetic interference (EMI). Difficulty from EMI has occurred on Soviet manned flights; high power Soyuz emitters might effect sensitive instruments and be hazardous to humans.

Low reliability. Soyuz represents early to mid-1960s Soviet technology, which is now deficient in materials, electronics, and subsystem redundancy; e.g., duplicate subsystems are used, as opposed to alternate—or avoidance—subsystems.

PREFLIGHT AREAS

Training time in simulators and mockups. Soviet crews do not get much experience directly transferable to spaceflight.

Mission and flight plans. The Soviet's mission flight plans often have been over-optimistic and, in emergencies, have not been comprehensive.

Spacecraft checkout. The continued existence of Soviet equipment problems on Soyuz, as well as the problems' nature, imply preflight checkout is inadequate.

INFLIGHT AREAS

Equipment checkout and use. Soviet crews' ability to prepare, use, and evaluate gear is limited by their limited training in maintenance and operation.

Crew participation. Soviet crews have very limited freedom of action and are not in the spacecraft's automatic control loop.

Crew discipline. Cosmonauts have not been willing to report all problems and, consequently, some malfunctions and errors are not recognized for later correction.

Management of mission. Soviet manned flights are directed almost completely from the ground; crews continually await ground permission for even minor corrective steps; moreover, key decisionmakers are not always available; and in general, Soviet mission control crews react slowly and inefficiently to complex or unexpected circumstances.

103. *Procedures.* To date there has been considerable disparity between operational flight demands and Soviet cosmonaut capabilities. Cosmonaut crews, particularly in the 1971 Salyut 1 operation, have been inadequately trained and have lacked skill in emergency repair and maintenance as well as in daily onboard operations. Built-in deficiencies in crew preparation have stemmed in part from the Soviet approach, which makes the crew virtual passengers and greatly limits their inflight responsibilities and spacecraft control options. In the past two to three years, poor rapport with—and the ineffectiveness of—ground personnel during flights have been very apparent, particularly in cases of problems and emergencies. During the Salyut 1 mission, neither the crew nor the ground control was sufficiently prepared to deal with the technological and medical problems encountered during the mission. Crew efficiency was impaired by highly questionable medical therapy prescribed by ground control during the fire and descent emergencies, when optimum performance was essential. The crew performed inner hatch operations inefficiently when undocking Soyuz 11 from the Salyut. Both ground control and the crew were unable to assess properly the critical hatch seal problems, and to take steps to solve them, during preparations for retrofire for reentry.

104. Flaws were evident in preparation and implementation of flight plans by crews and ground control. Preflight checkouts of vehicle subsystems have not been thorough, and inadequate crew training in Soyuz maintenance and engineering has limited inflight checkouts. Crews have been reluctant to report all inflight problems and cannot take responsibility for corrective measures without ground permission, even in emergencies.

Manned Lunar

105. *Circumlunar.* The Soviet manned lunar program was planned eventually to include first a circumlunar flight and then lunar landing missions. The lunar Zond program, using the SL-12 booster, apparently had as its ultimate objective a circumlunar flight with a crew of two. We believe that this program was intended to gain experience for manned lunar landings and, as it turned out, to upstage the US Apollo program. The hardware was first flight tested in late 1967, a few days after the beginning of the Apollo flight test program. The Soviets were apparently hopeful that a speedy man-rating of the SL-12 could be accomplished or that the Apollo program would encounter serious delays. They could not have hoped to land a man on the moon, as the SL-12 would not have supported this, but they could have achieved the first manned circumlunar mission had their strategy been successful. But out of a total of eight unmanned circumlunar flights by the end of 1970, three were failures. There have been no circumlunar Zond attempts for the past three years, the SL-12 has never been man-rated, and the Zond manned circumlunar program apparently has been abandoned.

106. *Lunar Landings.* The Soviets have never publicly indicated the existence of their own manned lunar landing program. The evidence of the existence of such a program and its status has stemmed primarily from the development of the TT-05 space launch vehicle and from current Soviet efforts to develop a space suit for use on the moon. Since the catastrophic failure of the first TT-05 launch attempt in 1969, which destroyed the J-1 pad, the Soviets have twice conducted a launch from the J-2 pad, in June 1971, and again in November 1972. Both of these ended in failure. In 1971 the failure

occurred during the first stage operation, and in 1972 during separation of the first and second stages. Repair activity at the J-1 launch pad now appears to be complete, but the rate at which the pad was rebuilt did not indicate a priority need.

107. There is little doubt that the TT-05 was designed to support a manned lunar program. The first and last launch attempts were clearly lunar-related, and like the lunar Zond program, were to include earth-return over or into the Indian Ocean. While we continue to believe that Soviet long-term goals include a manned lunar landing with the establishment of a lunar base, we doubt that a specific schedule still exists. The three straight failures of the TT-05 and the 1½ to 2 years between launch attempts indicate a program slip of at least four years.

108. A program slip of this magnitude moves the Soviet manned lunar landing program at least an equivalent number of years, if not more, into the future. In view of the failures of the TT-05 and problems in general with Soviet manned space programs, we cannot confidently judge when a successful manned lunar landing could be accomplished. If the Soviets successfully launch the TT-05 in the next year or so and accord a priority to the lunar program higher than indicated by the pace of repairs on the J-1 launch pad, they could still conduct a lunar mission before the end of the decade. This would require, however, a consistently successful TT-05 flight test program, and we doubt that the Soviets can do this. Even one additional major failure of the TT-05 will almost certainly push the mission into the early 1980s.

Lunar Probes

109. The Soviets have historically used their lunar program in order to enhance their image as a leading space power and to gain propaganda benefits by scoring spectacular "firsts." Early in the program, the thinly disguised purpose of gathering scientific data played a decidedly secondary role. These early Soviet efforts were characterized by persistence in the face of failure. Five failures preceded the first successful impactor; 11 failures occurred before the first lunar softlanding was accomplished; and there was one failure before a probe was successfully injected into lunar orbit.

110. By 1967 the US had pulled ahead in the lunar "space race." The US achieved the first photography of the moon by a spacecraft in lunar orbit, and the Apollo program was well underway. The Soviet counter-strategy, involving the Zond circumlunar program, failed over the next few years in its aim of sending one or more men around the moon. (See paragraph 105.)

111. Launches of lunar probes, using the SL-12, begun in late 1968 and intended to complement the Soviets limited circumlunar program, eventually became the sole Soviet lunar effort. In a last desperate attempt to compete with the Apollo program, a lunar probe was launched three days prior to the launch of Apollo-11, the first mission in which men landed on the moon. The Soviet lunar probe was scheduled to softland on the moon, gather a soil sample, and return the material to Earth prior to Apollo-11. The probe crashed, leaving the Apollo program unchallenged.

112. Soviet propaganda then took a new tack, claiming that unmanned lunar exploration was safer and more potentially rewarding than the manned Apollo program. At the same time the priority and frequency of launches decreased.

113. Since 1970 one orbiter mission, two soil sample/returner missions, and two lunar rover missions have been successfully accomplished. The primary objectives of the lunar orbiter are to perform scientific studies of the moon and of the solar system from lunar orbit. The most important experiment was the study of the lunar gravitational field. Other experiments carried by the orbiter are related to solar and galactic radiation, photography of some of the surface, and lunar magnetic fields. The primary objective of the return missions is to extract and return lunar soil samples to the Soviet Union. Secondary objectives are to photograph both the landing site and the soil sampling operation and to make radiation and temperature measurements.

114. The Lunokhod rovers returned some prestige to the Soviet lunar program. These rovers continued the Soviet emphasis on unmanned exploration. Two rovers have been landed on the lunar surface in November 1970 and January 1973. Both were controlled by five-man teams on earth. Lunokhod-1 traveled 5.7 nm and survived for 10½ months, while Lunokhod-2 traveled 20 nm but functioned only four months. The primary mission of the Lunokhod rovers was to perform extensive scientific experiments on the lunar surface: laser ranging from earth; astrophysical observations; solar, galactic, and extra-galactic radiation; photography of the nearby areas; magnetic field observations; and lunar soil studies.

115. The Soviets are expected to continue their unmanned lunar exploration efforts at about the same level of activity as in the past few years, primarily with improved lunar rovers and soil return vehicles. Missions involving soil collection by a lunar rover and subsequent transport of the material to a vehicle which would return to earth may occur in the near term. Because of the weights involved, such a mission would require two SL-12s to deliver the two payloads. Exploration of the far side of the moon with a lunar rover may be attempted in the mid-to-far term using a lunar orbiter relay satellite for communications with earth. The Soviets may introduce, too, a non-returnable, lunar scientific base, using a radio telescope, deep core surface samplers, and a seismometer.

116. We think it unlikely that the Soviets could undertake advanced unmanned lunar missions such as a complex scientific or a joint rover/return mission before late in the 1970s, even though a suitable launch vehicle may be available earlier. The development of the advanced payloads required for such missions will be the pacing item.

Planetary Probes

117. The Soviet interplanetary program has been conducted at a much higher level of effort than the US program. While the US has launched only 9 interplanetary probes, the Soviets have launched 34. The scientific instrumentation on the early Soviet probes was relatively crude, but has improved in recent missions. The desire to enhance the Soviet image, and the desire to achieve interplanetary space firsts, were the primary considerations in the early stages of their program. In recent years, however, the scientific aspects have assumed increased importance.

118. The Soviets have continued to launch spacecraft to Venus and Mars at every opportunity, with the exception of the 1967 Mars launch window. The earlier planetary spacecraft, as typified by the Venus probes, have consisted of a bus and a planetary encounter payload and have been launched by the SL-6. The bus provided all spacecraft sup-

port during the cruise phase of the mission and was basically the same regardless of the planetary encounter package. These spacecraft were relatively heavy and have been characterized by a limited number of experiments and by [redacted]

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119. After a long series of failures and partial failures, the Soviets during 1972 finally achieved a landing on Venus with a spacecraft [redacted] Up to that time the Soviet Venus program had been characterized by malfunctioning spacecraft and [redacted] The spacecraft malfunctions can be attributed to the hostile Venus environment and a major error in the original characterization of the Venus atmosphere. [redacted]

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120. A new generation of planetary spacecraft, launched by the SL-12, was first successfully flown in 1971 for the Mars 2 and Mars 3 missions. (Two unsuccessful launches had been attempted in 1969.) Both Mars 2 and Mars 3 combined, on the same spacecraft, a Mars lander and a Mars orbiter with somewhat limited capability and life. In both missions the lander failed to acquire data. The Mars 2 lander crashed due to a steep entry angle, and Mars 3 [redacted] 25X1, E.O.13526 The somewhat higher energy trajectory requirements of the 1973 Mars window compounded the weight problems. To reduce landing velocities the Soviets decided to split the missions, use separate Mars landers and orbiters, and send four spacecraft to Mars. We expect that each set of two spacecraft has some improved capability.

121. The SL-12 launched spacecraft are much larger and more complex than the SL-6 launched spacecraft. These planetary spacecraft incorporate [redacted]

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122. Mars missions in the next five years will be severely hampered by energy considerations. A considerably greater escape velocity will be required for the Soviets to exploit the next Mars window, in September 1975, than has been the case for past probes of that sort. Either the Soviets will have to undertake a different type of trajectory than they have used in the past, which will significantly lengthen the mission and cause communications problems, or they will have to drastically reduce the size of the payload. It is possible that the Soviets will skip this window completely. The 1977 window will have less stringent velocity requirements and the TT-05 or an uprated SL-12 might then be available.

123. Venus probes have no severe limitations from a weight or energy point of view, but a successful probe is difficult because of the very hostile atmosphere. The Soviets skipped their opportunity to launch to Venus during the window in November 1973. Discussions are now underway between the Soviets and the French concerning a project to float balloons in the dense Venusian atmosphere. Such balloons could be part of Venus probes (probably using the SL-12) launched in the follow-on window in mid-1975.

124. Launching one or more space probes to Mercury is a logical extension of the current Soviet planetary program, but we have no evidence they intend to do this. Another Soviet possibility is a Venus swingby mission with flyby or impact on Mercury. We believe that a public relations type attempt could be accomplished next year. A significant scientific venture probably will not occur before the 1976 window.

125. It is unlikely that Soviets will launch a mission to the outer planets before the 1976-1978 period. Such a mission might involve a flyby of Jupiter, and then possibly a gravity assist to another planet. The heaviest payload the standard SL-12 booster could get to Jupiter is too small for any kind of reasonable mission. Consequently, it is unlikely that a Jupiter mission will be forthcoming until new, major developments occur in the Soviet booster or propulsion systems. Lifetime limitations and long distance communications problems will also severely hamper Soviet progress in this area.

Scientific Satellites

126. The Soviets have for many years launched small research satellites to collect data on the space environment within 1,200 miles of the earth. The primary investigations have been of particle radiation and ionospheric characteristics. These satellites have also served as subsystem test-beds and have laid the groundwork for other satellite research programs. Data collection on the space environment for the most part has been taken over by the Intercosmos program of cooperation between the Soviet Union and East European Socialist countries. Intercosmos satellites generally perform near-earth environmental research in four areas: solar emissions, ionospheric and magnetospheric structure, low-energy cosmos rays and low-frequency radiation, and high-energy cosmic rays and cosmic dust.

127. Recently, the Soviets have initiated the Prognoz series which has the announced mission of studying the results of solar activities and their influence on interplanetary space and the earth's magnetosphere. Three spacecraft have been placed in highly eccentric 96-hour (four-day) orbits. Prognoz satellites reportedly collect data on corpuscular radiation, gamma rays, x-rays, and the near-earth magnetic field. Solar plasma fluxes and their interaction with outer regions of the earth's magnetosphere are also observed. These observations are intended to develop the capability to predict more accurately solar radiation levels in near-earth space. It is possible that the Prognoz satellites also could be used to monitor nuclear weapon detonations in the earth's atmosphere or in space. The few data available do not allow us to determine what the spacecraft is doing.

128. In addition to their purely scientific satellites, the Soviets have continued to launch scientific experiments on board other satellites such as their photoreconnaissance, communications, and geodetic satellites. This practice has helped compensate for the small number of scientific satellites launched, but has the disadvantage that the mission parameters are tailored to the primary mission rather than the scientific experiment.

129. Prior to Cosmos 605 in November 1973, the Soviets had not flown a biosatellite [redacted] since the 22-day dog mission in 1966 (Cosmos 110). [redacted] and in the past 5 years payloads of several circumlunar and earth orbital flights have in-

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cluded biological specimens. This practice probably will continue. The payload of Cosmos 605 included white rats, turtles, insects, and fungi. Major problems under investigation were the effects of weightlessness on the function of live systems and biological rhythms, and effects of high energy particles from space radiation on nerve cells.

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130. In 1973, during a visit to the US, prominent Soviet bioastronautics authorities showed marked interest in the methods and technology used for inflight experiments with primates and suggested a joint experiment launched by a Soviet booster. This would be included in the program planned by the USSR for at least one unmanned biological space experiment per year through 1978. A joint space biology project could be of mutual benefit, but the severe constraints which the USSR has imposed on Soviet biologists who have participated in biosatellite missions would create almost insurmountable problems for US space scientists.

131. We expect to see continuing Soviet unmanned space environmental research activities on a modest basis. The Soviets will emphasize the international cooperation aspects by launching foreign sensors on a fairly frequent basis using the SL-7 and SL-8 boosters. Major, lower orbit scientific experiments will tend to be included in Soviet manned space stations.

IV. COOPERATION WITH OTHER NATIONS IN SPACE ACTIVITIES

132. Soviet cooperative ventures in space are fostered, as well as constrained, by considerations of both political advantage and of technical merit. The general thaw in East-West relations over the past several years has reduced the political barriers to Soviet scientific collaboration with other technically advanced nations, particularly the US. Soviet and Western political decisions to pursue a general normalization of relations have prompted the USSR actively to seek possible avenues of scientific and technical exchange as symbols of détente. The Moscow summit agreement on cooperation in space, signed in May 1972, was primarily a political gesture and only secondarily a promise of joint technical cooperation.

USSR-US Cooperation

133. The record of accomplishments in USSR-US cooperation in space is not impressive in absolute terms. In every case the net gain has been in favor of the USSR.

134. Up to early 1962, US overtures to the USSR for cooperation in space activities met with little response. The first rudimentary step in USSR-US space cooperation occurred in 1962 with an agreement to establish a dedicated communications link to exchange meteorological satellite data. Although the US started to transmit data via this link as soon as it was established in 1964, it was not until 1969 that the Soviets started to send relatively significant amounts of their own data. But even now the Soviet data is not always transmitted within the agreed time periods.

135. The next step came in 1965, when a relatively minor agreement was made between NASA and the Soviet Academies of Sciences and Medical Sciences of the USSR to prepare a joint review of space biology and medicine. The agreement called for each country to prepare an equal number of chapters. The review was scheduled to be published in 1969.

After years of drawn-out discussions on the subjects to be covered and the selection of authors for each chapter, a manuscript is now scheduled to be published in 1973.

136. A milestone in US-USSR space cooperation was reached in May 1972, when the two countries agreed on the organization, development, scheduling, and conduct of the ASTP test docking mission in earth orbit. The flight now is scheduled to be carried out in July 1975 and will involve an Apollo Command Service module and a Soyuz spacecraft. Each country is to build its portion of the docking mechanism, but the design was done by the US. The mechanism will be installed on a docking module that also will serve as an airlock and transfer corridor between the two spacecraft. During the docked period—which may last as long as two days—the crews will visit each others' spacecraft and perform a few scientific and applications-related experiments.

137. The agreement that provided for the ASTP mission also pledged both countries to fulfill a Soviet Academy of Sciences and NASA agreement reached in 1971 for cooperation in space sciences and applications. As a part of this program to increase the exchange of data, an agreement was made to exchange information on Mars gained by the Soviet Mars 2 and 3 spacecraft and by the earlier US Mariner mission. To this end, a teletype link was established between the Academy and the Jet Propulsion Laboratory (JPL) in California. During the Mars 2 and Mars 3 missions, information was exchanged over this circuit. In most instances, the data sent by the Soviets were simply a repeat of Tass announcements. Since completion of these missions, the Soviets have forwarded additional data to JPL, but these have been mostly copies of papers presented at international meetings. Similar data have been promised by the Soviets for their current Mars missions. The US has supplied to the Soviets, on request, photographs and maps of the areas of interest to the Soviets.

138. Another area of Soviet-US data exchange has been in earth resources surveys. The two countries have agreed to coordinate experiments and to exchange ground, air, and space observations from various instruments over specified areas in each country. In this agreement, each party is to make observations over its own country. Nothing in the agreements even tacitly agrees to either party making observations over the other's country, although imagery of large areas of the USSR has been taken by the US ERTs spacecraft. (This is available for sale to the public.) While considerable data has been supplied by the Soviets in terms of papers, instrument output, and photographs, much of the data has not been in original form, and photographic products have been released only after much prodding by the US. The agreement specifies that raw data will be exchanged, and the instrument characteristics will be provided. To date this reluctance to supply raw data and instrument characteristics has been a severe hindrance to the data exchange program.

Cooperation with Other Nations

139. In addition to its dealings with the US, the Soviet Union has in the past sought, and continues to seek, space cooperation with other states. The extensive Franco-Soviet program began in 1966 and has expanded slowly since then. In addition, the Soviets have recently begun or are beginning programs with other countries—India, Sweden, West Germany—and with the European Space Research Organization (ESRO). All of these newer programs are still in relatively early

stages, but can be expected to grow. In their efforts with these countries, we believe the Soviets probably are principally motivated by reasons of politics and public relations, although in some cases possible gains in technology may have played a role.

140. Cooperative ventures with the Warsaw Pact nations have been occurring since the late 1960s. These started as technically trivial efforts at public relations, but have grown to a relatively significant degree in the past few years. Other Socialist nations now are included. For these nations, however, the practical, public, and technological gains have not been as fruitful—nor will they be in the future.

France

141. The French, in their cooperative efforts with the USSR, were motivated by a need for ways to orbit experiments for which they do not have launch vehicles, the desire to improve their prestige and status, and a desire to proceed independently of the US. For their part the Soviets hoped to enhance the image of a "special relationship" with France, to gain some publicity, and to profit from French technology. Program difficulties have been caused by Soviet reluctance to release design interface data, operational information, and experimental results, and by French funding problems which have resulted in delays, redirections, and cancellations.

142. Five programs have recently achieved notable success with Soviet-launched French scientific experiments: a solar radiation experiment on the Mars 3 probe, laser reflectors on Lunokhods 1 and 2, ionspheric equipment on the Oreol satellite, solar effects equipment on Prognoz 2, and a technology applications satellite launched piggyback with Molniya 1/20.

143. There also has been some cooperation in a vertical rocket program, using French instrumentation, for studies of the upper atmosphere. Moreover, a program of balloon observations by the French has been used by the Soviets to correlate some of the data collected by their weather satellites. These programs have been moderately successful. The French and the Soviets also are continuing their conjugate point experiments and are preparing to launch a Soviet particle accelerator from Kerguelen Island in the Indian Ocean to project particles along magnetic field lines to the conjugate point in the USSR.

144. One of the more venturesome joint programs was to involve a Soviet-launched probe to Venus. The probe would have deployed a series of balloon-like objects intended to float in the Venusian atmosphere and transmit data back to earth. This program never progressed beyond a proposal and was terminated in about 1971. A similar program has recently been reactivated with US assistance in balloon technology. Present French-Soviet cooperative projects include follow-on experiments similar to those already undertaken. The French and Soviets also have cooperated in television transmissions via the Soviet Molniya system of satellites, but, the program probably has not progressed beyond the test stage.

145. A space medicine program is being implemented to study the effect of cosmic radiation and immunological resistance using experimental biological packages. The program will also study the effect of weightlessness on the brain. The French are also developing an experiment for studying certain elements in space, including hydrogen and deuterium, utilizing an optical resonance method. There has been no announcement as to the satellite to be used or its launch date. We expect

USSR-French cooperative ventures to be continued over the next several years at about the current level of activity and degree of technical sophistication.

India

146. The USSR has been similarly engaged in the past few years in cultivating political and scientific ties with India. Very limited Indo-Soviet cooperation begun in the early 1960s, shortly after the establishment of the Thumba Equatorial Rocket Launching Station (TERLS). (The United Nations Committee on Outer Space later sponsored this site for rocket-launched investigations of the upper atmosphere in the region of the earth's magnetic equator.) A second, much larger step was taken in 1971 when the Soviets began supplying sounding rockets. Well over a hundred have now been launched at TERLS. A few Soviet technicians have been stationed occasionally at Thumba to give technical aid.

147. An even larger cooperative effort is based on an agreement signed in May 1972. It calls for the Soviets to launch an Indian built satellite to carry out ionospheric, neutron, gamma ray, and celestial x-ray measurements. The 500-pound satellite is to be placed into a 49 degree orbit, with an apogee of about 300 nm. The launch probably will take place from Kapustin Yar near the end of 1974. Control of the spacecraft and data collection are to be done at Sri Harikota, near Madras, and by the Soviet land and ship network. Many of the project's details are being handled by the Intercosmos organization.

ESRO

148. The Soviets will launch ESRO's HEOS-A3 (Highly Elliptical Orbiting Satellite) before the end of 1974, probably as a piggyback payload. This is the backup satellite to the HEOS-2, orbited by the US in January 1972. HEOS-A3 is designed to study the interplanetary magnetosphere. This launch stems from an agreement made in 1970 between the Soviet Academy of Sciences and the ESRO. Also, in September 1972, ESRO technicians at the European Space Research and Technical Center (ESTEC) supplied Soviet scientists with the information and equipment necessary to conduct an electrical field experiment. In exchange, the Soviets were to supply ESRO with the experiment's data. Another area of cooperation concerns the correlation of measurements carried out by ESRO's HEOS-A2 and a Soviet Prognoz satellite, which are similar projects. The possibility also exists for a joint project for measuring electrical fields in the magnetosphere and ionosphere by the sounding rockets and satellites.

Sweden

149. The Soviets and the Swedes reached an agreement in July 1973 for a Swedish scientific experiment to be carried on a Soviet satellite. It is expected to be launched during the summer of 1975. The purpose of the experiment is to make detailed studies of the resonance polarization of some of the spectral lines of the sun in the ultraviolet area.

West Germany

150. In September 1970, a West German minister visited the USSR to discuss a cooperative program in a number of scientific fields, including space. Subsequently, an exchange of delegations took place to discuss "concrete measures and project" which were to begin in 1972. An agreement was proposed for a cooperative effort to compare data on ground-based observations of space-related phenomena, such as trying to determine the effect of the space environment on the earth's

magnetic field. Information on the degree and specifics of the program are not available, but it is believed to be purely scientific and is expected to evolve slowly. The program eventually may result in placing a few scientific experiments on Soviet satellites or, similar to the French SRET effort, in the piggyback orbiting of small West German satellites with Soviet payloads.

Socialist Nations

151. Except for limited collaboration with Poland and Czechoslovakia in background research on space physiology, there was little true cooperation between the USSR and the East European nations until 1969. East European scientists often stated that before this time they received more information from the US space program than from the Soviet program. This dissatisfaction among the East Europeans may have contributed to the Soviet relaxation which became apparent with the first launchings of the Intercosmos satellites in 1969 and the "Vertikal" rockets in 1970. Eleven Intercosmos-type satellites have been launched through November 1973. Each has conducted some form of scientific reassessments of solar radiation and its effect on the earth. Each flight has included a variety of equipment, mission support, and data analysis by the cooperating nations. Usually the satellites report back by data link, and are not recovered, but Intercosmos 6 was recovered by the Soviets before its film was analyzed.

Rationale and Prospects for Space Cooperation

152. For a variety of reasons, cooperation in space activities, especially with the US, must appear especially attractive to the USSR:

— A complex form of space cooperation with the West, especially the US, is a politically important symbol of détente. The ASTP agreement was, in fact, a high point of the May 1972 Summit meeting.

— The Soviets doubtless view any dramatic cooperative enterprise—such as ASTP or the exchange of lunar samples—as an opportunity to demonstrate scientific and technical parity with the US. Joint US-Soviet efforts, even if based upon relatively straightforward applications of available technology, will help to refurbish the international image of the USSR as the coequal of the US in space.

— The USSR recognizes—if only privately—the technological preeminence of the US space program, and probably hopes to acquire technology and experience from any space partnership with the US. Not only is the US the natural potential partner for space cooperation, the US also is the country with a space program of sufficient size and diversity to be most useful to the Soviets. Moreover, several European countries also lead the USSR in many of the managerial techniques and technical disciplines needed for advanced space programs, and the USSR can expect to learn from them also.

— Space is a subject of world-wide popular interest and, as the Soviets demonstrated well in the late 1950s and early 1960s, cooperative activities promote a favorable image of the USSR in general.

153. Other considerations, however, serve somewhat to inhibit Soviet efforts at image building and cooperation with the West in space research:

— The USSR remains sensitive about disclosing most of the details of its space

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program. In part, these sensitivities stem from the relatively close linkages between the military and civilian space efforts.

- The Soviets are aware of their technological shortcomings, reluctant to expose them, and reluctant to risk public failure in such undertakings.
- The need to share with political adversaries the credit for cooperative achievements probably does not have as great a significance as it once had. The Soviets would like to have a separate program, supported solely by the "impetus of Communism and the great Soviet state." But they realize that the maintenance of a competitive program is now neither economically nor technologically feasible. Nevertheless, the Soviets are sensitive to criticism that "over-familiarity" with the US degrades the cause of Socialism.

154. A considerable fragmentation of administrative responsibility among the persons and entities involved in the space program throughout the Soviet government, military establishment, industry, scientific-technical leadership and Communist party, has led to problems in resolving policy questions, coordinating effort, and meeting schedules.

155. These considerations indicate that, while technical reasons influence—both positively and negatively—Soviet incentives to pursue cooperative ventures in space, the outlook for cooperation hinges more on Soviet political considerations and decisions than on technical questions. The latter will influence the extent, pace, and success of the cooperation, but the decisions to enter into the cooperation are essentially political. And the political considerations include a number of topics only indirectly related to scientific or technical relationships in space—such as strategic balance with the West, economic problems, internal Soviet political pressures, and criticism by other Socialist nations. From the Soviet standpoint, cooperation with the US in space has been a result of détente, not a reason for it, and we believe this subordination will continue.

156. At the same time, reversing the trend toward détente of the past several years would not be easy. The Soviet leadership has a substantial political stake in these developments—internally as well as externally—and in the economic and technical trade and cooperation accompanying them. Once started, these various facets of détente tend to reinforce one another and, in effect, have their own tendency to keep going. Because of all this, we expect that the Soviets will be interested in more cooperation. But cooperation with the US—and especially the US openness—is a particular strain on the Soviet system of doing things. Any additional cooperative efforts will be as slow and difficult in developing as those associated with ASTP, and the difficulty will grow with the complexity of the cooperation. Moreover, the initiative for any such efforts will come from the top of the Soviet government, as they did with ASTP, not from the organizations running the space program.

157. For the present, the USSR plainly intends to continue the present course of seeking expanded contacts with the West and other nations on space matters. New cooperative ventures have been started in the last couple years. The Soviet media have given heavy coverage to the preparations for the ASTP mission in 1975. In August 1973 Moscow went to inordinate lengths to publicize the US presentation of a lunar sample to the USSR. The clear intent was to impress upon observers the high regard the Soviets set on

space cooperation with the US. In addition to the cooperative ventures with the US and other nations, the Soviets also have entered into international treaty obligations governing activities in space.

158. On balance, as long as détente is useful and its pursuit remains central to Soviet policy toward the West, the USSR is likely to encourage collaboration in space with the US and with friendly third countries. The Soviets will publicly exploit joint ventures both as proof of the value of détente and as evidence of their stature as the equal of the US. At the same time, they will draw what they can from non-Soviet technology to improve the value and efficiency of their own space program. To the degree it feels necessary, the USSR will maintain its interest in space cooperation.

V. ORGANIZATION AND SELECTED TECHNOLOGY AREAS

Organization and Management

159. The general secrecy surrounding the USSR's space program has continued during the past few years, although the Soviets are becoming more willing to discuss some program aspects—such as mission length and objectives—of some publicized flights. This secrecy has resulted from a number of Soviet characteristics, including their history of secrecy and distrust of foreigners, their desire to hide sensitive space activity resulting from the close linkages between the military and civil space efforts, and their unwillingness to expose weaknesses and failures. Consequently, we still have a limited understanding of the organizational structure and dynamics behind all levels of the Soviet space effort—missions, programs, and the overall scope and direction.

160. A diverse grouping of organizations and individuals play significant roles in one or more aspects of the overall program. Reflecting the nature of Soviet society, these entities and persons are found at all levels—in the upper echelons of the Communist Party (Party Secretary D. F. Ustinov), the national government (Military Industrial Commission), the Ministry of Defense (SRF), industry (the Ministry of General Machine Building), and the scientific community (the Academy of Sciences). These organizational features appear to reflect a continuing separation among mission planning; hardware specification, design, production, and use; spacecraft command and control; and postflight evaluation and adjustment. It is probably only at the level of the Politburo that all the aspects of the Soviet space program come together.

161. A central role, however, appears to reside in the Karas' organization of the Soviet Rocket Forces (SRF), which continues to dominate the day-to-day operation of the USSR's space program. The Karas' organization still has its basic functions of:

a. Design coordination of payload specifications for payload customers.

b. Monitoring contract fulfillment and adherence to specifications at all stages of the production process, through a network of military representative teams based at major participating industrial facilities.

c. [redacted] 25X1, E.O.13526

d. [redacted] 25X1, E.O.13526

162. In the past few years there have been several important new insights into the management of Soviet space programs. The most significant one is the recognition that components of the Ministry of Defense (MOD) other than the SRF have a key operating role in the use of space. [redacted] 25X1, E.O.13526 This development may foreshadow the introduction in coming years of other satellites with missions directly supportive of specific military services.

163. The way in which the Soviet space effort is structured creates management difficulties, and it probably makes the solution of problems more difficult than they might be otherwise. Concerned organizations and individuals are from diverse parts of the Soviet power structure, they appear to each other as approximate equals, decisions are by committee, and there is little mechanism for the enforcement of decisions. The basic shortcomings in developing advanced space systems and in conducting complex missions include the management problems of bringing together, assembling, and carrying out operations and systems that are very complex in design and function. The Soviets know about modern management concepts and techniques used in the West—such as project management—but these have not had much exposure or use in the Soviet space program, and are in some ways incompatible with Soviet society.

164. Moreover, adequate supporting industries to provide special equipment, parts, and advanced technical know-how are in relatively short supply in the USSR. It is very difficult to introduce new types of production or the use of radically new materials in existing facilities. To build space systems, a few dedicated facilities with essentially the top choice of workers and engineers carry out most of the design and fabrication. This was adequate years ago, but no longer. Such evidence as we have suggests that one of the functions of the SRF's Karas' organization is the expediting of parts, components, assemblies and systems to maintain production flow against plans and schedules. And this sometimes has been very difficult to do.

165. Problems also show up in space flights. The most noteworthy cases occur in manned missions, probably because of their scope, complexity, and their requirement for quick resolution of problems. The fact that we have identified so many problems in these missions may be, in part, a function of their [redacted] The difficulties have occurred mostly in the conduct of the flight. We have seen problems in [redacted] preparation of the cosmonauts, and in procedures used at the control centers to resolve emergencies. Some aspects of these problems are related to technology, but others stem from limitations in management.

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Communications, Command and Control

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166. The USSR's ability to command and control its spacecraft has continued to improve over the past several years, [redacted] and is largely unified under a component of the SRF's Karas' organization. The central control point for unmanned satellites is near Moscow. The Manned Flight Control Center is located in the Crimea. In addition, a few space systems come wholly, or partially, under the auspices of other national level organizations. The PVO Strany appears to control the Soviet satellite interceptors and space surveillance radars. The Ministry of Communications participates in the operation of some of the communications satellites, and the Hydrometeorological Service in weather satellite activities. Some part of the Soviet Navy probably is involved in the control of the navigation satellites.

167. There are about a dozen sites within the USSR that can command most of the activity of Soviet reconnaissance satellites. These sites also control scientific spacecraft and calibration satellites, and collect data from manned spacecraft, weather satellites, and geodetic spacecraft and others. This extensive deployment of equipment for control of spacecraft gives the Soviets significant redundancy in their command and control network for the older spacecraft systems. This is significant in terms of mission length, survivability, and in terms of controlling large numbers of spacecraft. And this is especially useful during periods of tension for the use of photographic reconnaissance satellites. The newer satellite systems, developed in the late 1960s or now in R&D, have not shown this redundancy of control. We expect, however, that the Soviets will continue expansion of their command and control network, primarily for earth orbital systems, to furnish the required redundancy.

168. The Soviets have stated they are constructing a mission control center somewhere near Moscow specifically for the ASTP. It is possible that the Soviets are modifying and reactivating the old control center near Moscow that was used for the Vostok/Voskhod flights. The new center will avoid the problems of allowing US flight controllers access to either the recently established Manned Flight Control Center in the Crimea, or the older Coordinating Computer Center near Moscow. The capabilities of this additional center, especially in terms of the ASTP mission, are not known.

169. The Soviets also are continuing their construction of space-related antennas throughout the USSR. Most of them are medium and large-sized steerable dish antennas. Of the larger antennas, two diameters have been confirmed (82 and 105 feet). What is probably a single large dish of about 210 feet diameter is under construction outside Moscow. Not all of these antennas are expected to be integrated into the Soviet control network, however. Some of these antennas probably are intended for communications relay use, a few may be for [redacted] and others may see use in radio astronomy.

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170. Of particular interest is the conversion of a former Moscow ABM complex, E21, into a space-related role and the construction there of four large dish antennas 82 feet in diameter. This site may command and control [redacted] or it may relay satellite communications. In March of this year [redacted]

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not rule out the possibility that one of the [redacted]

171. Another former Moscow ABM site, E15, also is undergoing reconstruction, but it is too early to determine its role. Construction includes two buildings housing pedestals for antennas not yet observed. If related to a space role, it might be a terminal for communications satellites or a command site for future space-based surveillance systems.

172. The Soviet fleet of support ships also has been upgraded. The two new space operations control ships (SSOCS) *Yuriy Gagarin* and *Sergi Korolev* have been deployed to the Atlantic Ocean several times. Both vessels carry two medium-sized dish antennas (40 feet diameter); the *Gagarin* also carries two large dishes (82 feet). We expect the types of support exhibited so far to continue for the foreseeable future, such as the *Korolev's* support of manned missions from the Nova Scotia area and the *Gagarin's* role as a relay support vessel near Iceland for Brezhnev's visit to the US. The *Gagarin* has experienced operating problems, such as errors in antenna pointing, and this has lessened somewhat its usefulness.

173. The Soviets are making progress in flight control. The problems the SSOCS have had—such as [redacted] are being resolved. The Soviets have made progress too in the broad area of communications. This is especially significant in lunar and planetary flights, where the missions generally are more constrained by limitations in communications capability. In both cases, the Soviets are using more efficient ways of transmitting data over those great distances. Moreover, on a recent lunar probe (Luna 19) and on the recent Mars probes the Soviets have [redacted]

174. Continued upgrading of the Soviet command and control network is anticipated, generally along the lines the Soviets have demonstrated in the past few years. This includes larger and better-equipped control sites, more sophisticated roles for the support ships, expansion of command capabilities of new satellites, and further deployment of ground terminals for rapid relay of data through satellites. It is also expected that [redacted] By 1980, the Soviets may incorporate dedicated, data relay satellites for real time, global transmissions to and from operational spacecraft. The Soviets already are involved in laser applications for ranging. They are expected eventually to make use of lasers for accurate tracking of spacecraft, and—later on—for providing high data rate relay capabilities from spacecraft.

175. Soviet efforts to improve their flexibility and capability in the general area of spacecraft command and control has resulted in the use of several forms [redacted]

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Booster-Related Developments

176. Soviet progress since the late 1960s in developing launch vehicles and high energy upper-stage continues to be a mixture of successes, failures and attempts at corrections, and the undertaking of new applications.

177. Soviet space boosters still are characterized by those features that allowed the USSR to gain its lead in space exploration through the use of large heavy satellites, but which have now become liabilities. The Soviet approach—which was adequate for several years—did not force early advanced research and the development of more complicated boosters such as the SL-12 and the TT-05. It is clear that the development of the TT-05, and to a certain extent the SL-12, exceeded Soviet capabilities to effectively identify and correct trouble areas with complex launch vehicles during pre-flight testing and checkout. Now the Soviets find themselves years behind in the development of large boosters, and the missions that need such boosters have had to wait.

178. *TT-05.* The very large Soviet launch vehicle, the TT-05, was launched again from Tyuratam in November 1972. It was the third launch since the first one in mid-1969. This event, too, was a failure, although the first-stage apparently performed satisfactorily. The second stage did not ignite, and the booster impacted about 100 nm downrange. It is likely the Soviets will persevere in this developmental effort with about one launch a year until the booster's problems are corrected. We know too little about these problems to predict how long it will take. It is doubtful, however, that this can be done before two more launches occur, thereby pushing the availability date at least to 1975.

179. The reconstruction of the J-1 launch pad, continued launches of the TT-05, and continued construction of support and assembly buildings indicate the Soviets are still very much interested in having available the payload weight capability of this booster. But the unhurried pace of the repairs at J-1 suggests, among other things, that the USSR does not now have a pressing national priority for such a system and that missions requiring this booster—such as planetary and manned lunar—cannot be conducted until later in this decade or the 1980s.

180. *SL-12/13.* The Soviets also have continued to launch the two versions of their second largest space booster—the SL-12/13. (The SL-12 is used for lunar and planetary missions, and the SL-13 for earth orbital.) Eleven launches have occurred since mid-1971, including four recent Mars probes, each launched about a week apart. Unlike the high failure rate of the first few years of this booster's use, there was only one failure in the last 11 launches. Thus, it appears that the Soviets have finally solved the reliability problems this booster experienced earlier.

181. The Soviets are now constructing a new launch site at Tyuratam for a version of the SL-12/13 booster. This site has been under construction since early 1971, and might be ready for use by late 1974 or early 1975. In addition to the conventional propellant tanks, two unique propellant storage buildings are under construction, suggesting the use of high energy propellants with the booster's upper stages. The likely use is in the payload-associated fourth stage, and the likely fuel-oxidizer combination is liquid hydrogen and liquid

oxygen. The introduction of a high-energy fourth stage, or even high-energy third and fourth stages, would raise significantly the weight that the SL-12 could send beyond earth orbit. The weights increase to about 21,000 and 28,000 pounds, respectively for lunar missions, and to about 17,000 and 24,000 pounds for interplanetary missions.

High Energy Propellants

182. In the general area of high energy propellants, the Soviets are continuing their extensive R&D work begun in the mid-1960s. This work, however, has continued slowly and still has not been extended into the flight test stage. Major liquid hydrogen upper stage programs exist at Khimki (Plant 456) and Zagorsk, with other large efforts at Kurumoch, Zelenogorsk, and Nizhnaya Salda. The engine thrust levels being static tested at these sites range from the 15,000-pound class to the 150,000-pound class. Work in toxic propellants—such as liquid fluorine or fluorides, and in special additives, such as beryllium—also is continuing slowly.

183. Flight tests of engines of the 15,000-pound thrust class, using liquid hydrogen, could occur at any time, although the Soviets may wait until the SL-12/13 variant is ready at Tyuratam. Flight tests of larger engines could occur by 1975. Use of a fluorine-based oxidizer might be within current Soviet capabilities. Liquid fluorine/hydrogen engines could be available in 1975-1978. Flight tests of liquid engines with metal additives, and of hybrid propulsion systems, are possible in the 1977-1980 time period.

Other New Programs

184. The Soviets are constructing new launch sites at the Plesetsk and Kapustin Yar space complexes. Construction of *Launch Site 27 at Plesetsk* is proceeding at a rapid pace and could become operational by mid-1974. Thus far, Site 27 most closely resembles the SL-11 site G1 at Tyuratam, which is used to launch the satellite interceptor and radar reconnaissance payloads. The SL-11 booster probably will be used there but we cannot identify the spacecraft.

185. At Kapustin Yar, the *SL-8 launch site 7C* has been completed, and the first test launch occurred in January 1973. Missions may include cooperative ventures, many of which in the past have been launched from Kapustin Yar. The introduction of the SL-8 to Kapustin Yar more than doubles the space payload capability of the complex, heretofore limited to the SL-7 booster and its relatively small payloads.

186. In a key booster-related area of high technology, the Soviets have expressed interest in the US *space shuttle* and indicated they desire such a program. But the USSR is many years from achieving that goal, so far in fact that we cannot predict when a reusable Soviet shuttle of the US type might appear. The electronics, materials, and system test problems mentioned previously would plague any attempts by the Soviets to build such a shuttle quickly. However, we believe that the higher Soviet launch rates and their commitment to a manned space station may make development of a reusable shuttle attractive to them during the 1980s. In the interim, the Soviets will continue to use ferry spacecraft and existing boosters. They may begin to use spacecraft, and possibly boosters' stages, that are "reusable" to some degree. If so, they could claim the first space shuttle, as they did with their manned space station.

Nuclear Power, and Nuclear and Electric Propulsion

187. The Soviets are actively developing several classes of nuclear electric power sources which would be useful in long duration missions, such as those to the planet Jupiter or beyond, and in long duration earth orbital satellites. They could at any time orbit space generators employing thermoelectric or thermionic conversion technologies, and powered by radioisotopes, developing up to about two kw(e) in power. A small nuclear thermoelectric reactor also could be used in this power range, but probably will not. For power levels in the range of a few tens of kw(e), the Soviets seem to prefer in-pile thermionic reactors. Their development and operation of the TOPAZ reactor is now unique in the world, although the US abandoned such a system for lack of immediate mission requirements. They will probably have a system available for use in space at a power level in the 10-50 kw(e) range by the 1977-1978 period. The Soviets reportedly are planning megawatt-size thermionic systems for the 1980s.

188. Both Rankine and Brayton cycle dynamic conversion technologies are also being studied and could be in a system integration phase. Components of such systems have been developed to a high state-of-the-art, but even after some 15 years no applications have been identified. For the range above 100 kw(e), the Soviets are known to be developing thermionic reactor systems, as well as nuclear MHD. The Soviets now lead the US in the areas of thermionic energy conversion for space applications, and are expected to do so throughout the foreseeable future.

189. There is no evidence that the Soviets have a specific development program for a nuclear rocket propulsion system. However, they are known to have an extensive technology effort on gas-core concepts, which hold considerable promise in the long term for both power and propulsion. No meaningful projection can be made for the USSR's application in space of direct nuclear propulsion, other than to say that it is highly unlikely before the mid-1980s.

190. Actual Soviet uses in space of nuclear radioisotope subsystems have been infrequent. They are likely to be used during the rest of the decade, but only at 1 kw(e) or lower energy levels. Uses identified so far are limited to Soviet announcements. In 1965, several small satellites launched into near earth-orbit (Cosmos 80 and 87) used radioisotope power sources. They transmitted for nearly two years. The similar long life and small size of the SL-8 launched multiple satellite store/dump communications spacecraft suggest these satellites may well be using radioisotope power sources. The Soviets used radioisotope heat sources for the Lunokhod moon rovers in 1970 and 1973. Moreover, analysis of an unidentified facility west of Complex G at Tyuratam has led to the conclusion that the installation probably is a checkout facility for radioisotope sources for spacecraft heat and power.

191. In the area of electric propulsion, the Yantar test series of vertical flights operated ion engines that used argon, nitrogen, and air as propellants. The Soviets' stated objective for this work was the achievement of controlled flight in the upper layers of the atmosphere. The demonstrated engines did not develop sufficient thrust to overcome the pay-

load's drag, especially that of the air scoop. Two types of small electric jet engines were tested successfully on Meteor 10: one was referred to as a plasma engine, the other as an ion engine. The orbital period was lowered slightly during a one-week test period. This test, combined with future ones, may lead to a capability for satellite station-keeping and attitude control. In general, the Soviets might begin using primary electric propulsion by the late 1970s for orbital maintenance in earth orbit, and for trajectory corrections on deep space probes. Nuclear electric propulsion systems have for many years been projected for use on interplanetary missions, and we still expect the Soviets may eventually use them for that purpose.

Other Space Technologies

192. In general, Soviet technology lags the West in most of the areas related to space activities. The Soviets also suffer now from a generally shallower base in applying advanced technology to their space program. We do not see the type of technological proliferation apparent in Western—and especially US—space efforts. Since the beginning of the program, they have had relatively large boosters available, and that availability still has not driven the Soviets toward electronic miniaturization and use of low weight materials. With increasing mission requirements and fixed boosters, the Soviets have been finding it hard to improve spacecraft performance. And it is clear that performance compromises have been made to get certain systems—such as the Molniya and radar reconnaissance satellites—to work.

193. The whole field of electronics appears to us to be a major stumbling block. It has impacted in the program across the board—in communications, data processing and sensors, among others. In a key area, a problem has been the Soviets' relative lack of refined instrumentation to determine the cause of failures. This is probably a prime reason that new flight test programs of a complex nature almost always have several failures of one kind or another before successes are achieved. The SL-12 space booster went through a long series of failures between 1967 and 1970 before it became reliable. And the TT-05 is going through a similar experience now that will extend into 1974 at least. Because of this, it appears to us that ground testing has tended to be more of a go/no-go affair with potential failure areas remaining undiscovered until actual flight. This results in an "onion peeling" effect, where the solution of one problem only reveals another. There is evidence that the Soviets are attempting to improve this with improved telemetry systems, and procurement of more simulation equipment for the space program.

194. Sensor technology also enters into their capabilities to perform various space missions. In this context, flight hardware must be differentiated from laboratory equipment. We believe that Soviet scientists and engineers have a high degree of competence in developing radar, optical, magnetic, and radiation sensors in the laboratory. However, fabrication and environment limitations in spacecraft seriously limit Soviet capabilities to use new sensors for earth and space monitoring.

195. In addition to those basic hardware areas, we see problems in spacecraft too. The manned area is of high interest, and chronic failures in the manned program have involved propulsion, payload hardware, as well as man-

related operations and technology. The Soviets have continued to use outmoded technology, and their techniques and materials have become inadequate for the complex tasks now being attempted. They frequently have used oversimplified design approaches and have not provided sufficient redundancy or alternatives for inflight emergencies. The hardware failures demonstrate poor quality control procedures. Production items frequently seem to lack the quality of original single-piece hardware, and design changes following operational problems frequently have caused more problems.

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ANNEX

SOVIET SPACE EVENTS (1 July 1971 to 20 December 1973)

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TCS 889080-73

SOVIET SPACE EVENTS (1 July 1971 – 20 December 1973)

	Soviet Designation	Mission	Launch Site/ Vehicle	Outcome
16 July 1971	Meteor 9	Weather	PL/SL–03	Success
20 July 1971	Cosmos 429	Photoreconnaissance	TT/SL–04	Success
22 July 1971	—	ELINT Reconnaissance	PL/SL 08	Failure
23 July 1971	Cosmos 430	Photoreconnaissance	PL/SL–04	Success
28 July 1971	Molniya 1/18	Communications Relay	PL/SL 06	Success
30 July 1971	Cosmos 431	Photoreconnaissance	TT/SL 04	Success
3 August 1971	—	Radar Calibration	PL/SL–07	Failure
5 August 1971	Cosmos 432	Photoreconnaissance	TT/SL–04	Success
8 August 1971	Cosmos 433	SS-9 Mod 3*	TT/SL 11	Success
12 August 1971	Cosmos 434	Propulsion Testing	TT/SL–04	Success
19 August 1971	—	Photoreconnaissance	TT/SL–04	Failure
27 August 1971	Cosmos 435	Radar Calibration	PL/SL–07	Success
2 September 1971	Luna 18	Lunar Probe	TT/SL 12	Failure
7 September 1971	Cosmos 436	ELINT Reconnaissance	PL/SL–08	Success
10 September 1971	Cosmos 437	ELINT Reconnaissance	PL/SL 08	Success
14 September 1971	Cosmos 438	Photoreconnaissance	PL/SL–04	Success
21 September 1971	Cosmos 439	Photoreconnaissance	PL/SL–04	Success
24 September 1971	Cosmos 440	Command System Checkout	PL/SL–07	Success
28 September 1971	Cosmos 441	Photoreconnaissance	TT/SL–04	Success
28 September 1971	Luna 19	Lunar Probe	TT/SL–12	Success
29 September 1971	Cosmos 442	Photoreconnaissance	PL/SL–04	Success
7 October 1971	Cosmos 443	Photoreconnaissance	PL/SL 04	Success
13 October 1971	Cosmos 444–451	Store/Dump Communications Relay	PL/SL–08	Success
14 October 1971	Cosmos 452	Photoreconnaissance	TT/SL–04	Success
19 October 1971	Cosmos 453	Radar Calibration	PL/SL–07	Success
2 November 1971	Cosmos 454	Photoreconnaissance	PL/SL 04	Success
17 November 1971	Cosmos 455	Radar Calibration	PL/SL–07	Success
19 November 1971	Cosmos 456	Photoreconnaissance	PL/SL–04	Success
20 November 1971	Cosmos 457	Geodetic	PL/SL 08	Success
24 November 1971	Molniya 2/1	Communications Relay	PL/SL–06	Success
29 November 1971	Cosmos 458	Radar Calibration	PL/SL–07	Success
29 November 1971	Cosmos 459	Satellite Intercept Target	PL/SL–08	Success
30 November 1971	Cosmos 460	ELINT Reconnaissance	PL/SL 08	Success
2 December 1971	Cosmos 461	Scientific	PL/SL 08	Success
2 December 1971	Intercos 5	Scientific	KY/SL–07	Success
3 December 1971	Cosmos 462	Satellite Interceptor	TT/SL–11	Success
6 December 1971	Cosmos 463	Photoreconnaissance	TT/SL–04	Success
10 December 1971	Cosmos 464	Photoreconnaissance	PL/SL–04	Success
15 December 1971	Cosmos 465	Navigation	PL/SL–08	Success
16 December 1971	Cosmos 466	Photoreconnaissance	TT/SL–04	Success
17 December 1971	Cosmos 467	Radar Calibration	PL/SL–07	Success
17 December 1971	Cosmos 468	Store/Dump Communications Relay	PL/SL–08	Success
19 December 1971	Molniya 1/19	Communications Relay	PL/SL–06	Success
25 December 1971	Cosmos 469	Radar Reconnaissance	TT/SL–11	Success
27 December 1971	Cosmos 470	Photographic-related	PL/SL 04	Success
27 December 1971	Oreol	Scientific	PL/SL–08	Success

Footnotes at end of table.

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SOVIET SPACE EVENTS (1 July 1971 – 20 December 1973) (Continued)

Date	Soviet Designation	Mission	Launch Site/ Vehicle	Outcome
29 December 1971	Meteor 10	Weather	PL/SL 03	Success
12 January 1972	Cosmos 471	Photoreconnaissance	TT/SL–04	Success
25 January 1972	Cosmos 472	Radar Calibration	PL/SL–07	Success
3 February 1972	Cosmos 473	Photoreconnaissance	TT/SL–04	Success
14 February 1972	Luna 20	Lunar Probe	TT/SL–12	Success
16 February 1972	Cosmos 474	Photoreconnaissance	TT/SL–04	Success
25 February 1972	Cosmos 475	Navigation	PL/SL–08	Success
1 March 1972	Cosmos 476	ELINT Reconnaissance	PL/SL–03	Success
4 March 1972	Cosmos 477	Photoreconnaissance	PL/SL–04	Success
15 March 1972	Cosmos 478	Photoreconnaissance	PL/SL 04	Success
22 March 1972	Cosmos 479	ELINT Reconnaissance	PL/SL 08	Success
25 March 1972	Cosmos 480	Geodetic	PL/SL–08	Success
25 March 1972	Cosmos 481	Radar Calibration	PL/SL–07	Success
27 March 1972	Venus 8	Venus Probe	TT/SL 06	Success
30 March 1972	Meteor 11	Weather	PL/SL–03	Success
31 March 1972	Cosmos 482	Venus Probe	TT/SL–06	Failure
3 April 1972	Cosmos 483	Photoreconnaissance	PL/SL 04	Success
4 April 1972	Molniya 1/20	Communications Relay	PL/SL 06	Success
6 April 1972	Cosmos 484	Photoreconnaissance	PL/SL–04	Success
7 April 1972	Intercosmos 6	Scientific	TT/SL 04	Success
11 April 1972	Cosmos 485	Radar Calibration	PL/SL 07	Success
14 April 1972	Cosmos 486	Photoreconnaissance	PL/SL 04	Success
14 April 1972	Prognoz 1	Scientific	TT/SL 06	Success
21 April 1972	Cosmos 487	Radar Calibration	PL/SL 07	Success
25 April 1972	—	Radar Calibration	PL/SL–07	Failure
5 May 1972	Cosmos 488	Photoreconnaissance	PL/SL–04	Success
6 May 1972	Cosmos 489	Navigation	PL/SL–08	Success
17 May 1972	Cosmos 490	Photoreconnaissance	PL/SL 04	Success
19 May 1972	Molniya 2/2	Communications Relay	PL/SL–06	Success
25 May 1972	Cosmos 491	Photoreconnaissance	TT/SL–04	Success
9 June 1972	Cosmos 492	Photoreconnaissance	TT/SL 04	Success
21 June 1972	Cosmos 493	Photoreconnaissance	TT/SL–04	Success
23 June 1972	Cosmos 494	Store/Dump Communications Relay	PL/SL–08	Success
23 June 1972	Cosmos 495	Photoreconnaissance	PL/SL–04	Success
26 June 1972	Cosmos 496	Unmanned Soyuz	TT/SL–04	Success
29 June 1972	Prognoz 2	Scientific	TT/SL–06	Success
30 June 1972	Cosmos 497	Command System Checkout	PL/SL–07	Success
30 June 1972	Intercosmos 7	Scientific	KY/SL–07	Success
30 June 1972	Meteor 12	Weather	PL/SL–03	Success
5 July 1972	Cosmos 498	Radar Calibration	PL/SL–07	Success
6 July 1972	Cosmos 499	Photoreconnaissance	TT/SL–04	Success
10 July 1972	Cosmos 500	ELINT Reconnaissance	PL/SL–08	Success
12 July 1972	Cosmos 501	Radar Calibration	KY/SL 07	Success
13 July 1972	Cosmos 502	Photographic-related	PL/SL 04	Success
19 July 1972	Cosmos 503	Photoreconnaissance	PL/SL–04	Success
20 July 1972	Cosmos 504–511	Store/Dump Communications Relay	PL/SL–08	Success

Footnotes at end of table.

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TCS 889080-73

SOVIET SPACE EVENTS (1 July 1971 – 20 December 1973) (Continued)

Date	Soviet Designation	Mission	Launch Site/ Vehicle	Outcome
28 July 1972	Cosmos 512	Photoreconnaissance	PL/SL–04	Success
29 July 1972	—	Salyut Station	TT/SL–13	Failure
2 August 1972	Cosmos 513	Photoreconnaissance	TT/SL–04	Success
16 August 1972	Cosmos 514	Navigation	PL/SL–08	Success
18 August 1972	Cosmos 515	Photoreconnaissance	PL/SL–04	Success
21 August 1972	Cosmos 516	Radar Reconnaissance	TT/SL–11	Success
30 August 1972	Cosmos 517	Photoreconnaissance	TT/SL–04	Success
2 September 1972	—	Photoreconnaissance	PL/SL 04	Failure
15 September 1972	Cosmos 518	Photoreconnaissance	PL/SL–04	Success
16 September 1972	Cosmos 519	Photoreconnaissance	TT/SL–04	Success
19 September 1972	Cosmos 520	Possible High Altitude Surveillance	PL/SL–06	Success
29 September 1972	Cosmos 521	Satellite Intercept Target	PL/SL–08	Success
30 September 1972	Molniya 2/3	Communications Relay	PL/SL–06	Success
4 October 1972	Cosmos 522	Photoreconnaissance	PL/SL–04	Success
5 October 1972	Cosmos 523	Radar Calibration	PL/SL–07	Success
11 October 1972	Cosmos 524	Radar Calibration	PL/SL–07	Success
14 October 1972	Molniya 1/21	Communications Relay	PL/SL–06	Success
17 October 1972	—	Store/Dump Communications	PL/SL–08	Failure
18 October 1972	Cosmos 525	Photoreconnaissance	PL/SL–04	Success
25 October 1972	Cosmos 526	Radar Calibration	PL/SL–07	Success
26 October 1972	Meteor 13	Weather	PL/SL–03	Success
31 October 1972	Cosmos 527	Photoreconnaissance	PL/SL–04	Success
1 November 1972	Cosmos 528–535	Store/Dump Communications Relay	PL/SL–08	Success
3 November 1972	Cosmos 536	ELINT Reconnaissance	PL/SL–08	Success
23 November 1972	—	Lunar-related	TT/TT–05	Failure
25 November 1972	Cosmos 537	Photoreconnaissance	TT/SL–04	Success
30 November 1972	Intercosmos 8	Scientific	PL/SL–07	Success
2 December 1972	Molniya 1/22	Communications Relay	TT/SL–06	Success
12 December 1972	Molniya 2/4	Communications Relay	PL/SL–06	Success
14 December 1972	Cosmos 538	Photoreconnaissance	PL/SL–04	Success
21 December 1972	Cosmos 539	Geodetic	PL/SL–08	Success
25 December 1972	Cosmos 540	Store/Dump Communications Relay	PL/SL–08	Success
27 December 1972	Cosmos 541	Photographic-related	PL/SL–04	Success
28 December 1972	Cosmos 542	ELINT Reconnaissance	PL/SL 03	Success
8 January 1973	Luna 21	Lunar Probe	TT/SL–12	Success
11 January 1973	Cosmos 543	Photoreconnaissance	TT/SL 04	Success
20 January 1973	Cosmos 544	ELINT Reconnaissance	PL/SL–08	Success
24 January 1973	Cosmos 545	Radar Calibration	PL/SL–07	Success
26 January 1973	Cosmos 546	Launch Site & Vehicle Test	KY/SL–08	Success
1 February 1973	Cosmos 547	Photoreconnaissance	TT/SL–04	Success
3 February 1973	Molniya 1/23	Communications Relay	TT/SL–06	Success
8 February 1973	Cosmos 548	Photoreconnaissance	PL/SL–04	Success
15 February 1973	Prognoz 3	Scientific	TT/SL–06	Success
28 February 1973	Cosmos 549	ELINT Reconnaissance	PL/SL–08	Success
1 March 1973	Cosmos 550	Photoreconnaissance	PL/SL–04	Success
6 March 1973	Cosmos 551	Photoreconnaissance	TT/SL–04	Success

Footnotes at end of table.

SOVIET SPACE EVENTS (1 July 1971 – 20 December 1973) (Continued)

Date	Soviet Designation	Mission	Launch Site/ Vehicle	Outcome
20 March 1973	Meteor 14	Weather	PL/SL–03	Success
22 March 1973	Cosmos 552	Photoreconnaissance	PL/SL–04	Success
3 April 1973	Salyut 2	Salyut-class Space Station, possibly man-related	TT/SL–13	Failure
5 April 1973	Molniya 2/5	Communications Relay	PL/SL–06	Success
12 April 1973	Cosmos 553	Radar Calibration	PL/SL–07	Success
19 April 1973	Copernicus 500[b]	Scientific	KY/SL–07	Success
19 April 1973	Cosmos 554	Photoreconnaissance	PL/SL–04	Failure
25 April 1973	—	Radar Reconnaissance	TT/SL–11	Failure
25 April 1973	Cosmos 555	Photoreconnaissance	PL/SL–04	Success
5 May 1973	Cosmos 556	Photoreconnaissance	PL/SL–04	Success
11 May 1973	Cosmos 557	Salyut-class Space Station	TT/SL–13	Failure
17 May 1973	Cosmos 558	Radar Calibration	PL/SL–07	Success
18 May 1973	Cosmos 559	Photoreconnaissance	PL/SL–04	Success
23 May 1973	Cosmos 560	Photoreconnaissance	PL/SL–04	Success
25 May 1973	Cosmos 561	Photoreconnaissance	PL/SL–04	Success
29 May 1973	Meteor 15	Weather	PL/SL–03	Success
5 June 1973	Cosmos 562	Radar Calibration	PL/SL–07	Success
6 June 1973	Cosmos 563	Photoreconnaissance	PL/SL–04	Success
8 June 1973	Cosmos 564 571	Store/Dump Communications Relay	PL/SL–08	Success
10 June 1973	Cosmos 572	Photoreconnaissance	TT/SL–04	Success
15 June 1973	Cosmos 573	Soyuz-related Testing	TT/SL–04	Success
20 June 1973	Cosmos 574	Navigation	PL/SL–08	Success
21 June 1973	Cosmos 575	Photoreconnaissance	PL/SL–04	Success
27 June 1973	Cosmos 576	Photographic-related	PL/SL–04	Success
4 July 1973	—	Unidentified	PL/SL–04	Failure
11 July 1973	Molniya 2/6	Communications Relay	PL/SL–06	Success
21 July 1973	Mars 4	Mars Probe	TT/SL–12	Unknown (enroute)
25 July 1973	Cosmos 577	Photoreconnaissance	PL/SL–04	Success
25 July 1973	Mars 5	Mars Probe	TT/SL–12	Unknown (enroute)
1 August 1973	Cosmos 578	Photoreconnaissance	PL/SL–04	Success
5 August 1973	Mars 6	Mars Probe	TT/SL–12	Unknown (enroute)
9 August 1973	Mars 7	Mars Probe	TT/SL–12	Unknown (enroute)
21 August 1973	Cosmos 579	Photoreconnaissance	PL/SL–04	Success
22 August 1973	Cosmos 580	Radar Calibration	PL/SL–07	Success
24 August 1973	Cosmos 581	Photoreconnaissance	PL/SL–04	Success
28 August 1973	Cosmos 582	ELINT Reconnaissance	PL/SL–08	Success
30 August 1973	Molniya 1/24	Communications Relay	PL/SL–06	Success
30 August 1973	Cosmos 583	Photoreconnaissance	TT/SL–04	Success
6 September 1973	Cosmos 584	Photoreconnaissance	PL/SL–04	Success
8 September 1973	Cosmos 585	Geodetic	PL/SL–08	Success
14 September 1973	Cosmos 586	Navigation	PL/SL–08	Success

Footnotes at end of table.

SOVIET SPACE EVENTS (1 July 1971 – 20 December 1973) (Continued)

Date	Soviet Designation	Mission	Launch Site/ Vehicle	Outcome
21 September 1973	Cosmos 587	Photoreconnaissance	PL/SL–04	Success
27 September 1973	Soyuz 12	Manned	TT/SL–04	Success
2 October 1973	Cosmos 588–595	Store/Dump Communications Relay	PL/SL–08	Success
3 October 1973	Cosmos 596	Photoreconnaissance	PL/SL–04	Success
6 October 1973	Cosmos 597	Photoreconnaissance	PL/SL–04	Success
10 October 1973	Cosmos 598	Photoreconnaissance	PL/SL–04	Success
15 October 1973	Cosmos 599	Photoreconnaissance	TT/SL–04	Success
16 October 1973	Cosmos 600	Photoreconnaissance	PL/SL–04	Success
16 October 1973	Cosmos 601	Radar Calibration	PL/SL–07	Success
19 October 1973	Molniya 2/7	Communications Relay	PL/SL–06	Success
20 October 1973	Cosmos 602	Photoreconnaissance	PL/SL–04	Success
27 October 1973	Cosmos 603	Photoreconnaissance	PL/SL–04	Success
29 October 1973	Cosmos 604	ELINT Reconnaissance	PL/SL–03	Success
30 October 1973	Intercosmos 10	Scientific	PL/SL–08	Success
31 October 1973	Cosmos 605	Scientific	PL/SL–04	Success
2 November 1973	Cosmos 606	Possible High Altitude Surveillance	PL/SL–06	Unknown
10 November 1973	Cosmos 607	Photoreconnaissance	PL/SL–04	Success
14 November 1973	Molniya 1/25	Communications Relay	PL/SL–06	Success
20 November 1973	Cosmos 608	Calibration	PL/SL–07	Success
21 November 1973	Cosmos 609	Photoreconnaissance	TT/SL–04	Success
27 November 1973	Cosmos 610	ELINT Reconnaissance	PL/SL–08	Success
28 November 1973	Cosmos 611	Calibration	PL/SL–07	Success
28 November 1973	Cosmos 612	Photoreconnaissance	PL/SL–04	Success
30 November 1973	Cosmos 613	Soyuz-class satellite, man-related	TT/SL–04	Success
30 November 1973	Molniya 1/26	Communications Relay	PL/SL–06	Success
4 December 1973	Cosmos 614	Store/Dump Communications Relay	PL/SL–08	Success
13 December 1973	Cosmos 615	Command System Checkout	PL/SL–07	Success
17 December 1973	Cosmos 616	Photographic-related	PL/SL–04	Success
18 December 1973	*Soyuz 13*	Manned	TT/SL–04	Success
19 December 1973	Cosmos 617–624	Store/Dump Communications Relay	PL/SL–08	Success

[a] For details of the SS-9 Mod 3 program, see NIE 11-8-72, Soviet Intercontinental Attack Forces, dated 26 October 1972, TOP SECRET, ALL SOURCE,

[b] Intercosmos 9.

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