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SOVIET CAPABILITIES IN GUIDED MISSILES AND SPACE VEHICLES

Submitted by the
DIRECTOR OF CENTRAL INTELLIGENCE

The following intelligence organizations participated in the preparation of this estimate: The Central Intelligence Agency and the intelligence organizations of the Departments of State, the Army, the Navy, the Air Force, and The Joint Staff.

Concurred in by the
UNITED STATES INTELLIGENCE BOARD

on 8 September 1959. Concurring were the Director of Intelligence and Research, Department of State; the Assistant Chief of Staff for Intelligence, Department of the Army; the Assistant Chief of Naval Operations for Intelligence, Department of the Navy; the Assistant Chief of Staff, Intelligence, USAF; the Director for Intelligence, The Joint Staff; the Atomic Energy Commission Representative to the USIB; the Assistant to the Secretary of Defense, Special Operations; and the Director of the National Security Agency. The Assistant Director, Federal Bureau of Investigation, abstained, the subject being outside of his jurisdiction.

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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.

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. [redacted] 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. [redacted] 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. [redacted] 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.

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, [ ] 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

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. *ICBM 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 [ ] 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. [ ] 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. [ ]

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, [ ] 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.

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. [redacted]

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

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

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.

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).