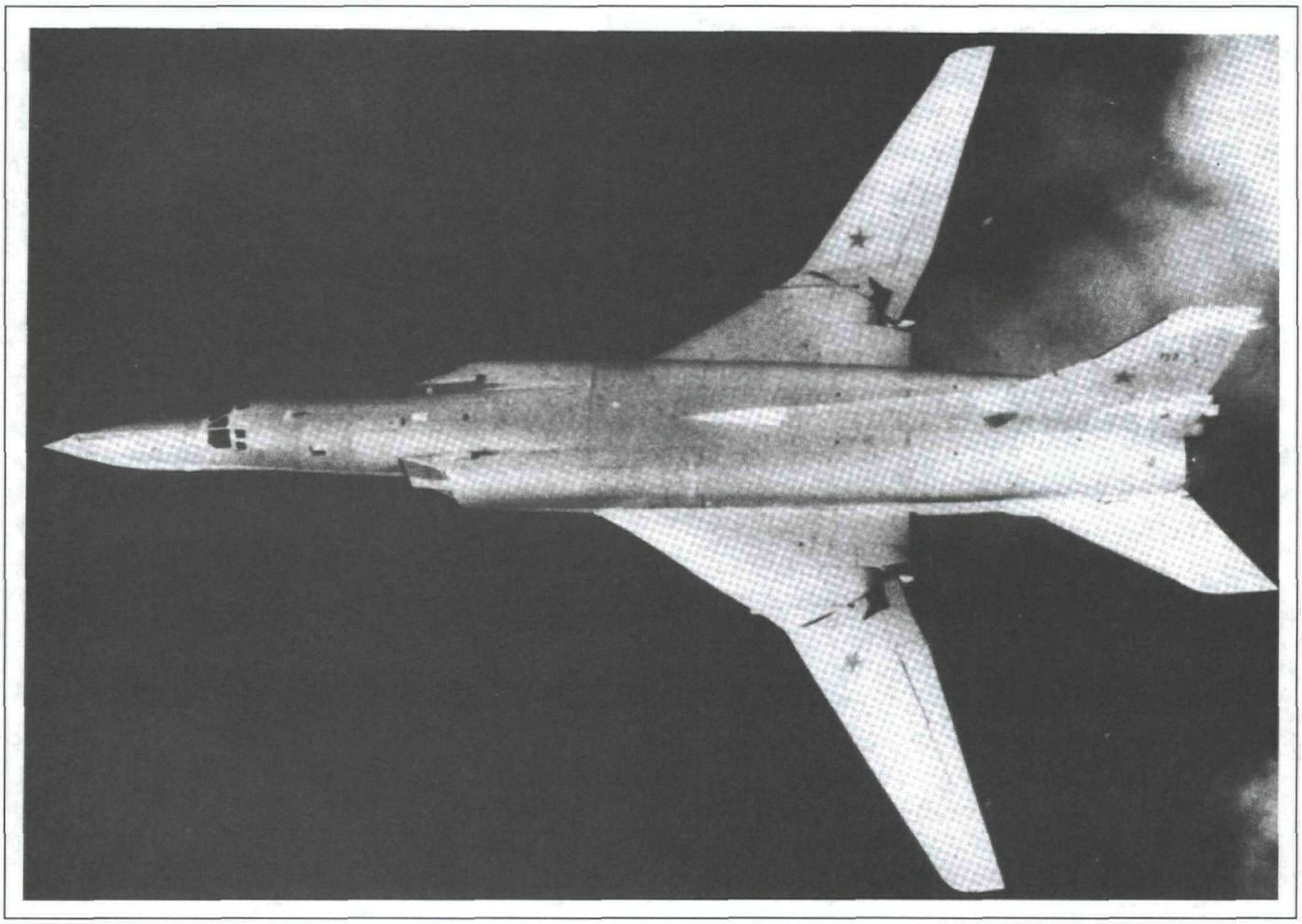
CIA's Analysis of Soviet Science and Technology



CIA's Analysis of Soviet Science and Technology
Author's Comments: Clarence Smith

By the 1950s it was clear that the USSR possessed both nuclear weapons and long-range delivery methods. But key questions remained for US policymakers. How advanced and how effective were these capabilities? Could they be used against the continental United States and its Allies on the USSR's periphery? The answers were fundamental to the US strategic deterrent position.

Technical intelligence was the primary tool used to address these questions because the USSR, Eastern Europe, and China were "denied areas" that presented difficult challenges to traditional human and military reconnaissance collection. These countries were repressive police states that severely restricted internal movement and foreign contacts; they also had effective air defenses. This meant traditional espionage and reconnaissance methods were too limited to provide the access or the information needed by the West to monitor Soviet Bloc weapons and remote test sites. To counter this, the CIA and the Intelligence Community (IC) invented innovative collection approaches using remote sensors. A lack of "hard" intelligence was the key driver in developing US satellite imaging and signals intelligence collection systems. In addition to the actual technical collection, it was necessary to develop ways of deriving analytical results from the raw products of these new collection sources. The IC's challenge was not only to create new collection methods but to derive useful information from the data.

The CIA's Office of Scientific Intelligence, and later the Directorate of Science & Technology (DS&T), led technical intelligence collection and analysis activities. Those who had been involved in analyzing activities such as the Berlin Tunnel taps of Soviet military headquarters in East Germany, formed the original nucleus. Also included were analytical components dealing with science, technology, and weapons. These analysts had to answer key questions about Soviet strategic weapons: How many weapons did the USSR have? What were their capabilities? Where were they located?

The intelligence reports and estimates selected for this volume from the early 1950s through the mid-1980s reflect the impact of advancements in technical collection and analysis. NIE 11-5-59, "Soviet Capabilities in Guided Missiles and Space Vehicles," reflects a basic agreement within the Intelligence Community on Soviet capabilities. By October 1964 (NIE 11-8-64), however, there were debates within the IC about Soviet ICBM capabilities and the number of deployed sites. These disagreements were primarily the result of the fact that, while the United States now had more data, there were now more opportunities for different interpretations of the information. Similarly, in the defensive missile area, IC analysts disagreed over Soviet ABM capabilities. NIE 11-3-65 addresses the beginning of the SAM upgrade issue. These strategic offensive and defensive missile concerns stayed in the forefront of the challenges facing IC analysts well into the 1970s. The selected documents reflect these issues.

17.

INTELLOFAX 6 [redacted] CONFIDENTIAL 30133

CENTRAL INTELLIGENCE AGENCY

Copy #11

12 October 1949

INTELLIGENCE MEMORANDUM NO. 237

SUBJECT: Capabilities of the USSR in Air-to-Air Guided Missiles and Related Proximity Fuses

Part I. 1 May 1950

It is just possible that reproductions of German air-to-air missiles might be ready in limited quantities (less than one hundred) for operational use by the Soviets in 1950. These missiles would be relatively ineffective against a heavily armed bomber of the B-36 type. It is also possible that a relatively crude proximity fuse might be used since such a fuse need not utilize miniature or ruggedized vacuum tubes. See Appendix A for a summary of intelligence data.

Part II. 1 May 1953 and 1 May 1956

Assuming that Soviet scientists engaged in the development of an air-to-air guided missile are the equal of scientists in America and assuming further that they have the benefit of espionage directed against U.S. efforts, it is believed that a Soviet-developed, supersonic, air-to-air guided missile might be ready by 1955. See Appendix A.

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[redacted]

17. (continued)

APPENDIX A

Substance of Intelligence on Air-to-Air Guided Missiles and Proximity Fuses for Them

Except for the comments of one moderately well-placed source, we have no data on Soviet development of air-to-air guided missiles. This source does not know whether or not any of the German projects are being followed up, but he thinks it more than likely, since the Soviets have always been interested in rockets for air-to-air combat.

Two air-to-air missiles were under development by the Germans at the end of World War II. One of these, the X-4, was to be carried aloft and launched from the FW 190 and Me262 aircraft. Development tests of this missile appeared successful, but the missile was never used operationally because of the inherent danger in the liquid-fuel propellant system. A power rocket unit was under development for a safer and more practical propulsion system.

The X-4 had an approximate maximum speed of 820 feet/second and a maximum Mach number of 0.795. The missile was remotely controlled by electrical impulses transmitted along a pair of fine insulated wires connecting it with the parent aircraft. The sense of the signals transmitted and hence the direction the missile travelled was determined by the motion of a joystick operated by the pilot of the parent aircraft. The maximum distance at which the missile could be operated was approximately 3-3/4 miles.

Information on stability and position of the missile in flight was obtained visually by means of a reflector-type aiming device. The operator was assisted in his guidance by means of candle flares carried

[redacted]

17. (continued)

on the missile. During the period of guidance, it is believed that the launching aircraft would be very susceptible to fighter attack. Harassing tactics by opposing aircraft would be sufficient to disturb the aim of the pilot.

The other air-to-air missile under development was the Hs-298, which was designed for use against enemy bombers. It was carried underneath the wing and fuselage of fast bombers or fighters equipped with special launching rails. The German government placed high priority on the development of the Hs-298. By early 1945 it was being mass produced. Production was discontinued in February of the same year, however, probably because of the discovery of the vulnerability of the parent planes to attacks by fighters. Test flights were carried out with three missiles. Two missiles were successfully launched, but one exploded prematurely and the other nose-dived and crashed. The third stuck on the launching rail. We have no data on completely successful flights. The missile was never used operationally. It was anticipated that the missile could attack a target flying without evasive action at a slant range of 5,000 yards. The missile was to be capable of attacking a target 1,000 yards above the point of release. Targets always had to be attacked visually within a limited field. The approximate maximum speed of the Hs-298 was 790 feet/second, and it had a maximum Mach number of 0.72. Its maximum range was about 5,000 yards.

The guidance system was to be similar to that of the X-4 except that at first a radio link instead of a wire link was planned. Since such a radio link was susceptible to jamming, a wire link was developed. We do not believe any flights were made using this method of control.

Two crew members of the parent aircraft were required to operate the

17. (continued)

aiming system. One sighted on the target with an aiming device, and the other guided the missile by looking through a telescope and operating a joystick. The pilot had to maneuver the parent aircraft so as to keep the target ahead and to starboard, since the aiming device was mounted on the starboard side.

It was planned to use proximity fuses with both the X-4 and Hs-298 but none was available by the end of the war.

18.

[redacted]

FUTURE SOVIET EARTH SATELLITE CAPABILITIES

PROBLEM

To define near future Soviet earth satellite Space Vehicle capabilities.

CONCLUSIONS

It is concluded that Sputnik III, by the use of a combination of propulsion stages, could be one of the following types:

1. A 160-300 lb scientific earth satellite.

2. A large satellite up to 5,000 lbs containing an animal passenger with the intention of returning the animal to earth.

3. The orbiting of a preliminary (1000 - 5000 lbs) reconnaissance satellite.

4. Impacting a payload (100 - 400 lbs) on the moon.

In view of the extremely high priority placed on the effects of outer space on mammals and high interest in manned space flight it is considered most probable that Sputnik III will contain an animal suitable for space studies.

DISCUSSION

The Soviet Union announced that Sputnik I, orbited on 4 October 1957, had a weight of about 185 lbs. and Sputnik II, orbited on 3 November 1957 had a weight of about 1120 lbs. Sputnik III could probably be launched at any time and, according to Soviet statements, additional satellites will probably be launched at about one month intervals throughout the remainder of the IGY.

We believe that the Soviet ICBM and the Soviet earth satellite vehicles probably utilized the same first and second stage propulsion system. The Soviet ICBM is estimated to have a gross weight of about 300,000 lbs. with a propulsion system consisting of paired nominal 100 metric ton thrust engines or an equivalent single engine in the first state and a nominal 35 metric ton engine in the second stage.

[redacted]

18. (continued)

[redacted]

Additionally, although no evidence exists, we believe the Soviets are probably capable of adding a third propulsion stage to this system. The capability of such a staged propulsion system to orbit satellites or propel payloads to the moon are approximately:

	STAGES	CONFIGURATION	SATELLITE WT. ORBITED	MOON IMPACT WEIGHT
1.	2	paired 100 mt engines plus a 35 mt engine	200 lbs	----
2.	2	paired 120 mt engines plus a 35 mt engine	1200 lbs	----
3.	3	paired 100 mt engines plus a 35 mt engine plus 12 mt engine	3000 lbs	100
4.	3	paired 120 mt engines plus a 35 mt engine plus 12 mt engine	5000 lbs	400

The use of super fuels in large quantities would allow greatly increased payload weights, but would also introduce hazardous handling problems for personnel, and cause equipment and site contamination problems. Major thrust unit component redesign would also be necessary, requiring additional R & D flight tests. None of these problems are insurmountable but do take time to solve. Small quantities of super fuels (up to about 10%), however, could be added to conventional fuels without particular difficulty thereby increasing the specific impulse and allow payload weights to be increased to some degree. There have been contradictory statements by knowledgeable Soviet officials about whether a super fuel was used in the Sputnik II launchings, and firm knowledge on this point is lacking.

We believe that the present Soviet capability for Sputnik III probably includes the orbiting of up to about 5000 lbs. of satellite. We believe that Sputnik III will be in one of the categories, which are discussed in the following:

1. The orbiting of a 160-300 lb. scientific earth satellite.

2. The orbiting of a large satellite (up to 5000 lbs.) containing an animal passenger with intention of returning the animal to earth.

[redacted]

18. (continued)

3. The orbiting of a preliminary (1000-5000 lbs) reconnaissance satellite.

4. Impacting a payload on the moon (100-400 lbs).

If Sputnik III is devoted to purely scientific aspects of upper atmosphere research, it will most probably carry instrumentation for the study of cosmic rays, x-rays, ultraviolet radiation, the earth magnetic field, temperature, pressure, meteors and ionospheric phenomena. A 300 lb. satellite could carry the necessary equipment and power for about two-three weeks of transmissions providing satelli transmissions were not continuous. Satellite to ground command data readout would have to be fairly frequent due to limited data storage facilities in a satellite of this size.

The biological experiment in Sputnik II could have allowed determination of a dog's major physiological reactions during launching and at high altitude with a single major exception of cosmic radiation effects. Recovery and study of the animal is essential to this radiation effects determination. The effort involved in returning a mammal to earth includes the provision of an additional propulsion stage to remove the satellite from orbit and provision of escape or deceleration apparatus to allow safe re-entry conditions. It is possible that the first satellite intended to return an animal to earth will have a low orbit, short life and more predictable recovery location.

While Soviet interest in a reconnaissance satellite is probably not as high as that of the US, the capability to orbit at least 1200 lb. satellite (by two stage rocket system) is high and includes the possibility of the payload being optical or electronic reconnaissance equipment and the transmission of such information to Soviet recording stations. There is no reason to believe that the USSR would not be able to provide this equipment.

The fact that a longer interval of time has been required to launch Sputnik III may be indicative of a more complex launching device, such as a three stage vehicle orbiting a large satellite or a lunar flight.

Implicit in the Soviet orbiting of a mammal in their second satelli attempt is the extremely high priority placed on the effects of outer sp on mammals and high interest in manned space flight.

- 3 -

GEOPHYSICAL AND ASTROPHYSICAL INSTRUMENTATION OF SOVIET SPUTNIKS I, II, AND III

SUMMARY

The recent development of Soviet artificial earth satellites as carriers of instruments in sustained flight above the shielding effects of the earth's atmosphere represents a major technical advance potentially of great importance in the geophysical and astrophysical sciences and to the successful achievement of manned space flight. All three Soviet sputniks placed in orbit to date are important in contributing knowledge of the physical environment and communication conditions for subsequent astronautical efforts of the USSR.

The Soviet Union has obtained an advantage over the United States in geophysical and astrophysical research because it has placed in orbit much larger satellites capable of carrying more varied and heavier instrument payloads. With the exception that Soviet satellites have not penetrated as far into space as U.S. satellites, the near-polar orbits of the Soviet satellites offer more advantages than the near-equatorial orbits of the U.S. satellites.

Although Sputniks I and II were not outstanding in their geophysical and astrophysical instrumentation, Sputnik III represents a scientific achievement of considerable magnitude because of the large number of significant observations that are conducted simultaneously. The equipment for detecting primary gamma rays is apparently unique and, if successful, would provide data of considerable scientific significance. The numerous cosmic ray and auroral particle experiments are of special value because Sputnik III traverses the auroral zones. Instruments included in Sputnik III, not duplicated in the U.S. satellite program, for the IGY, are magnetic and ionization manometers, mass spectrometers, flux meters, and ion traps. Sputnik III apparently is similar to advanced U.S. satellites in that it employs solar as well as chemical batteries and has telemetering systems that probably store data for release at a later time when the satellite is interrogated * as it passes over a receiving station. Sputnik III also may contain equipment that has not been described by the Soviets. On the other hand, Sputnik III apparently lacks a means of orientation control; therefore, it probably contains no elaborate earth-scanning device, such as a television camera. The Soviet instrumentation generally is heavier and less refined than similar U.S. equipment; but some miniaturization has been noted, and much of the equipment in Sputnik III appears to be transistorized. There are indications that the Soviets have copied some U.S. instruments.

Soviet ground equipment for optical and radio tracking of satellites appears to be adequate but less elaborate than U.S. equipment. The Soviets are steadily expanding and improving their capabilities for precision tracking and are placing considerable emphasis on this phase of their observations.

* In response to a radio signal from the ground, the satellite transmits stored data.

20.

~~TOP SECRET~~

SOVIET CAPABILITIES IN GUIDED MISSILES AND SPACE VEHICLES

FOREWORD

This advance portion of the forthcoming national intelligence estimate on all Soviet missile development programs has been prepared to meet the immediate needs of intelligence consumers and to facilitate work by the intelligence community on certain parallel estimates and projects. It will be incorporated into the final version of NIE 11-5-59 (due in October 1959), subject to any further modification or revision which may be required by additional evidence or reanalysis in the interim. This text supersedes those portions of NIE 11-5-58 relating to the missiles discussed herein.

THE PROBLEM

To estimate Soviet capabilities and probable programs for the development of 700 nautical mile and 1,100 nautical mile ballistic missiles, intercontinental ballistic missiles, and fleet ballistic missiles, including their major performance characteristics and dates of operational availability.

THE ESTIMATE

SURFACE-TO-SURFACE BALLISTIC MISSILE SYSTEMS

1. The USSR has developed a family of surface-to-surface ballistic missiles through an intensive and well conceived program conducted at high priority since shortly after World War II. Missiles known to have been developed or to be under development at present include those with maximum ranges of about 75 nautical miles (n.m.), 200 n.m., 350 n.m., 700 n.m., 1,100 n.m., and intercontinental ballistic missiles (ICBM).[1] We have more extensive information on the ballistic missile program than on any other Soviet missile program. We therefore estimate this program with considerable assurance, although our confidence in the details varies.

[1] As a rule of thumb, a ballistic missile can be considered capable of firing to about one-third of maximum operational range without serious degradation in accuracy, and to even shorter ranges with degraded accuracy.

20. (continued)

2. A substantial body of evidence supports our belief that the Soviet ballistic missile development program has for a number of years been well coordinated, extensively supported, and conducted by qualified personnel with access to excellent facilities. It has resulted in the development of operational missiles whose reliability, accuracy and other performance characteristics meet high standards.

3. We believe that in the development of longer range systems, maximum use has been made of proven components. On the basis of indirect evidence and the logic of a coordinated development program, we consider it reasonable to conclude that the two active Soviet ballistic missile test ranges (Kapustin Yar for missiles up to 1,100 n.m. range, Tyura Tam for ICBMs and space vehicles) have been mutually supporting with respect to component testing and shared experience.

4. The type of warhead employed with Soviet ballistic missiles will vary with the specific mission of the missile. In general, however, we believe that for missiles with maximum ranges of less than 700 n.m. high explosive (HE), nuclear, or chemical warfare (CW) warheads will be employed in accordance with Soviet military doctrine, depending upon nuclear stockpiles, missile accuracy, character of the target, and results desired. We estimate that for missiles with ranges of 700 n.m. and over, only nuclear warheads will be employed, although we do not exclude the possibility of CW use in 700 n.m. missiles for certain limited purposes. We believe that the USSR is capable of developing techniques for missile dissemination of biological warfare (BW) agents, although we have no specific evidence relating BW and missile research and development. In view of operational considerations we consider BW use in ballistic missiles unlikely, although possible for certain special purposes.

5. Mobility appears to be a basic consideration in Soviet ballistic missile design and we have good evidence of road mobility on some systems with ranges of 700 n.m. and less. The size and weight of the 1,100 n.m. missile may be such as to limit its road mobility to selected first class road nets; in view of this limitation, we believe it may be road and/or rail mobile. In the case of road mobile systems, it is probable that missile carriers and support vehicles are readily adaptable for rail transport. Mobility as it applies to an ICBM system is discussed below in paragraphs 27–29.

700 Nautical Mile Ballistic Missile System (SS–4)

6. There is considerable evidence[ ]that a missile which would meet the Soviet requirement for a 700 n.m. range weapon has been under test at Kapustin Yar for many years. We believe that test firings began in about 1953; an average of about two per month have occurred since mid-1955. We estimate that this system has been available for operational use since about 1956, although no operational sites or units have been identified.

7. Until recently we were unable to determine whether the largest missile in the 7 November 1957 Moscow Parade (nicknamed SHYSTER for recognition purposes) was the 700 n.m. missile or the 350 n.m. missile.[ ] evidence[ ] together with statements and photographs released by the USSR, has provided sufficient data to permit the determination that SHYSTER is probably the 700 n.m. missile. Analysis of this evidence has caused us to change our previous estimate of maximum warhead weight from 5,000–6,000 pounds to approximately 3,000 pounds.

8. We continue to estimate that prior to 1958 this missile utilized radio/inertial guidance and that commencing in 1958–1960 an all inertial system would become available. There are some indications[ ]that inertial components were being tested in late 1958. Missiles already produced and equipped with the radio/inertial system will not necessarily undergo retrofit to the all inertial system.

9.[ ] We do not believe a second generation missile of this range is yet being devel-

oped. There are indications that the 700 n.m. missile has contributed to the development of other missiles, but the exact nature of this contribution cannot be determined.

10. We estimate that this missile system is operational and in production in the USSR, and that it probably has the following characteristics: [2]

US Designation	SHYSTER—SS-4
IOC Date[3]	1956
Maximum Range ...	700 n.m.
Length	68 feet
Diameter	Approximately 5 feet
Propulsion	Single thrust chamber, jet vane controlled (no verniers), approximately 90,000 lbs. thrust, liquid oxygen/kerosene, two step thrust cutoff.
Configuration/ Structure	Single stage ballistic, integral tankage.
Guidance	1956–1958 radio/inertial, 1958–1960, all inertial (retrofit optional).
Accuracy	1–2 n.m. CEP at 700 n.m. under average operational conditions.
Maximum Warhead Weight	Approximately 3,000 lbs., in a separating nosecone.
Ground Environment	Road Mobile

1,100 Nautical Mile Ballistic Missile System (SS–5)

11. [ ] a missile of about 1,100 n.m. maximum range has been under test at Kapustin Yar for over two years; since mid-1957 more than 40 such missiles have been test fired. There have been periods of high firing rate as well as periods of inactivity, the latter including one as long as nine months. [ ] the 1,100 n.m. missile could have become operational in late 1958 or early 1959, although no operational sites or units have been identified.

12. [ ] There are indications of inertial components, of engine burning time, and of four combustion chambers in the engine. Like the V–2 and the 700 n.m. missile, this engine shuts down in two steps. Jet vanes are probably used for missile stabilization and control. We no longer believe that the 1,100 n.m. missile is essentially a modified 700 n.m. missile, although it would be in keeping with Soviet practice for this system to make maximum usage of proven components and designs from other programs.

13. On the basis of all available evidence, we estimate that the 1,100 n.m. system is operational and in production in the USSR, and that it probably has the following characteristics:

US Designation	SS–5
IOC Date	Late 1958 or early 1959
Maximum Range ...	1,100 n.m.
Propulsion	Four combustion chambers, liquid oxygen/kerosene, two step thrust cutoff, jet vane stabilization and control.
Configuration	Single stage ballistic
Guidance	Radio/inertial or all inertial
Accuracy	2 n.m. CEP at 1,100 n.m. under average operational conditions.
Maximum Warhead Weight	Approximately 3,000 lbs., in a separating nosecone.
Ground Environment	Road and/or rail mobile.

Intermediate Missile Systems of Longer Range

14. Assuming deployment within Soviet territory, 700 n.m. and 1,100 n.m. missiles are capable of reaching a large majority of critical targets in Eurasia and its periphery. It is possible that the USSR intends at a later date to develop a ballistic missile system with maximum range of about 1,500 to 2,500 n.m. to supplement existing target coverage and to permit deployment in more secure areas. In 1949, fairly early in the USSR's ballistic missile program, the Soviets instructed German missile specialists to make design studies on missiles with ranges as great as 1,600 n.m. We know of no further developmental work

[2] For estimates of reliability and reaction times under various conditions for this and other systems discussed herein, see Annexes A and B.

[3] Date at which one or more missiles could have been placed in the hands of trained personnel in one operational unit.

20. (continued)

on such missiles, and we do not believe there have been any test firings or preparations for firings to intermediate ranges of greater than 1,100 n.m. We conclude that an intermediate missile of longer range has had a fairly low priority. In any case, the initiation of test firings would probably precede first operational capability by 18 months to two years.

Intercontinental Ballistic Missile System (SS–6)

15. In our most recent estimate on Soviet development of ICBMs (NIE 11–4–58, paragraphs 125 and 126), we considered it probable that the USSR would achieve an initial operational capability with 10 prototype ICBMs at some time during the year 1959. We also held it to be possible, although unlikely, that a limited capability with comparatively unproven ICBMs might have been established in 1958. These conclusions rested on a variety of factors, including the estimated very high priority the USSR placed on achieving an ICBM capability for both political and military purposes, the estimated willingness of Soviet planners to accept considerable risks in initiating ICBM production and deployment, and the available evidence on Soviet test firings and capabilities in ballistic missile development.

16. We now have considerable additional knowledge of the ICBM test firing program, [redacted] This evidence shows that during 1959 the test program has proceeded in an orderly manner which we believe is effectively testing a complete ICBM system. There is good evidence that from the beginning of the test firing program in 1957 until the present there have been well over a dozen ICBM test firings, a high percentage of which have been successful in traveling from the Tyura Tam rangehead over a distance of approximately 3,500 n.m. to the terminal end of the range in the Kamchatka Peninsula area. In the test program, since its inception in August 1957, we have observed periods of launching activity and inactivity, but the evidence is not sufficient to determine whether this was due to a setback in the program. Reanalysis of test firing patterns for both ICBM and shorter range missile systems leads us to believe that this periodicity of test firing activity is the Soviet method of conducting an orderly program. In any event, both the rate and number of ICBM test firings are lower than we had expected by this time.

17. *Operational Capability Dates.* Considering all the evidence, we believe it is now well established that the USSR is not engaged in a "crash" program for ICBM development. We therefore believe it extremely unlikely that an initial operational capability (IOC) was established early in the program with prototype missiles or with missiles of very doubtful performance characteristics.

18. On the other hand, we still consider it a logical course of action for the USSR to acquire a substantial ICBM capability at the earliest reasonable date. (The IOC for the ICBM marks the beginning of the planned buildup in operational capabilities and represents the date when the weapon system could be counted on to accomplish limited tasks in the event of war.) The hard evidence at hand does not establish whether or not series production of ICBMs has actually begun, nor does it confirm the existence of operational launching facilities. However, Khrushchev's statements of the winter of 1958–1959 regarding the establishment of ICBM series production are consistent with a logical decision to tool up for series production and to begin preparation of operational units and facilities before all technical aspects of the system had been fully demonstrated. Considering that production lead times are probably on the order of 12–18 months, we believe the USSR has had sufficient time to begin turning out series produced missiles.

19. In light of all the evidence, we believe that a Soviet IOC with a few—say, 10—series produced ICBMs is at least imminent, if in fact it has not already occurred. The evidence is insufficient, however, to support a precise estimate of IOC date. We believe that for

20. (continued)

planning purposes it should be considered that by 1 January 1960 it will have occurred.[4]

20. The rate of operational buildup subsequent to IOC date would depend not only on the priority assigned, but also to a great degree on the planned force level. This will be discussed in the forthcoming NIE 11-8-59, "Soviet Capabilities for Strategic Attack Through Mid-1964."

21. *I C B M Performance Characteristics.* There is no direct information on the configuration of the Soviet ICBM and no conclusive intelligence regarding ICBM component testing, although Soviet statements indicate a positive relationship between the ICBM, space vehicles, and proven military hardware. Analysis of possible vehicles used in Sputnik [redacted] indicates that the ICBM could be a one and one-half or parallel stage configuration but is probably not tandem. At this time we do not believe there is sufficient evidence to permit selection of a single most probable ICBM configuration.

22. [redacted] Variations in the performance of Soviet ICBMs and space vehicles could be accounted for by modifications of one basic type of vehicle to accomplish specific purposes. It is also possible that some or all of the space vehicles do not specifically represent the basic ICBM, but were special purpose vehicles. While we cannot firmly relate any of these vehicles to the ICBM, the energy they required can be correlated to alternative ICBM warhead weights. An ICBM of a size sufficient to orbit Sputniks I and II would have a gross takeoff weight of about 350,000 pounds and could carry a warhead of 2,000-3,000 pounds in a heat-sink nosecone. An ICBM of a size sufficient to propel Sputnik III or Lunik would have a gross takeoff weight of about 500,000 pounds and could carry a warhead of 5,000-6,000 pounds. [redacted]

[redacted]

23. While the evidence is not conclusive and we cannot eliminate the possibility of a lighter warhead, we believe the current Soviet ICBM is probably capable of delivering a warhead of about 6,000 pounds to a range of about 5,500 n.m. with a heat-sink nosecone configuration. A reduction in warhead weight from that used to 5,500 n.m. would permit an increase in range. For example, a range of about 7,500 n.m. could be achieved with a warhead of about 3,000 pounds with the same nosecone configuration. Since there is no firm evidence on whether the Soviet ICBM employs a heat-sink or ablative type nosecone, it must be noted that the ablative type would permit an even heavier warhead or extended range. Although we believe them to be within Soviet capabilities, neither radar camouflage of nosecone nor decoys have been detected in ICBM test firings to date.

24. We estimate ICBM guidance at IOC date to be a combination of radar track/radio command/inertial, although an all inertial system is possible (see paragraph 25). Soviet "state of the art" in precision radars, gyros and accelerometers leads us to estimate a theoretical CEP of about 3 n.m. at IOC at 5,500 n.m. range. Under operational conditions the theoretical CEP will be degraded by numerous factors, such as geodetic errors, insufficiently known weather and wind conditions in the target area, the inability of equipment to remain at peaked effectiveness for prolonged periods, variations in the tolerances of components, inexperienced personnel (especially at IOC and at new sites) and the pressure of combat conditions on the personnel. The

[4] The Assistant to the Secretary of Defense, Special Operations; the Director for Intelligence, The Joint Staff; the Assistant Chief of Staff for Intelligence, Department of the Army; and the Assistant Chief of Naval Operations for Intelligence, Department of the Navy, believe that, in view of the orderly conduct of the Soviet ICBM test program (paragraph 16), as opposed to a "crash" program (paragraph 17), and in view of the fact that both the rate and number of ICBM firings, [redacted] are lower than the intelligence community expected by this time (paragraph 16), the IOC will probably occur in the first half of 1960, with a possibility of its occurring in the latter part of 1959.

20. (continued)

amount of degradation which would be introduced by such factors is unknown, but we estimate that CEP under operational conditions would be no greater than 5 n.m. at IOC date.

25. The guidance system and other factors would be improved so that under operational conditions a CEP of 3 n.m. in 1963 and 2 n.m. in 1966 is estimated as feasible. We have no knowledge as to Soviet intentions to retrofit inertial systems into ICBMs fabricated prior to operational adoption of an all inertial system, which could probably occur in the period 1960–1962.

26. Available evidence does not support the testing of more than one basic type of ICBM at Tyura Tam—the possible variations in range and warhead weight discussed in paragraph 23 could be accomplished with one basic missile.[5] Likewise, there is no evidence to indicate development of a second generation ICBM to replace that now being tested. If developed and tested in the future, such a missile would probably be designed to overcome certain operational difficulties and to permit simplified logistics. It might therefore be considerably smaller than the current system, taking advantage of improvements in the technology of construction, component design, warhead efficiency, fuels, and guidance.

27. *ICBM Ground Environment.* There is no firm evidence to indicate the Soviet concept of ICBM deployment or the nature of operational launching sites. From other ballistic missile systems it appears that mobility is a basic Soviet design consideration. The size, weight, complexity and mission of the ICBM, however, bring new factors to bear on launching system and site parameters.

28. As opposed to the advantages of hard or soft fixed site systems, a mobile system can reduce vulnerability by making site location and identification more difficult. Eliminating road mobile systems as being infeasible for the Soviet ICBM, we believe a rail mobile system, using special railroad rolling stock and presurveyed and preconstructed sites, to have certain advantages and disadvantages. So long as a multiplicity of sites existed, a rail mobile system would increase flexibility, decrease vulnerability and reduce the opportunity for enemy knowledge of occupied sites. On the other hand, missile system reliability might be reduced and sizable special trains would be required. The number and type of cars would depend on the size and configuration of the missile and the amount of fixed equipment installed at each of the prepared sites. The permanent installation at the launching site in such a rail system could be no more than a concrete slab on a special spur, but might include other facilities such as a small liquid oxygen facility, missile checkout building, missile erecting equipment, etc.

29. The available evidence suggests that the Soviet ICBM could be rail mobile; it is insufficient to establish whether the system as a whole will consist of rail mobile units, fixed installations, or a combination of the two. Whatever ground environment is selected, however, the Soviet rail network will play a central role in the operational deployment and logistic support of the ICBM system.

30. *ICBM System Summary.* In summary, we estimate that an ICBM is probably now in

[5] The Assistant Chief of Staff, Intelligence, USAF believes that the ICBM currently undergoing tests at Tyura Tam is a follow-on weapon. A possible correlation of 700/1,100 n.m. missile tests at the Kapustin Yar missile test center and ICBM/space vehicle firings at Tyura Tam can be made. Chronologically the 700 n.m. missile firings, the early Soviet space launchings (Sputnik I and II), and the successful ICBM firings from August 1957 to May 1958, could be related to the objective of developing an ICBM with a gross weight of approximately 350,000 pounds, carrying a 2,000 pound warhead to a range of 5,500 n.m. A similar chronological correlation emerges from analysis of the test firings of the 1,100 n.m. missile, the later Soviet space ventures (Sputnik III and Lunik) and the most recent run of successful ICBM test firings (January 1959 to date). If the initial success of the ICBM were derived from extensive 700 n.m. subsystem testing and experience gained from Sputniks I and II, the similar pattern of activity with respect to Kapustin Yar test firings of the 1,100 n.m. missile, Sputnik III, Lunik, and the most recent successful run of ICBM firings would suggest a follow-on R&D program of a missile designed for greater warhead weight and accuracy.

series production in the USSR, and that an IOC with a few—say, 10—series produced missiles is at least imminent. Probable characteristics of the system are estimated as follows:

US Designation	SS-6
IOC Date	See Paragraph 19
Maximum Range ...	5,500 n.m. with 6,000 lb. warhead
Propulsion	Liquid oxygen/kerosene, single-step final stage shutoff, and large verniers.
Configuration	One and one-half or parallel staging
Guidance	Probably radar track/radio command/inertial. All inertial could probably be available in 1960–1962.
Accuracy	CEP not greater than 5 n.m. at 5,500 n.m. under average operational conditions at IOC date; improvable to 3 n.m. in 1963 and 2 n.m. in 1966.
Maximum Warhead Weight	Probably 6,000 lbs. at 5,500 n.m. range
Ground Environment	Rail mobile and/or fixed installations

SUBMARINE-LAUNCHED MISSILE SYSTEMS

31. There is little evidence of research and development associated with specific missile systems for Soviet naval application, although there have been sporadic reports of possible launchings of missiles or rockets in the various Soviet fleet areas. C

32. Since 1955 there have been sightings of "W" class and smaller submarines with capsules and/or launcher-like structures on their decks. These included an excellent sighting in Leningrad in 1956 of a submarine with a capsule and launching ramp. It is probable that a few "W" class submarines have been converted to carry subsonic cruise type missiles having a maximum operational range of 150–200 n.m. and a low altitude cruise capability. Some smaller submarines have possibly been converted as well. Two such missiles can be carried in a deck capsule and launched from a ramp. Characteristics of the system are approximately as follows:

US Designation	SS-7
IOC Date	1955–1956
Maximum range of missiles	150–200 n.m.
Number per submarine	2
Launching condition	Surfaced
Guidance	Programmed with doppler assist, possibly with homing
Accuracy	2–4 n.m. CEP under operational conditions; 150–500 feet with homing.
Maximum Warhead Weight	2,000 lb.

33. Since 1956 there have been a few sightings and photographs of "Z" class submarines with greatly enlarged sails. Since 1958, three such submarines have been observed with two dome-shaped covers in the after portion of the enlarged sail. These submarines may have been modified for carrying and launching ballistic missiles. If so, an initial operational capability with at least three submarines has existed since mid-1958. Small numbers of modified "Z" class submarines are now in both the Northern and Pacific Fleet areas. Such submarines could carry two missiles each, but could probably launch them only while fully surfaced. The missile might have a range of about 200 n.m., a warhead weighing about 1,000 pounds, and a CEP under average operational conditions of 2–4 n.m. at maximum range.

34. There is inconclusive evidence that the Soviets are developing an advanced submarine/ballistic missile system. None of the small amount of evidence available concerns development of an associated missile itself. Based mainly on estimated Soviet requirements and technical capabilities, we believe

20. (continued)

the USSR will probably develop a submarine/ballistic missile system having the following characteristics:

US Designation	SS-9
IOC Date	1961-1963
Maximum range of missiles	500-1,000 n.m.
Number per submarine	6-12
Launching condition	Submerged or surfaced
Propellant	Solid or storable liquid
Guidance	All inertial
Accuracy	2-4 n.m. CEP under operational conditions
Maximum Warhead Weight	About 1,000 pounds

20. (continued)

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ANNEX A

ESTIMATED MISSILE RELIABILITIES

For several years after an IOC, the reliability of a missile system will probably improve, and then level off. Although we have little information on which to base an estimate of the operational reliability of Soviet missiles, the following are considered reasonable estimates.

US DESIGNATION	IN-COMMISSION RATE [1]	RELIABILITY	
		On launcher [2]	In flight [3]
SS-4	85	90	80
SS-5 at IOC	75	85	75
IOC plus 3 yrs	85	95	80
SS-6 at IOC	70	80	50
IOC plus 3 yrs	80	90	75
SS-7	Not applicable [4]	80	75
SS-9 at IOC		80	60
IOC plus 3 yrs	Not applicable [4]	90	75

[1] Percentage of national operational inventory considered "good enough to try" to launch at any given time.
[2] Percentage of those missiles in operational units considered "good enough to try" to launch that will actually get off the launcher when fired.
[3] Percentage of those missiles that get off the launcher that will actually reach the *vicinity* of the target, i.e., perform within the designed specifications of the missile system.
[4] In these categories, only those missiles considered "good enough to try" to launch will be loaded on submarines.

20. (continued)

ANNEX B

ESTIMATED REACTION TIMES

The reaction times of Soviet missile units would vary according to the type of missile, the location (on or off site), and degree of alert. In the absence of information we consider the following are reasonable estimates:

Reaction Times, Ground-launched Systems

a. For units in transit at the time of alert, the following times are estimated for the launching of the first missile after the unit has arrived at the prepared launching site:

SS-4—SS-5	2-4 hours
SS-6	4-12 hours

b. The following reaction times are estimated for the SS-4 through SS-6 when the missile unit is in place at a launching site under the alert condition indicated:

Case I —Crews on routine standby, electrical equipment cold, missiles not fueled but could have been checked out recently.
Reaction time 2-4 hours

Case II —Crews on alert, electrical equipment warmed up, missiles not fueled.
Reaction time 15-30 minutes

Case III—Crews on alert, electrical equipment warmed up, missiles fueled and occasionally topped. This ready-to-fire condition probably could not be maintained for more than 10-15 hours.
Reaction time 5-15 minutes

Naval Systems—While on station the reaction time for shipboard surface-to-surface missiles would be short. We estimate about 15 minutes for a submarine that must launch surfaced (SS-7), with an additional 7 minutes to launch a second missile, about 15 minutes or less for a submarine that can launch submerged (SS-9).

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No. 1391/64

CENTRAL INTELLIGENCE AGENCY

18 JUNE 1964

MEMORANDUM

SUBJECT: The Soviet Reconnaissance Satellite Program

A Soviet military reconnaissance satellite program appears to be well under way with possibly as many as 12 flights since 1962. The program uses recoverable vehicles launched from Tyuratam under the mantle of the Cosmos series. [redacted] The program is expensive, possibly costing as much as 500 to 700 million dollars so far, and places added demands on resources available for Soviet space programs. A requirement for precise targeting information on US targets, not obtainable through other collection means, seems to be the primary reason for the program. Also, Soviet collection of other military intelligence on the US could be usefully supplemented by satellite photography. Khrushchev's open acknowledgments of the program have been aimed at stopping U-2 flights over Cuba, but also imply a desire for a tacit understanding on reconnaissance satellites. The existence of the Soviet program tends to reduce the likelihood of a Soviet attempt to attack a US satellite.

* * * * * * * *

1. We have concluded that the Soviet military reconnaissance satellite program may have involved as many as 12 flights since 1962. The evidence is convincing that these were military reconnaissance satellites, although they may have had additional missions. Their launch times and orbits were ideally

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Prepared jointly by the Directorate of Science and Technology and the Directorate of Intelligence.

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21. (continued)

suited for reconnaissance coverage of the US during daylight hours, the payload was recovered, they were earth oriented and stabilized within the requirements of a sophisticated camera system, and telemetry from them reflected payload activity like that of a reconnaissance photographic payload.

2. A study of the [16] Cosmos satellites successfully launched from Tyuratam between [26 April 1962 and 10 June 1964] leads us to believe that four of them were military reconnaissance satellites, [eight] others probably were, and four probably were not.]

3. [redacted]

4. Moscow has held that the purpose of the Cosmos series, which began in March 1962, was to collect scientific data. It became clear, however, that different types of vehicles were being launched from two different rangeheads, Kapustin Yar and Tyuratam, and the characteristics of the 14 satellites successfully orbited from Kapustin Yar rule out a reconnaissance mission.

5. The [16] successful Cosmos operations from Tyuratam which we have examined are believed to have used [redacted]

All were recovered in the Soviet Union three to ten days after launching. The most recent in the series, Cosmos 32, had an inclination of 51 degrees to the equator, while all previous Tyuratam Cosmos satellites had inclinations of 65 degrees. This change suggests that the Soviets are improving their reconnaissance program because the inclination of Cosmos 32 permitted greater coverage of the US each day.]

21. (continued)

6. The series launched from Tyuratam may have had other missions in addition to photographic reconnaissance. [redacted]

7. We have identified most of the Tyuratam satellites [redacted]

[redacted]

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21. (continued)

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f. [redacted]

g. [redacted]

h. Soviet statements: Khrushchev himself has alluded to Soviet satellite reconnaissance on several occasions. In 1963, he told Belgian Foreign Minister Spaak that the Soviets were engaged in photographing the United States and that he could produce the photographs to prove it Former Senator Benton also quoted Khrushchev as saying, during their recent meeting in Moscow, that Soviet space cameras have filmed US military installations.

8. If we are correct in concluding that most of the Cosmos satellites launched from Tyuratam have a reconnaissance mission, it would seem that Moscow is devoting a substantial share of its space effort to the collection of military intelligence. [According to preliminary estimates based on the costs of US scientific satellites, the cost of Tyuratam Cosmos operations to date may have amounted to the equivalent of about 700 million to one billion dollars, roughly 20 percent of total expenditures estimated for all observed Soviet space programs. As a rough proportion of this estimate, the costs of a military reconnaissance program including the 12 satellites launched so far would be on the order of 500 to 700 million dollars.]

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21. (continued)

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9. Also important is the additional strain imposed on the human and material resources available for Soviet space programs by the demands of a reconnaissance program.

10. We believe that the USSR has made this large investment primarily for missile targeting purposes. Strategic missile systems require precise information on the geodetic relationship of the target to the launch point, particularly in the case of hardened targets. The precise targeting information needed on the hundreds of targets in the US is only obtainable by satellite photography. [redacted]

11. Despite the USSR's comparatively easy access to much information on military weapons and installations in the US it has requirements for military reconnaissance satellites beyond those for targeting data.

a. [redacted]

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21. (continued)

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12. In view of Soviet activity in the reconnaissance satellite field, Moscow may be more tolerant of similar US programs than it has been in the past. Khrushchev's recent open acknowledgment of both US and Soviet efforts tends to bear this out. Although his immediate objective in these remarks has been to secure a cessation of U-2 flights over Cuba, they suggest a desire on his part for a tacit understanding with the US on reconnaissance satellites.

13. We believe that the Soviets intend to develop an antisatellite capability. [redacted] In our view, however, the existence of a Soviet reconnaissance satellite program tends to reduce the likelihood of a Soviet attempt to destroy or neutralize a US satellite.

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22.

SOVIET CAPABILITIES FOR STRATEGIC ATTACK

THE PROBLEM

To estimate probable trends in the strength and deployment of Soviet forces for strategic attack and in Soviet capabilities for such attack through mid-1970.

SCOPE NOTE

This estimate covers those Soviet military forces which are suitable for strategic attack. Other major aspects of the Soviet military strength are treated in separate estimates on air and missile defense, on theater forces, on the nuclear program, and on the space program. Trends in the USSR's overall military posture and in Soviet military policy are examined in an annual estimate, the next issuance of which will be in the first quarter of 1965.

SUMMARY AND CONCLUSIONS

A. Major changes in Soviet programs for the development of strategic attack forces have become apparent during the past year. In 1962–1963, certain ICBM and ballistic missile submarine programs came to an end, and a pause ensued in the growth of these forces. At the same time, the pace of ICBM research and development increased markedly. More recently, the USSR has resumed ICBM deployment in a new and improved configuration, and the probable advent of a new submarine which we believe is designed to carry ballistic missiles probably marks the start of yet another deployment program. (*Para. 1*)

B. Soviet military policy in recent years has been to build up strategic offensive and defensive capabilities, maintain and improve large general purpose forces, and pursue research and development

programs in advanced weapons. In our view, the primary concern of Soviet military policy for the next several years will continue to be the strengthening of the USSR's strategic deterrent. The evidence to date does not indicate that Soviet deployment programs are directed toward a rapid numerical buildup. We do not believe that the USSR aims at matching the US in numbers of intercontinental delivery vehicles. Recognition that the US would detect and match or overmatch such an effort, together with economic constraints, appears to have ruled out this option. (*Paras. 2–4*)

C. A stress on qualitative factors suggests that the Soviets see technological advance in weapons as a means by which they can improve their strategic position relative to the West. In the ICBM force, for example, major qualitative improvements currently being achieved include hardening and dispersal (which will sharply increase the number of aiming points), as well as better accuracy and larger payloads. (*Paras. 4–5*)

D. By the end of the decade, Soviet intercontinental attack capabilities will rest primarily upon an ICBM force of some hundreds of launchers, supplemented by a sizable missile-submarine fleet and a large but reduced bomber force. These forces will represent a marked improvement in Soviet retaliatory capability and a considerable strengthening of the Soviet deterrent. In the light of current and programmed US military capabilities, however, we do not believe that the Soviets will expect to achieve, within the period of this estimate, strategic attack capabilities which would make rational the deliberate initiation of general war. (*Para. 5*)

The ICBM Program

E. Major developments since mid-1963 include a proliferation of test facilities at Tyuratam, flight-testing of two third-generation ICBM systems (the SS–9 and SS–10), and the beginning of construction of hard, single-silo ICBM launchers, probably for one or both of the new systems. The deployment of second-generation ICBMs has probably ceased, and a pause between the second- and third-generation programs has slowed deployment. We believe that the Soviets now have about 200 operational ICBM launchers, and that the total number of operational launchers in mid-1965 will approximate the low

side of the 250–350 range previously estimated. These figures do not include R&D launchers at Tyuratam.[1] (*Paras. 6–8, 10–18, 31*)

F. Research and development on third-generation systems has been generally successful. The SS–9 system appears to be an outgrowth of the SS–7 with improved accuracy and a larger payload. We have little information on the characteristics of the SS–10. Both new systems could enter service in 1965. We believe that work is underway on still other ICBM systems, which we cannot as yet identify. We continue to believe that the Soviets are developing a very large ICBM, capable of delivering [ ] We estimate that it could enter service in the period mid-1966 to mid-1967. In addition, the Soviets might be developing a new, small ICBM employing improved propellants. If they are, it could become operational as early as 1967. (*Paras. 19–26*)

G. The Soviets are now emphasizing deployment of single-silo hard launchers for ICBMs, and we expect this emphasis to continue. We expect third-generation deployment to include the expansion of both second-generation complexes and the initiation of additional new complexes. (*Paras. 9, 27*)

H. The growth of the Soviet ICBM force over the next several years will be influenced by a number of factors. In economic terms, the program must compete for funds with other military and space activities and with the civilian economy. In the technical field, we believe that research and development is proceeding on additional, follow-on ICBM systems, and we doubt that with these in the offing the USSR will fix upon any one or even two existing systems for urgent deployment on a large scale. We are also mindful that the interruptions that marked second-generation deployment programs may recur. In strategic terms, the Soviets evidently judge that an ICBM force in the hundreds of launchers, together with their other strategic forces, provides a deterrent. On the basis of the evidence now available, to us, we do not believe that they are attempting to deploy a force capable of a first-strike which would reduce the effects of US

[1] The Assistant Chief of Staff, Intelligence, USAF, considers the estimate of the numbers of launchers operational now and expected in mid-1965 is too low. He estimates that the Soviets now have about 240 operational launchers, including about 20 at Tyuratam and a 10 percent allowance for unlocated launchers. He believes the total number in mid-1965 will be between 275 and 325. See his footnote, page 11, para. 10.

retaliation to an acceptable level.[2] At the same time, we expect them to continue a vigorous R&D effort in the hope of achieving important technological advances, in both the offensive and defensive fields, which would alter the present strategic relationship in a major way. (*Para. 30*)

I. We estimate a Soviet ICBM force of 400–700 operational launchers for mid-1970; in our previous estimate, we projected this force level for mid-1969. By mid-1970, we believe that the force will include most or all of the launchers now deployed, some 125–200 single-silo SS–9/10 launchers, and 10–20 launchers for very large ICBMs. We believe that the attainment of as many as 700 operational launchers by mid-1970 would be likely only if the Soviets begin deploying a new, small ICBM at a rapid rate about 1967. The Soviet ICBM force which we estimate for mid-1970 will represent a substantial increase in numbers and deliverable megatonnage. Further, the trend to single silos will increase the number of aiming points represented by individual launch sites from about 100 at present to some 300–575 in mid-1970, the bulk of them hard. This will greatly improve the survivability, and hence the retaliatory capability, of the force.[3] (*Paras. 32–37*)

J. In the past few years the Soviets have improved the readiness and reaction time of their ICBM force. Our evidence now indicates that from the normal state of readiness, the soft sites which constitute the bulk of the present force would require 1–3 hours to fire. Hard sites would require about half an hour or less. A higher state of alert (i.e., 5–15 minutes to fire) can be maintained at most soft sites for a number of hours and at most hard sites for days. (*Paras. 38–40*)

K. There is ample evidence that the Soviets designed their soft ICBM systems to have a refire capability. We have re-examined the

[2] The Assistant Chief of Staff, Intelligence, USAF, considers that the Soviets may already have directed their intensive military R&D effort toward achievement of an effective first-strike counter-force capability before the close of this decade. Considering the length of time covered by this estimate and the number of unknowns involved, he believes this is a possibility which should not be disregarded.

[3] The Assistant Chief of Staff, Intelligence, USAF, considers the ICBM force by mid-1970 could range from approximately 600 to as high as 900 operational launchers depending on whether a new, small, easily deployed system is introduced. (See his footnote to table on page 18.) An ICBM force of this size would increase the number of aiming points represented by individual launch sites to approximately 400–700 in mid-1970.

factors likely to affect refire time, and conclude that it would require little longer to fire the second missile than the first. Our present estimate of refire time is 2–4 hours, considerably less than previously estimated. We believe that, on the average, two or more missiles are provided per soft launcher for initial firing, refire, and maintenance spares. We believe that hard ICBM sites do not have a refire capability. (*Paras. 41–43*)

L. We have little evidence on the hardness of Soviet ICBM sites. Given the many uncertainties in this area, only a very tenuous estimate can be made, but our best judgment is that Soviet hard ICBM sites have a hardness in the 300–600 psi range. This implies a design overpressure in the 200–400 psi range, somewhat higher than previously estimated.[4] (*Paras. 49–50*)

M. Qualitative improvements in the force can be expected as new ICBM systems enter service. Currently operational ICBMs have CEPs on the order of 1–2 n.m. The SS–9 will probably have an accuracy of 0.5–1.0 n.m. with radio assist, or 1.0–1.5 with all-inertial guidance. By mid-1970, the Soviets could achieve accuracies on the order of 0.5 n.m. or better. The SS–9 will probably carry a payload [ ] as compared with [ ] for second-generation ICBMs. We do not believe that the Soviets have yet developed penetration aids or multiple warheads, but they may do so in the future, particularly if the US deploys antimissile defenses. (*Paras. 44–48*)

MRBMs and IRBMs

N. Deployment programs for the 1,020 n.m. MRBM and the 2,200 n.m. IRBM are now ending, and almost certainly will be completed by mid-1965. We estimate that at that time the MRBM/IRBM force will have a strength of about 760 operational launchers, 145 of them hard. The bulk of the force (about 90 percent) is deployed in western USSR, with the remainder in the southern and far eastern regions of the USSR. This force is capable of delivering a devastating first strike or a powerful retaliatory attack against targets in Eurasia, and can attack such areas as Greenland and Alaska as well. Some of the

[4] The Assistant Chief of Staff, Intelligence, USAF, considers that, given the uncertainties involved, no meaningful estimate of the hardness of Soviet hard sites can be made. However, he believes that the design overpressure of Soviet hard sites is no greater than the 100–300 psi previously estimated.

MRBM/IRBM launchers are probably intended to support ground operations. (*Paras. 51–55*)

O. We doubt that the Soviets will expand their MRBM/IRBM force during the period of this estimate. It is possible, however, that operational capabilities will be improved by the introduction of a new missile system, which probably would be deployed in single-silos. Such a system, employing improved propellants, could become operational in the 1966–1968 period and would probably replace some of the soft launchers now operational. (*Paras. 56–59*)

Missile Submarine Forces

P. The Soviets now have operational some 40–50 ballistic missile submarines, including 8–10 nuclear powered. Most of these submarines are equipped with 350 n.m. missiles and must surface to fire. One or two are equipped with a new 700 n.m. submerged-launch missile, and others will probably be retrofitted. The USSR also has operational about 30 cruise-missile submarines, including 11–14 nuclear powered. The majority are equipped with 300 n.m. missiles designed for low altitude attack, primarily against ships. The remainder carry a newer 450 n.m. version of this missile, which probably has an improved capability to attack land targets. Current Soviet missile submarines carry relatively few missiles: the ballistic missile classes, two or three, and the cruise missile types, up to eight. The entire present force has a total of 120–140 ballistic missile tubes and 135–150 cruise-missile launchers. (*Paras. 60–71*)

Q. We believe that the Soviets have under construction a submarine which we estimate to be the first of a new nuclear-powered, ballistic missile class. We estimate that it will employ the submerged-launch 700 n.m. missile, and have a few more missile tubes than current classes. The first unit will probably become operational in 1965. Beyond this new class, we consider it unlikely that the Soviets will develop an entirely new follow-on ballistic missile submarine system within the period of this estimate, although they will probably continue to improve existing systems. We believe that they will also continue to construct cruise-missile submarines. By mid-1970 the Soviet missile submarine force will probably number 100–130 ships, about half of them cruise-missile submarines and about half ballistic. (*Paras. 72–75*)

R. In the past year, limited numbers of Soviet missile submarines have engaged in patrols in the open oceans. We expect a gradual expansion of this activity. By the end of the decade, Soviet missile submarines will probably be conducting regular patrols throughout the North Atlantic and Pacific, and possibly into the Mediterranean. (*Para. 76*)

Long-Range Bomber Forces

S. We have no recent evidence of major changes in the capabilities and structure of Soviet Long-Range Aviation (LRA). The force now includes some 190–220 heavy bombers and tankers and 850–900 mediums. It is being improved primarily through the continued introduction of Blinder supersonic dash medium bombers and through modification of older bombers for air-to-surface missile delivery, for aerial refueling, and for reconnaissance. Use of both medium and heavy bombers of the LRA in support of maritime operations has increased. (*Paras. 80–86*)

T. Considering noncombat attrition factors and the requirements for Arctic staging and aerial refueling, we estimate that the Soviets could put somewhat more than 100 heavy bombers over target areas in the US on two-way missions. Recent trends lead us to believe that medium bombers do not now figure prominently in Soviet plans for an initial bomber attack against North America. Nevertheless, should they elect to do so, we believe that at present the Soviets could put up to 150 Badgers over North American target areas on two-way missions. We have serious doubt about how effectively the Soviets could launch large-scale bomber operations against North America. We consider it probable that initial attacks would not be simultaneous, but would extend over a considerable number of hours.[6] (*Paras. 91–97*)

U. The Soviets will probably maintain sizable bomber forces, which will decrease gradually through attrition and retirement. Although continued Soviet work on advanced transports could be applied to military purposes, we think it unlikely that the Soviets will bring any follow-on heavy bomber into operational service during the period

[6] The Assistant Chief of Staff, Intelligence, USAF, considers this paragraph seriously underestimates the manned aircraft threat to the continental US. In the event war should eventuate and the USSR attacks the US with nuclear weapons, he believes this will be an all-out effort aimed at putting a maximum number of weapons on US targets. He therefore estimates that the number of heavy and medium bombers, including BADGERS on one-way missions, could exceed 500. See his footnote on page 32, para. 94.

of this estimate. We believe that Blinder medium bombers, some equipped with advanced air-to-surface missiles, will be introduced during much of the period of this estimate. By mid-1970, Long-Range Aviation will probably include some 140–180 heavy bombers of present types and 300–500 mediums, mostly Blinders.[6] (*Paras. 87–90*)

Space Weapons

V. Although the USSR almost certainly is investigating the feasibility of space systems for use as offensive and defensive weapons, we have no evidence that a program to establish an orbital bombardment capability is seriously contemplated by the Soviet leadership. We think that orbital weapons will not compare favorably with ICBMs over the next six years in terms of effectiveness, reaction time, targeting flexibility, vulnerability, average life, and positive control. In view of these considerations, the much greater cost of orbital weapon systems, and Soviet endorsement of the UN resolution against nuclear weapons in space, we believe that the Soviets are unlikely to develop and deploy an orbital weapon system within the period of this estimate. (*Paras. 98–103*)

[6] The Assistant Chief of Staff, Intelligence, USAF, believes the Soviets will continue to consider manned strategic aircraft an important adjunct to their ICBM force. He estimates that the USSR will introduce a follow-on heavy bomber. He further estimates the heavy bomber force will remain at about 200 or somewhat larger, depending on the timing of the expected follow-on bomber, and that by mid-1970 the medium bomber/tanker force will probably still include about 650–850 aircraft. See his footnote to table on page 31 following para. 90.

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SOVIET STRATEGIC AIR AND MISSILE DEFENSES

THE PROBLEM

To estimate the capabilities and limitations of Soviet strategic air and missile defense forces through mid-1967, and general trends in these forces through 1975.

CONCLUSIONS

A. Confronted by powerful Western strategic attack forces, the USSR is sustaining its vigorous effort to strengthen its defenses. We believe that the Soviets are responding to those challenges to their security that they can now see or foresee from aircraft, ballistic missiles, and earth satellites. (*Paras. 1-5*)

Air Defenses

B. The Soviets have achieved a formidable capability against aircraft attacking at medium and high altitudes, but their air defense system probably is still susceptible to penetration by stand-off weapons and low-altitude tactics. The Soviets probably foresee little reduction in the bomber threat over the next ten years. To meet this challenge, they are improving their warning and control systems and are changing the character of their interceptor force through the introduction of new high-performance, all-weather aircraft. In addition, there are recent indications that the Soviets are now employing light AAA in some areas for low-altitude defense. (*Paras. 3, 4, 8-19*)

C. The Soviets probably will continue to improve and to rely on the SA-2 as the principal SAM system. We believe that they will develop an improved or new SAM system for low altitude defense; such a system would probably be deployed more extensively than the SA-3. Deployment of a long-range SAM system probably is now

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underway in the northwestern USSR and probably will be extended to other peripheral areas and to some key urban locations in the interior.[1] [2] (*Paras. 20-26*)

Ballistic Missile Defenses

D. For nearly ten years, the Soviets have given high priority to research and development of antimissile defenses. We estimate that they have now begun to deploy such defenses at Moscow. These defenses could probably achieve some capability as early as 1967, but we think a more likely date for an initial operational capability is 1968. We do not yet know the performance characteristics of this system, or how it will function. (*Paras. 27-34*)

E. The Soviets will almost certainly continue with their extensive effort to develop ballistic missile defenses to counter the increasingly sophisticated threat that will be posed by US strategic missile forces. We cannot now estimate with confidence the scale or timing of future Soviet ABM deployment. We believe, however, that the Soviets will deploy ABM defenses for major urban-industrial areas. By 1975, they could deploy defenses for some 20 to 30 areas containing a quarter of the Soviet population and more than half of Soviet industry. (*Paras. 36-37*)

Antisatellite Defenses

F. The Soviets could already have developed a limited antisatellite capability based on an operational missile with a nuclear warhead and existing electronic capabilities. We have no evidence that they have

[1] Lieutenant General Joseph F. Carroll, USAF Director, Defense Intelligence Agency, Major General John J. Davis, the Assistant Chief of Staff, Intelligence, US Army, and Major General Jack E. Thomas, Assistant Chief of Staff, Intelligence, US Air Force, believe that the many uncertainties stemming from analysis of available evidence does not permit a confident judgment as to the specific mission of the new defensive systems being deployed in northwest USSR. They acknowledge that available evidence does support a conclusion that the sites in the northwest may be intended for defense against the aerodynamic threat. However, on balance, considering all the evidence, they believe it is more likely that the systems being deployed at these sites are primarily for defense against ballistic missiles.

[2] Rear Admiral Rufus L. Taylor, Assistant Chief of Naval Operations (Intelligence), Department of the Navy, and Lieutenant General Marshall S. Carter, USA, Director, National Security Agency, do not concur in the degree of confidence reflected in this judgment. Although they concur that the deployment activity is more likely a long range SAM system than an ABM system, they believe that the evidence at this time is such that a confident judgment is premature.

done so. In any event, we believe that the Soviets would prefer to have a system which could track foreign satellites more accurately and permit the use of non-nuclear kill mechanisms. We estimate that the Soviets will have an operational capability with such a system within the next few years. We believe, however, that the Soviets would attack a US satellite in peacetime only if, along with a strong desire for secrecy, they were willing for other reasons to greatly disrupt East-West relations.[3] *(Paras. 38-41)*

[3] Mr. Thomas L. Hughes, the Director of Intelligence and Research, Department of State, believes that the Soviets would conclude that the adverse consequences of destroying or damaging US satellites in peacetime would outweigh the advantages of such an action. He therefore believes it highly unlikely that they would attack US satellites in peacetime.

24.

SOVIET MILITARY RESEARCH AND DEVELOPMENT

THE PROBLEM

To assess the scope and nature of Soviet military research and development (R&D), to estimate the types of weapon and space systems likely to emerge from that effort in the next few years, and to discuss factors that will affect the course of Soviet military R&D over the longer term.

CONCLUSIONS

A. Military research and development (R&D) has been and will continue to be one of the highest priority undertakings in the USSR. The Soviets regard such an effort as imperative in order to prevent the US from gaining a technological advantage, to gain, if possible, some advantage for themselves, and to strengthen the technological base of Soviet power. Most Soviet military R&D is directed toward the qualitative improvement of existing kinds of weapon systems, but we believe that much is also devoted to the investigation of a broad range of new and advanced technologies having potential military applications.

B. With the rapid technological advance of the postwar era, there has been a great expansion in the funds, personnel, and facilities devoted to military R&D and the space program. We estimate that between 1950 and 1966 expenditures for these purposes increased tenfold. It is impossible to make a precise comparison of US and Soviet expenditures; our analysis suggests that if Soviet military R&D and space programs at their present levels were purchased in the US, they would generate an approximate annual expenditure more than three-fourths the amount of US outlays for the same purposes. And the Soviet effort rests on a considerably smaller economic base.

24. (continued)

C. Soviet advanced research in fields applicable to military developments is probably now about equal to that of the West. Despite excellent theoretical work, however, Soviet military hardware frequently has not reflected the most advanced state-of-the-art in the USSR. In large part, this can be attributed to a conservative design philosophy which emphasizes proven technology and favors rugged, relatively simple equipment. In part, however, this Soviet choice may have been forced by deficiencies in manufacturing and fabrication techniques. Soviet production technology generally lags behind that of the US, although the Soviets are taking steps to correct these deficiencies.

D. It is almost certain that the Soviets have some type of R&D underway in every important field of military technology. Stringent Soviet security practices normally prevent us from detecting military R&D at the laboratory or drawing board stage. We can, however, detect major weapon systems during testing or early deployment. On the basis of evidence of development activity, our judgment of Soviet requirements, and other considerations, we can make estimates concerning the next generation of major Soviet weapon systems. We cannot estimate, however, the specific weapons which the Soviets will develop for introduction in the longer term, 10 or more years from now.

E. Soviet expenditures for R&D are continuing to grow, but the trend is showing a declining rate of growth, probably because the most costly stages of expansion have been finished. With the higher base level thus achieved, a slower growth rate still implies substantial annual increments. We estimate that total R&D expenditures—for military and civilian R&D and the space program together—will increase by about 7 or 8 percent annually through 1970. If, as we estimate, the Soviet space effort is leveling off, even this moderate growth rate would permit an increase in allocations to civilian R&D and continuation of a strong military R&D effort.

F. The Soviets will continue to press their search for new technologies and systems that offer the prospect of improving their strategic situation. We see no areas at present where Soviet technology is significantly ahead of that of the US. Considering the size and quality of the Soviet R&D effort, however, it is possible that the USSR could move ahead of the US in some particular field of strategic importance. The Soviet leaders would certainly seek to exploit any

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significant technological advance for political and military advantage, but in deciding to deploy any new weapon system they would have to weigh the prospective gain against the economic costs and the capabilities of the US to counter it.

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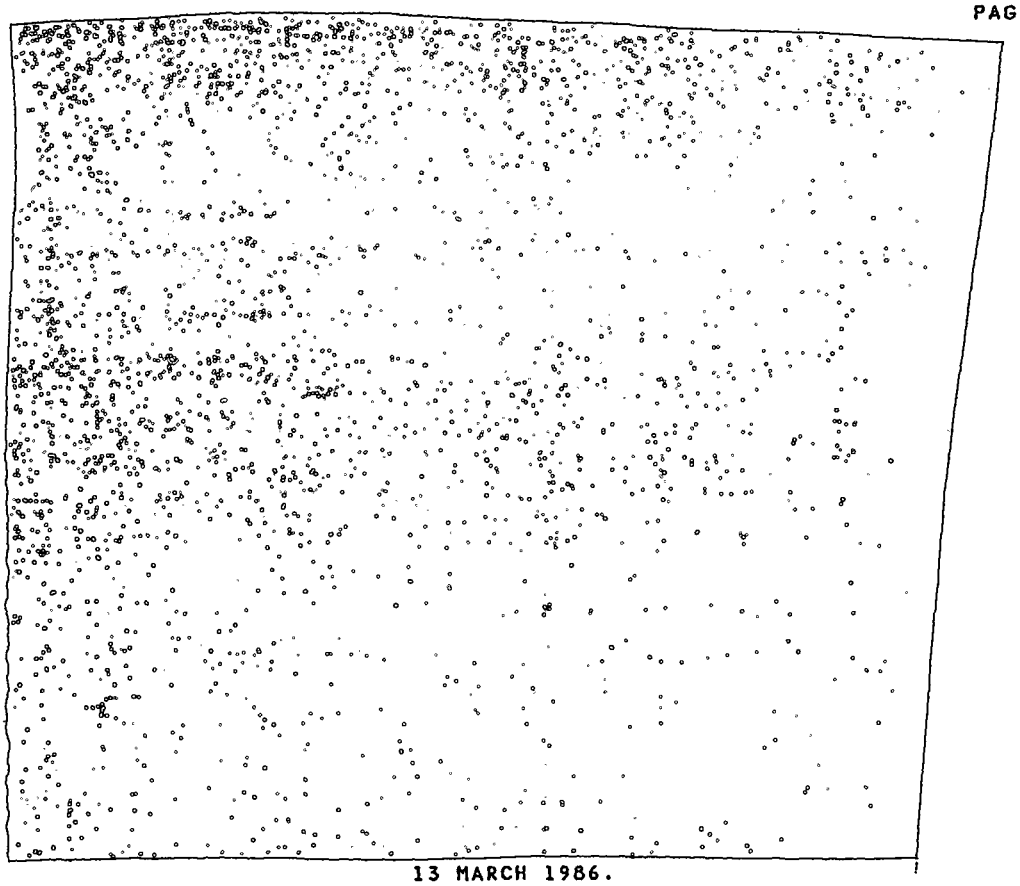
PAGE:0336



13 MARCH 1986.

KEY JUDGMENTS: SOVIET LASER CHEMISTRY RESEARCH AND APPLICATIONS

SINCE THE EARLY 1960S THE SOVIETS HAVE PIONEERED THE FIELD OF LASER CHEMISTRY IN WHICH A LASER IS USED TO INFLUENCE OR DIRECT A CHEMICAL REACTION. TWENTY YEARS OF CONTINUOUS RESEARCH HAS GIVEN THE SOVIETS SCIENTIFIC RECOGNITION AS WORLD LEADERS IN THIS SCIENCE AND A TECHNOLOGICAL BASE FOR DEVELOPING SIGNIFICANT INDUSTRIAL APPLICATIONS IN ELECTRONICS, CHEMICAL ENGINEERING, PROCESS CONTROL, AND GENETIC ENGINEERING.

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1. KEY JUDGMENTS: SOVIET LASER CHEMISTRY RESEARCH AND APPLICATIONS

THE FOLLOWING KEY JUDGMENTS ARE REPRINTED FROM A

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25. (continued)

[redacted]

PAGE:0337

RECENTLY PUBLISHED SCIENTIFIC AND TECHNICAL INTELLIGENCE REPORT PRODUCED BY THE OFFICE OF SCIENTIFIC AND WEAPONS RESEARCH. [redacted]

WE BELIEVE SOVIET BASIC RESEARCH IN LASER CHEMISTRY IS EQUAL TO OR AHEAD OF US RESEARCH IN MOST AREAS. OUR JUDGMENT IS FORMED PRIMARILY FROM ANALYSIS OF OPEN-LITERATURE PUBLICATIONS BY SOVIET SCIENTISTS [redacted] LASER CHEMISTRY IS A TECHNOLOGICAL BASE FOR THE DEVELOPMENT OF NUCLEAR POWER AND WEAPONS, ELECTRONICS, CHEMICAL ENGINEERING, PROCESS CONTROL, AND GENETIC ENGINEERING. [redacted]

IN LASER CHEMISTRY, LASER LIGHT IS USED TO PROMOTE CHANGES IN THE PHYSICAL OR CHEMICAL PROPERTIES OF MATTER. THESE CHANGES CAN PRODUCE NEW CHEMICAL COMPOUNDS, HIGHER YIELDS IN PROCESSES FOR MAKING CONVENTIONAL COMPOUNDS, OR COMPOUNDS WITH PROPERTIES NOT EASILY OBTAINED THROUGH CONVENTIONAL CHEMISTRY. LASER CHEMISTRY CAN ALSO BE USED TO SEPARATE VERY SIMILAR ATOMS OR MOLECULES AND TO DETECT THE PRESENCE OF THESE SPECIES IN EXTREMELY SMALL QUANTITIES. THE SOVIETS HAVE PERFORMED EXTENSIVE RESEARCH IN ALL FIELDS OF LASER CHEMISTRY. [redacted] ALTHOUGH THE SOVIETS LEAD THE UNITED STATES IN MANY AREAS OF BASIC RESEARCH, THEY HAVE BEEN SURPASSED BY THE UNITED STATES IN THE INDUSTRIALIZATION OF APPLICATIONS OFFERING THE GREATEST NEAR TERM ECONOMIC POTENTIAL. WE BELIEVE THAT THE SOVIETS HAVE LAGGED BEHIND THE UNITED STATES IN INDUSTRIALIZATION PRIMARILY BECAUSE OF A LACK OF COOPERATION BETWEEN SOVIET BASIC RESEARCH INSTITUTES AND INDUSTRY--NOT BECAUSE THE SOVIETS ARE TECHNICALLY LIMITED IN THEIR ABILITY TO APPLY ADVANCES FROM BASIC RESEARCH. THE SOVIETS, HOWEVER, HAVE NOW ESTABLISHED A WELL-DEFINED, GOAL-ORIENTED PROGRAM, WHOSE INITIAL SUCCESS COULD GREATLY INCREASE THE RATE OF INCORPORATION OF BASIC SOVIET LASER CHEMISTRY RESEARCH INTO INDUSTRY. IF THIS PROGRAM IS SUCCESSFUL, THE SOVIETS COULD IMPROVE THE DEVELOPMENT OF APPLICATIONS BY 1995. [redacted]

LASER CHEMISTRY AS APPLIED TO ISOTOPE SEPARATION PROMISES TO BE A MORE EFFICIENT AND ECONOMICAL WAY OF SEPARATING OR ENRICHING MANY NUCLEAR ISOTOPES--IMPORTANT IN BASIC RESEARCH, MEDICAL RESEARCH, NUCLEAR POWER, AND NUCLEAR WEAPONS. THE SOVIETS LEAD THE WEST IN THE BASIC RESEARCH OF LASER ISOTOPE SEPARATION (LIS). THEY HAVE BUILT THE WORLD'S FIRST TWO PILOT PLANTS FOR THE SEPARATION OF LIGHT ISOTOPES, AND WE BELIEVE THEY ARE NOW CAPABLE OF OPERATING THESE PLANTS AND INDUSTRIAL-LEVEL SEPARATION PLANTS FOR LIGHT ATOMS AND LOW MOLECULAR WEIGHT MOLECULES. THEIR RESEARCH, HOWEVER, MAY NOT BE AS APPLICABLE TO THE SEPARATION OF URANIUM AND PLUTONIUM ISOTOPES AS THAT PURSUED IN THE UNITED STATES. IN OUR JUDGMENT, THEY WILL NOT BE ABLE TO OPERATE AN INDUSTRIAL PLANT FOR THE ENRICHMENT OF URANIUM BEFORE THE YEAR 2000. [redacted]

[redacted]

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PAGE:0338

THE SOVIETS, ACCORDING TO OPEN SOURCES, HAVE PROPOSED USING LASER ISOTOPE SEPARATION TO PRODUCE HIGH PURITY CARBON-13. A POTENTIAL APPLICATION FOR LARGE QUANTITIES OF CARBON-13 IS FOR USE IN CARBON-DIOXIDE LASER WEAPONS. THE SOVIETS, ACCORDING TO A SCIENTIFIC PUBLICATION, ARE AWARE OF THE ADVANTAGES OF CARBON-13 AND MAY BE MOTIVATED TO DEVELOP A CARBON-13 LIS PROCESS TO MEET MILITARY OBJECTIVES. [redacted]
LASER CHEMISTRY AS APPLIED TO ULTRAPURIFICATION IS USED TO REMOVE TRACE IMPURITIES FROM A BULK MATERIAL. WHEN APPLIED TO MATERIALS WHERE HIGH PURITY IS REQUIRED, SUCH AS SEMICONDUCTORS OR PHARMACEUTICALS, IT CAN DRAMATICALLY INCREASE THE VALUE OF THE MATERIAL. THE SOVIETS LEAD THE WEST IN THIS TYPE OF BASIC RESEARCH. USING LASER PURIFICATION, THEY HAVE DEVELOPED HIGH-QUALITY ELECTRONICS-GRADE SEMICONDUCTOR MATERIALS IN ORDER TO REDUCE A PRESENT SHORTAGE OF THESE MATERIALS. WE BELIEVE THAT BY 1990 THE SOVIETS COULD OPERATE A PILOT PLANT. [redacted]
LASER CHEMICAL SYNTHESIS OFFERS GREATER CONTROL OVER THE CHEMICAL REACTION PATHS AND PRODUCTS THAN CONVENTIONAL

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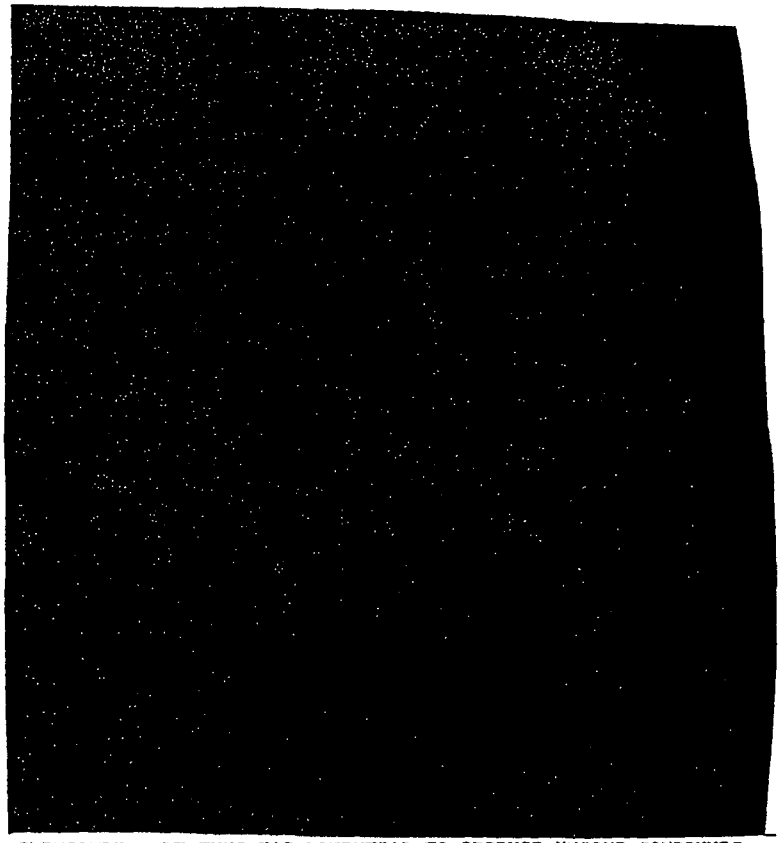

CHEMISTRY. IT THUS HAS POTENTIAL TO PRODUCE UNIQUE COMPOUNDS, TO INCREASE THE SELECTIVITY AND YIELDS OF INDUSTRIAL REACTIONS, AND TO PERFORM CONTROLLED CHEMICAL REACTIONS ON SURFACES AND IN LIVING ORGANISMS. THE SOVIETS LEAD IN THE BASIC RESEARCH OF LASER CHEMICAL SYNTHESIS, AND WE BELIEVE THEY WILL ESTABLISH A PILOT PLANT FOR LASER-INDUCED CHEMICAL SYNTHESIS BY 1995.

LASER SURFACE CHEMISTRY IS IMPORTANT IN THE PRODUCTION OF ADVANCED MICROELECTRONIC COMPONENTS AND THE COATING OF ADVANCED MATERIALS. SOVIET LASER SURFACE CHEMISTRY RESEARCH IS PURSUING CONCEPTS EQUAL TO OR MORE ADVANCED THAN THOSE IN THE WEST. THIS BASIC RESEARCH, HOWEVER, OFTEN HAS POINTED TOARD APPLICATIONS THAT ARE TOO ADVANCED TO OFFER SOVIET INDUSTRY PRACTICAL SOLUTIONS TO EXISTING PROBLEMS. AS THE SOVIET ELECTRONICS INDUSTRY DEVELOPS IN THE COMING DECADE, HOWEVER, WE BELIEVE LASER SURFACE CHEMISTRY WILL PLAY A MORE

CONFIDENTIAL

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CONFIDENTIAL

PAGE:0002

SIGNIFICANT ROLE. [redacted]
ONE AREA OF LASER PHOTOCHEMISTRY IN WHICH THE SOVIETS MAINTAIN A SIGNIFICANT LEAD IN BOTH BASIC AND APPLIED RESEARCH IS LASER PHOTOBIOLOGY, POTENTIALLY USEFUL IN GENETIC ENGINEERING AND BIOLOGICAL WARFARE RESEARCH. THIS EFFORT IS WELL ORGANIZED WITH PHYSICISTS, CHEMISTS, BIOLOGISTS, AND MEDICAL DOCTORS WORKING JOINTLY IN THE RESEARCH. THE SOVIETS HAVE ACHIEVED SELECTIVE LASER CHEMISTRY RESULTS ON BIOLOGICAL MOLECULES AND HAVE MUTATED BACTERIA AND VIRUSES SELECTIVELY. [redacted]
THE SELECTIVITY OF LASER CHEMISTRY PROVIDES A HIGHLY SENSITIVE METHOD FOR DETECTING AND MEASURING TRACE QUANTITIES OF ATOMS OR MOLECULES. IT HAS A WIDE RANGE OF APPLICATIONS FROM PROCESS AND QUALITY CONTROL IN INDUSTRY TO THE DETECTION OF POLLUTANTS OR CHEMICAL WEAPONS IN THE ATMOSPHERE. THE SOVIETS, WHO LEAD IN THE BASIC RESEARCH OF LASER ANALYTICAL CHEMISTRY, ARE PLACING SPECIAL EMPHASIS ON THOSE APPLICATIONS THAT IMPROVE BOTH THE PROCESS CONTROL AND AUTOMATION OF THE SEMICONDUCTOR INDUSTRY. [redacted]

COMPARISON OF SOVIET AND US ACHIEVEMENTS IN LASER CHEMISTRY

RESEARCH AREA	BASIC RESEARCH	APPLIED RESEARCH	PILOT PLANTS	INDUSTRIAL PLANTS
LIGHT ISOTOPE SEPARATION	USSR GREATER THAN US	USSR GREATER THAN US	USSR GREATER THAN US	USSR GREATER THAN US
URANIUM/ PLUTONIUM SEPARATION	US EQUALS USSR	US GREATER THAN USSR	US GREATER THAN USSR	NONE
ULTRAPURIFICATION	USSR GREATER THAN US	US GREATER THAN USSR	US GREATER THAN USSR	US GREATER THAN USSR
DIRECT PHOTOCHEMISTRY	USSR GREATER THAN US	US GREATER THAN USSR	US GREATER THAN USSR	NONE
LASER-INDUCED CHEMISTRY	US EQUALS USSR	US EQUALS USSR	US EQUALS USSR	NONE
LASER SURFACE CHEMISTRY	USSR GREATER THAN US	USSR GREATER THAN US	US GREATER THAN USSR	US GREATER THAN USSR
LASER PHOTOBIOLOGY	USSR GREATER THAN US	USSR GREATER THAN US	USSR GREATER THAN US	NONE
LASER ANALYTICAL CHEMISTRY	USSR GREATER THAN US	USSR GREATER THAN US	US EQUALS USSR	US GREATER THAN USSR

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Soviet Quest for Supercomputing Capabilities [redacted]

Key Judgments

Information available as of 1 April 1986 was used in this report.

Soviet development of supercomputers—required for large-scale scientific computing (LSSC)—lags that of the United States by about 10 years. Through the year 2000, Soviet LSSC is virtually certain to remain at least five and probably 10 to 15 years behind the West. At present, we believe that the Soviets have no machines in the true supercomputer class. The best Soviet scientific computers are slower by at least a factor of 20 than their Western counterparts, and Soviet claimed computer capabilities are greatly exaggerated. Rapid future Soviet progress in LSSC is likely to depend on the technology transfer of both software and hardware from the West. Accordingly, we expect substantially increased Soviet efforts at industrial espionage—particularly efforts directed at software acquisition. [redacted]

Lack of LSSC handicaps many important aspects of Soviet weapons programs, especially in the nuclear and aerodynamic fields. To compensate for their inability to do effective computer modeling of weapon systems, Soviet developers must make trade-offs involving:

- More extensive experimental testing programs.
- Larger engineering design teams.
- Longer system development time.
- Greater development expense.
- Reduced system performance and reliability.

In some fields, such as reentry vehicle design, the Soviets have been successful in making such trade-offs; in other fields, their progress has been severely hindered. [redacted]

Soviet LSSC lags in both software and hardware. Although the Soviets have great strength in some well-established areas of traditional pure mathematics, the USSR has made few contributions to theoretical computer science. Those contributions that they have made—in the area of algorithms—have not been exploited in the USSR. The lack of a "computer culture" in the Soviet Union has reduced the Soviets' ability to encourage and support research in advanced software. In hardware, the best Soviet machines fall far short of Western supercomputers. Their reliability is poor, their processing rate is slow, and their memory sizes are limited. By the early 1990s, the Soviets could have a true supercomputer, the El'brus-3, in production; at present, however, system development is only in the very early stages. [redacted]

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In our judgment, Soviet propaganda boasting of computer capabilities may be designed to undercut attempts to restrict Communist Bloc access to Western supercomputers by making such safeguards appear unnecessary. In specific computer software areas, the Soviets have acquired and exploited significant Western programs and will probably increase their efforts to steal or purchase software. Hardware acquired by the USSR includes machines up to—but probably not above—the VAX "supermini" class. Soviet efforts to access or acquire a true supercomputer such as a Cray-1 are likely to be strenuous. Unrestricted access to Western supercomputer technology would help the Soviets close the gap in this field, perhaps cutting their development time in half. [redacted]

Two long-term trends may help the Soviets in LSSC development during the next 10 to 15 years. First, as computer science research progresses, the labor-intensive nature of software development probably will be reduced; research into automatic programing and ultra-high-level computer languages may make it possible to set up and solve complex LSSC problems much more easily than at present. It will be difficult to keep this technology out of Soviet hands, and acquisition of it may eventually help reduce the Soviet lag in LSSC capability. Second, as Western computer hardware technology advances, more computer power will become available in smaller, cheaper packages. In 10 to 15 years, it is possible that desktop computers with power equal to that of today's supercomputers will be available for under $10,000. We believe that such hardware will also be virtually impossible to keep away from the Soviet Union. [redacted]

In both hardware and software, even if the gap between the West and the USSR remains constant or widens, the Soviets will still be making rapid progress in absolute terms. In 10 to 15 years, we believe the top Soviet scientific institutions will probably have equipment comparable to that of the best US national laboratories at present. Average research institutes may reach that level a few years later. [redacted]

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Central Intelligence Agency

Washington, D.C. 20505

DIRECTORATE OF INTELLIGENCE

19 June 1986

THE KRASNOYARSK RADAR: CLOSING THE FINAL GAP IN COVERAGE FOR BALLISTIC MISSILE EARLY WARNING

Summary

The large phased-array-radar (LPAR) located near Krasnoyarsk, USSR has been an ABM Treaty issue since it was first detected in July 1983 because of its inland, rather than peripheral, siting. Responding to US demands about its inconsistency with the ABM Treaty, the Soviets have repeatedly argued that the radar is for satellite detection and tracking.

Our analyses indicate, and [redacted] that the primary mission of this radar is ballistic missile detection and tracking. Further, we believe the Krasnoyarsk LPAR closes the final gap in the Soviet ballistic missile early warning (BMEW) and tracking network that includes LPARs and the older Hen House type radars.

We believe the siting of an LPAR near Krasnoyarsk was motivated primarily by the requirement to close this BMEW gap and at the same time achieve more favorable RV-impact prediction accuracy at the expense of warning-time. Although the Soviets lose some tracking time because of the inland location, track times are comparable to those of the rest of their BMEW system. We believe the

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This typescript memorandum was prepared by [redacted] and [redacted] of the Office of Scientific and Weapons Research. [redacted] OSWR, contributed to this report. Questions and comments are welcome, and may be directed to the Chief, [redacted] OSWR on [redacted]

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specific location of the radar was determined on the basis of logistical requirements for construction and maintenance, and construction and operations costs.

The Soviet Weapons Industry: An Overview

Summary

Over the last two decades, the Soviet Union has delivered weapons to its military at a level unequaled anywhere in the world. Over 50,000 tanks, 80,000 light armored vehicles, 9,600 strategic ballistic missiles, 50,000 aircraft, 650,000 surface-to-air missiles, and 270 submarines have been procured since 1965.

In the process, the Soviets have built the largest weapons industry in the world. Roughly 50 major design bureaus control the development of 150 to 200 weapons at any one time. Weapons are assembled in about 150 major production complexes scattered throughout the Soviet Union. Designers and producers are supported by thousands of organizations in Soviet academia and industry.

Since the 1920s, the entire complex has been operated in a way that exploits the priority given to defense and the advantages of a command economy, and minimizes the impact of Soviet technical weaknesses. Soviet weapons acquisition has been characterized by:

- Centralized management by party and government organizations, demonstrating continuity and stability in personnel and programs.
- Final leadership authorization of weapon programs and their funding early in the acquisition process.
- Relatively simple, low-risk weapon designs, emphasizing standard components and existing technologies.
- Easily manufactured systems, which can be fabricated by a technologically unsophisticated industrial base with semiskilled or unskilled labor operating general purpose conventional machine tools and equipment.
- Long production runs yielding large numbers of weapons.
- Weapon advances that emphasize incremental upgrades instead of the development of completely new systems or subsystems.

Developments in the economy, technology, and the foreign threat are inducing the Soviets to modify these strategies. The slower growth of the Soviet economy in the past decade and harsh constraints on the availability of key resources have led the Soviet leaders to stress efficiency more than in the past. At the same time, dramatic improvements in Western weapons and advances in their own and foreign military research and development

(R&D) have led them to seek greater advances in weapon performance and capabilities. Changes are under way in the Soviet defense industrial establishment that respond to these new conditions:

- *In resource allocation.* The Soviets appear to be evaluating more carefully the priority accorded the defense industries. Defense will continue to have a high priority, but the increasing costs and complexities of producing advanced weapons are inducing them to seek more cost-effective ways to meet military requirements. In addition, writings and statements indicate the Soviets recognize that their long-term defense needs require more balanced development in Soviet industry, services, and the technology base.

- *In weapon development.* The Soviets are shifting from well proven to more advanced technologies and from simple to more complex weapon designs. They will continue to rely on traditional, proven approaches to develop most of their weapons. But in several areas—such as strategic defense—they will find it more and more difficult to meet new threats by relying on those strategies. Development cycles for some systems may lengthen as a consequence, particularly in the test phase.

- *In production.* The Soviets are manufacturing advanced weapons in smaller quantities and at lower rates. Improved weapon performance and greater multimission capabilities, along with greater production problems and the higher procurement and maintenance costs of new weapons, are encouraging the Soviets in some cases to reduce the numbers produced. The danger of obsolescence from a more rapidly changing threat and military technology base will further encourage shorter production runs. Retrofit programs, which enhance and prolong the combat worthiness of older systems, are probably intended to partly compensate for this.

- *In the industrial base.* The high-technology support sector of the weapons industry—radioelectronics, telecommunications, specialty materials, and advanced production equipment—will generally continue to grow more rapidly than weapon and equipment producers. Throughout the defense industries, the Soviets are using incentives and investment policy to encourage the renovation and modernization of established facilities instead of new plant construction.

- *In administration.* Small-scale changes in planning and management are being implemented. The Soviets are modifying industrial organization and revising plan targets, prices, and incentives to encourage innovation and quality over quantity. They will not undermine the central planning system by providing managers with real autonomy, however, and the defense industries will continue to be the most thoroughly scrutinized part of the Soviet economy.

- *In seeking help from abroad.* The Soviets are stressing and supporting the buildup of the scientific-technical base of their East European allies and will seek more imports of technology and equipment from them. They will also continue to rely heavily on acquisition of Western technology.

Changes in the Soviet armed forces in the 1990s will drive—and be driven by—changes in the weapons industry. Alterations in doctrine, force structure, logistic organization, maintenance requirements, and manpower utilization are likely to accompany the evolution in the products of the defense industries. In some cases, the long-term impact of increasingly sophisticated weapons may be a reduction in total numbers maintained in active inventories. Overall force effectiveness is likely to increase, nonetheless, as the mobility, survivability, and lethality of new weapons improve.

Certain aspects of the weapons industry are unique in the Soviet economy, but many of its problems confront the civilian sector as well. Although the defense industrial ministries have never been completely insulated from civilian industry—an indispensable supplier of materials, components, and subassemblies—the lines between the two sectors have become increasingly blurred as weapons have grown in complexity. Since the last years of the Brezhnev era, the Soviets have been implementing policies to speed the modernization of both the civilian and defense industries.

The Soviet defense industries face considerable challenges in their mission to produce sufficient quantities of highly advanced weapons for the forces of the next decade. Nevertheless, expansion in high-technology industries, advances in precision machining and other fabrication technologies, and continued aggressive exploitation of Western technology will allow the Soviets to overcome some of the difficulties with which their domestic R&D base is currently struggling. Moreover, the Soviets' speed in introducing generic equivalents of Western technologies into their own systems and their ability to surge ahead along a narrow front of military technologies will help them remain competitive in deployed military capabilities.

In any event, the Soviet weapons industry will remain a potent force in the 1990s. It has been a vital ingredient in Soviet military power, which has been the primary instrument of the Soviet leadership in achieving national *security, political leverage, and prestige throughout the world.* The weapons industry will continue to be at the forefront of Soviet technology and industrial prowess, and it will absorb a large share of the best Soviet *resources. Its leaders will continue to wield considerable influence on* Soviet policy. And—because of growing economic constraints and the potential of advancing military technology—its performance is likely to be an even greater determinant of Soviet military power than is the case today.

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Central Intelligence Agency

Washington, D.C. 20505

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DIRECTORATE OF INTELLIGENCE

1 August 1988

US STEALTH PROGRAMS AND TECHNOLOGY: SOVIET EXPLOITATION OF THE WESTERN PRESS

Summary

The Western press has reported extensively on US Stealth -- or very low observable (VLO) systems -- since the mid-1970s. Western reporters often intertwine fact and analysis when writing about US programs. This blending of fact and analysis probably keeps US Stealth programs shrouded in mystery and perpetuates false rumors about the capabilities of Stealth technology. We believe the majority of Stealth technology articles found in the press reiterate well-established signature-reduction techniques that have appeared in technical journals and books.

The Soviets read the Western press to learn about US Stealth programs and technology. They likely used this information to develop comparable offensive systems, to focus research and development efforts toward the design of defenses to counter the Western Stealth threat, and to guide their covert intelligence collection efforts. Although the Soviets use the press to learn about US military systems, we estimate that the special access controls surrounding the US Stealth programs have reduced the amount and quality of militarily significant reporting appearing in the press

The Soviets likely have a good understanding of US Stealth programs and technology from successful Western technology acquisitions, their research and development efforts, and their analysis of the Western press. The relationship among Soviet Stealth acquisitions, the press, and the Soviet weapons development cycle leads us to conclude that the Soviets may be at the prototype stage of an indigenous Stealth program.

Background

The Soviets have a multi-channel Western technology acquisition effort that relies upon a network of covert intelligence operations, trade diverters, international trade agreements, and open source collectors. This well-funded collection effort is targeted primarily against US defense contractors, their affiliates overseas, and their competitors [redacted] the Soviets seek information about future Western military systems to develop comparable offensive systems, to focus research and development efforts towards the design of defenses to counter Western threats, and to estimate the relative technology level of the Soviet Union vis-a-vis the West.

The Soviets use the Western press to guide their covert intelligence collection efforts and trade

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This memorandum was prepared by [redacted], Office of Scientific and Weapons Research. It contains information available as of 1 August 1988. Comments and questions may be directed to the Chief [redacted], OSWR

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The Flat Twin ABM Radar: *Not as Capable as* Previously Believed

Summary

Information available as of 1 August 1991 was used in this report.

New analysis of the Soviet Flat Twin ballistic missile defense radar shows that it is not as capable as previously believed. Our analysis indicates severe constraints imposed on the Flat Twin by its antenna. This strengthens our belief that a widespread, fast-paced Soviet ABM deployment using the Flat Twin is unlikely because of the number of radars required, as well as the extreme difficulty of modifying the Flat Twin to make it perform effectively.

Our analysis of the Flat Twin's antenna indicates that the Flat Twin is much less capable in off-boresight scanning for track and search than we had previously estimated. indicate that the Flat Twin has a maximum scanning capability of about ±15 degrees in azimuth and elevation for tracking. also indicates that the Flat Twin can search less than ±10 degrees. This reassessed search capability is considerably less than the earlier estimate of ±45 degrees.

Because of the Flat Twin's scanning limitations, a widespread ABM system using the Flat Twin would require an overwhelming number of radars. A system deployed at Moscow and 40 of the most important areas in the Soviet Union would require about 500 to 570 Flat Twin radars. These numbers are about 30 percent higher than our previous assessment. Although the Soviets would require fewer Flat Twin radars to defend their 125 high-priority deployment sites under the START treaty, the number required is still considerable. Under the START treaty limit of about 4,900 US ballistic missile warheads—the level to be achieved by 1996—our modeling indicates that a Soviet defense would require about 510 to 600 Flat Twin radars. Under a potential future START treaty permitting about 2,450 US ballistic missile warheads, we calculate that the number of Flat Twin radars required for defense would be reduced to about 380 to 450.

Given the Flat Twin's limitations as a widespread ABM system, we believe that the Soviets would use a new type of ABM radar. We would expect a new radar to have a greatly improved scan angle, a better multiple-target-tracking capability, and greater detection range. Thus, a significant reduction in the number of radars required in a widespread ABM system would result.