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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, The Joint Staff, AEC and NSA.

Concurred in by the

UNITED STATES INTELLIGENCE BOARD

on 3 November 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

THE PROBLEM

To estimate Soviet capabilities and probable programs for the development of guided missiles, and the major performance characteristics and dates of operational availability of such missiles. Further, to estimate the technical capabilities of the Soviets in space including the earliest possible dates of achievement of important space ventures.

FOREWORD

This estimate supersedes NIE 11–5–58, "Soviet Capabilities in Guided Missiles and Space Vehicles," dated 19 August 1958, "Memorandum to Holders of NIE 11–5–58," dated 25 November 1958, and the "Advance Portion of NIE 11–5–59," dated 8 September 1959. It is made on the basis of our belief that the USSR does not now intend to initiate general war deliberately and is not now preparing for general war as of any particular date. It assumes that there will be no international agreement on the control of armaments or outer space.

In view of the paucity of positive intelligence on Soviet missile and space programs, we have given considerable weight to estimated Soviet military requirements, estimated Soviet capabilities in related fields, and US guided missile experience.

For guided missiles, except where noted otherwise, the initial operational capability dates given are the years during which we estimate one or more series produced missiles could *probably* have been placed in the hands of trained personnel in one operational unit, thus constituting a limited capability for operational employment. For space flight activities, the dates given are the earliest *possible* time periods by which we believe each specific objective could be achieved, although we believe it unlikely that all these objectives will be achieved within the specified time periods.

Forthcoming estimates will consider to what extent the USSR has the resources and industrial capacity to produce the missile systems described herein, together with the ancillary equipment necessary to their deployment.

Revised paragraph 6 to be attached to back of page 1.

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6. We estimate Soviet ICBM guidance at IOC date as a combination radar track/radio command/inertial system which is called "radio-inertial," although an all-inertial system is possible. Soviet capabilities in related components at IOC point to a *theoretical* CEP of about 2 n.m. with the radio-inertial system. The Soviets probably will incorporate the all-inertial system in their ICBM sometime during the 1960–1962 period and, should they adopt this system in 1960, they could achieve a *theoretical* CEP of about 3 n.m. The data available for estimating both the above *theoretical* CEPs are far from exact. The precise amount of degradation which would be introduced by operational factors is unknown, but we estimate a CEP under operational conditions at IOC date of about 3 n.m. with the radio-inertial system; with an all-inertial system the operational CEP in 1960 would be about 5 n.m. We further believe that the Soviets will be able to improve the accuracy of their ICBM following IOC, and that over the next few years, and probably not later than during 1963, the operational CEP for an all-inertial system could be reduced to about 2 n.m., and the operational CEP of the radio-inertial system would be somewhat better.*

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* The Assistant Chief of Staff for Intelligence, Department of the Army, believes that this re-examination which resulted in the estimated better Soviet ICBM accuracy either reflects, or was suggested, by recent US ICBM test experience which caused certain members of the USIB to revise their judgment as to the validity of the most recent intelligence study of this problem conducted for the USIB by the Guided Missile and Astronautics Intelligence Committee (GMAIC). The Assistant Chief of Staff for Intelligence, Department of the Army, recognizes that it is prudent to estimate that the Soviets would sooner or later, if not currently, possess an ICBM system of an accuracy comparable to that of the US ICBM. However, at present, he perceives no justification for abandoning the estimates derived from so recent an analysis of all available technical intelligence information. A further significant consideration is that estimates of *operational* accuracy are based on *theoretical* degradation of test range performance which further increases the uncertainties in such estimates. Accordingly, it is believed that there is no present intelligence basis for changing the conclusions as to operational accuracy as contained in the GMAIC report and, therefore, that the more likely range of *operational* accuracy for Soviet ICBM at IOC, using "radio-inertial" guidance, is on the order of a 3–5 n.m. CEP; that by sometime in 1963, with the all-inertial system, the CEP could be reduced to 2.5 n.m., although the operational CEP of the "radio-inertial" system would be somewhat better.

SUMMARY AND CONCLUSIONS

1. Soviet programs in the development of guided missiles and in space flight have been carried forward on a wide front over the past year. As these Soviet programs and our own intelligence collection and analysis have advanced, we have acquired considerable new information on both specific developments and the extensive scientific and technical capability underlying them. In general, this information has confirmed progress along the lines indicated in previous estimates. Of the 19 Soviet missile systems estimated as probably available for operational use now or within the next two years, we have evidence on the existence of 13. The others are inferred from Soviet requirements and technical capabilities. Evidence on some systems is extensive, but for most there are serious deficiencies, not only in the quantity and quality of information but also in its timeliness.

Surface-to-Surface Ballistic Missiles

2. Missiles in this category which we know the USSR has developed or has under development 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 an intercontinental ballistic missile (ICBM). These missiles probably meet high standards in reliability, accuracy, and other performance characteristics. We believe that in the development of longer range systems, maximum use has been made of proven components.

3. Mobility appears to be a basic design consideration. Systems with ranges of 700 n.m. and less are probably road mobile. The 1,100 n.m. system is probably road and/or rail mobile. The available evidence suggests that the Soviet ICBM could be rail mobile, but we do not know whether the ICBM system as a whole will consist of rail mobile units, fixed installations, or a combination of the two. In any case, the system will be heavily dependent on the Soviet rail network.

4. *ICBM.* During 1959 the Soviet ICBM test firing program resumed after a period of virtual inactivity in the second half of 1958. Recent firing schedules indicate that the program as a whole is proceeding in an orderly fashion rather than on a "crash" basis. We do not know that series production of ICBMs has actually begun, nor do we have evidence of operational launching facilities. However, there has been ample time for the USSR to begin turning out series produced ICBMs, as implied by Soviet claims. Evidence derived from Soviet ICBM flight tests is considered adequate to gauge the general progress of the program. We cannot state with certainty the precise timing of the initial operational capability (IOC) of a few—say, 10—series produced ICBMs. In light of all the evidence, we believe that for planning purposes it should be considered that the IOC will have occurred by 1 January 1960.

5. On the basis of correlated data from ICBM and space vehicle launchings, we believe the Soviet ICBM to be a one and one-half or parallel staged vehicle, employing liquid oxygen/kerosene propulsion, capable of delivering a 6,000 pound nuclear warhead to a range of 5,500 n.m. if employed with a heat-sink nosecone. A reduction in warhead weight would permit an increase in range; use of an ablative nosecone would permit a heavier warhead or extended range.

Revised para 6. - back of page 1

~~6. We estimate Soviet ICBM guidance at IOC date as a combination radar track/radio command/inertial system, although an all-inertial system is possible. Soviet capabilities in related components point to a theoretical accuracy (CEP) of about 3 n.m. The amount of degradation which would be introduced by operational factors is unknown, but we estimate that CEP under operational conditions would be no greater than 5 n.m. at IOC date and may be better, say between 3 and 5 n.m. In any event, we estimate that under operational conditions a CEP of 3 n.m. in 1963 and 2 n.m. in 1966 will be feasible.~~

7. *Other Surface-to-Surface Ballistic Missiles.* By late 1958 or early 1959, research and devel-

opment work on an 1,100 n.m. missile had advanced to the point where this system was probably ready for operational use. Test firings on this and shorter range ballistic missiles have continued during 1959; [

] Although no units or installations have yet been identified with these missiles, all systems from 75 n.m. to 1,100 n.m. are probably now in operational use. From launching sites within the USSR, 700 and 1,100 n.m. missiles could deliver 3,000 pound nuclear warheads against a large majority of critical targets in Eurasia and periphery, with CEPs of 1–2 n.m. and about 2 n.m., respectively. All-inertial guidance could probably be available now or by the end of 1960.

Air Defense Missiles

8. In the surface-to-air missile category, a new system is being added to the defenses of Soviet industrial and population centers. It probably became operational in 1957, and has been deployed extensively during at least the past year, including some units in East Germany. In contrast to the massive, immobile system which has been employed at Moscow for the past several years, the new system is flexible and employs small fire units. It can, at relatively low cost, be deployed widely for defense of large areas, smaller fixed points, and forces in the field. Both the old and new systems can effectively deliver high explosive (HE) or nuclear warheads against present Western bomber types, except at very low altitude.

9. In the absence of evidence, but considering Soviet technical capabilities and probable needs, we estimate that within the next year or two the USSR will probably have available two additional surface-to-air missile systems, one designed primarily to engage very low altitude targets, the other for long-range (on the order of 100 n.m.) engagement of targets at altitudes up to 90,000 feet. These systems will have increased kill capabilities against aircraft and cruise-type missiles. We also believe that in 1963–1966 the Soviets will have available an antiballistic missile system with undetermined capability against ICBMs, IRBMs, submarine-launched, and air-launched ballistic missiles.

10. We continue to estimate that the USSR has several types of short-range (up to 6 n.m.) air-to-air missiles with HE warheads, for employment with day and all-weather interceptors. Additional types, with longer ranges and capable of carrying nuclear warheads, will probably become available in 1960 and after.

Air-to-Surface Missiles

11. A subsonic air-launched antiship missile, capable of delivering nuclear or HE warheads from a maximum range of 55 n.m., is now assigned to jet medium bomber units in widely separated coastal areas of the USSR. The Soviets will probably have available in about 1961 a supersonic missile which will provide medium and heavy bombers with a standoff capability of at least 350 n.m., and will be adaptable for use against land targets or ships at sea. They may now have in operation an air-launched decoy to simulate medium or heavy bombers.

Naval-Launched Missiles

12. We estimate that at least one and perhaps two types of submarine-launched missiles with nuclear warheads are operational in small numbers of modified, long-range, conventionally-powered submarines. One is a subsonic cruise-type system with a maximum range of 150–200 n.m., low altitude cruise capability, and CEP of 2–4 n.m. In addition, some submarines may have been modified to launch ballistic missiles of similar range and accuracy. Both these systems would require the submarine to surface before launching a missile. Based chiefly on Soviet requirements and capabilities, we estimate that in 1961–1963 the USSR will probably achieve a system capable of delivering ballistic missiles with nuclear warheads to a maximum range of 500–1,000 n.m. from a submerged submarine.

13. The Soviet Navy's modernization program includes the arming of surface ships with missiles. Some destroyers are being modified

and others constructed to launch subsonic cruise-type missiles, probably of 30–40 n.m. range, in lieu of main battery guns and torpedoes. It is logical to suppose that such missiles will be installed on any modified or newly-constructed Soviet cruisers. Ground-launched surface-to-air missiles will probably be adapted for use by surface ships. The USSR will probably also develop missile systems for antisubmarine warfare: surface ship-launched and submarine-launched versions could probably enter service between 1962 and 1966.

Space Program

14. The probable main objectives of the Soviet space program are: to conduct scientific research, to develop military applications, to attain manned space travel, and to support Soviet propaganda and policy. The actual launching program has, like the ICBM test firing program, proceeded at a fairly deliberate pace. Its recent emphasis has been on scientific and propaganda objectives. In addition to high altitude research vehicles, the program since mid-1958 has included three space vehicles which reached the vicinity of the moon. All three lunar probes were major feats of theory and technology.

15. Supported by high thrust propulsion systems and a wealth of scientific and technical know-how, the Soviet space effort will achieve large and increasingly refined satellites and space vehicles with scientific and perhaps military utility. Judging by the USSR's known and estimated capabilities, and in light of the obvious Soviet desire to achieve worldwide propaganda and psychological impact, we believe that during the next 12 months or so the Soviet space program will include one or more of the following:

a. vertical or downrange flight and recovery of a manned capsule;
b. unmanned lunar satellite or soft landing on the moon;
c. probe to the vicinity of Mars or Venus;
d. orbiting and recovery of capsules containing instruments, an animal, and thereafter perhaps a man.

SIMPLIFIED TABULAR SUMMARY

PROBABLE SOVIET GUIDED MISSILE DEVELOPMENT PROGRAM *

ARBITRARY DESIGNATION	OPERATIONAL DATE	MAXIMUM RANGE	MAXIMUM WARHEAD WEIGHT	ACCURACY (CEP)	OTHER
			lbs.		
Surface-to-Surface Ballistic Missiles					**Deployment Concept**
SS-1 SCUD	1954–1957	75 n.m.	1,500	1,200 ft.	Road mobile
SS-2	1954	200 n.m.	2,000	⅓–⅔ n.m.	Road mobile
SS-3	1954	350 n.m.	2,000	½–1 n.m.	Road mobile
SS-4 SHYSTER	1956	700 n.m.	3,000	1–2 n.m.	Road mobile
SS-5	Late 1958–early 1959	1,100 n.m.	3,000	2 n.m.	Road and/or rail mobile.
SS-6 ICBM	See paras. 4, 73	5,500 n.m.	6,000	See paras. 6, 78, 79.	Rail mobile and/or fixed sites.
SS-antitank	Prior to 1958	5,000–6,000 yds.	20–40	2 ft.	
Ground-Launched Surface-to-Air Missiles					**Effective Altitude**
SA-1 Moscow	1954	20–30 n.m.	450–700	65–120 ft.	3,000–60,000 ft.
SA-2 GUIDELINE	1957	25–40 n.m.	450–700	65–120 ft.(?)	(?)–60,000 ft.
SA-3	About 1960	10–25 n.m.	150–250	20–50 ft.	50 ft.–40,000 ft.
SA-4	1960–1961	About 100 n.m.	450–700	100 ft.	Up to 90,000 ft.
SA-5	1963–1966	Undetermined capability against ballistic missiles			
Air-to-Air Missiles					**Conditions for Use**
AA-1	1955–1956	2–5 n.m.	40	20 ft.	All weather
AA-2	1955–1956	1–4 n.m.	25	10 ft.	Limited
AA-3	1958	2½–6 n.m.	25	15 ft.	All weather
AA-4	1960	5–20 n.m.	150	10–50 ft.	All weather
AA-5	1963	5–20 n.m.	150	10–50 ft.	All weather
Air-to-Surface Missiles					**Speed**
AS-1 Komet	1956–1957	55 n.m.	3,000	150 ft. against ships.	Subsonic
AS-2	1961	At least 350 n.m.	3,000	2 n.m. on land, 150 ft. against ships.	Supersonic
Submarine-Launched Missiles					**Conditions for Use**
SS-7 cruise-type	1955–1956	150–200 n.m.	2,000	2–4 n.m.	Surfaced
SS-9 ballistic	1961–1963	500–1,000 n.m.	1,000	2–4 n.m.	Submerged
Other Naval-Launched Missiles					**Deployment Concept**
SS-8 cruise-type	1958	30–40 n.m.	2,000	150 ft.	Destroyers, cruisers.
SS-10 ASW	1962–1964	20 n.m.	See para. 94	See para. 94	Surface ship launched.
	1963–1965				Submarine launched.

SA-2, SA-3, and SA-4 will probably be adapted to surface ships.

* For a detailed summary of each missile category, covering all estimated characteristics and other pertinent information including possible developments, see Section IX. For a detailed summary of estimated Soviet capabilities in space flight, see Section VIII.

DISCUSSION

I. AIR DEFENSE MISSILE SYSTEMS

SURFACE-TO-AIR MISSILE SYSTEMS

16. At the end of World War II the Soviets, realizing the future importance and role of surface-to-air guided missiles (SAMs), took steps to develop a capability in this field. They appropriated German missile hardware and designs and deported to the USSR technical personnel who had worked on German SAM projects during the war. These efforts advanced their state of the art more rapidly than if the Soviets had initiated research and development in this field without assistance. Thus when the Soviets decided to proceed with the development of a missile system to counter the threat posed by growing Western air capabilities, they had a considerable background of research and development on which to base a choice.

17. In late 1949 or early 1950, the SAM system employing a guidance scheme known as the B–200 was selected and its development was placed on a priority basis. The Soviets deployed this system for the defense of Moscow in a vast complex to the exclusion, at that time, of protection of other potential targets in the USSR. This was the first in a family of surface-to-air missile systems the Soviets have developed or are believed to have under development. Each of these systems is designed to counter a specific threat, fill a particular gap, or take advantage of scientific and technical advances to assist in solving air defense problems.

SA–1 System

18. This is the arbitrary US intelligence designation of the Soviet SAM system whose deployment is limited to the Moscow area. The system employs the B–200 track-while-scan guidance system and the V–301 command-guided missile. Because German scientific and technical personnel assisted in the development of this system, and because it has been under observation for about six years and fully deployed for about three years, more information is available on this than on any other Soviet SAM system.

19. The priority assigned to the SA–1 system in late 1949 or early 1950 resulted in a telescoping of development time. Components and subassemblies of the B–200 system were reported to be in production at Plant No. 304, Kuntsevo, and in plants in Leningrad as early as 1952. The herringbone or chevron-type ground installations typical of the SA–1 system were under construction at least as early as mid-1953. Deployment of the system was begun in 1954 and the entire complex was probably operational by 1956. The sites required approximately three to four years to construct and necessitated a considerable expenditure of manpower and materials. To date, 47 missile sites have been located with accuracy sufficient to indicate that the over-all deployment pattern consists of two concentric rings with radii approximately 25 and 45 n.m. from the center of Moscow. (See Figure 1) There are probably 56 sites in the defense complex, of which 22 are on the inner ring and 34 on the outer. A typical site has 60 launch positions joined by a road network. (See Figure 2) Missile erection equipment for these sites was probably produced at "Mashinostroitel" Moscow.

20. Each of these large, fixed sites incorporates a track-while-scan radar (designated "Yo-Yo" by US intelligence), having about 54° coverage in both the vertical and horizontal planes, and a maximum radar range capability of about 32 n.m. The system uses missile and target track data obtained from the Yo-Yo for computing missile corrections, which are then transmitted to the missile by a radio link. It is believed that the system, as originally deployed, utilized four tracking consoles, each capable of handling five missile-target pairs, thus giving each site the capability of engaging as many as 20 targets simultaneously. This individual site capability, together with the spacing of adjacent sites for mutual support and the deployment of an inner ring of

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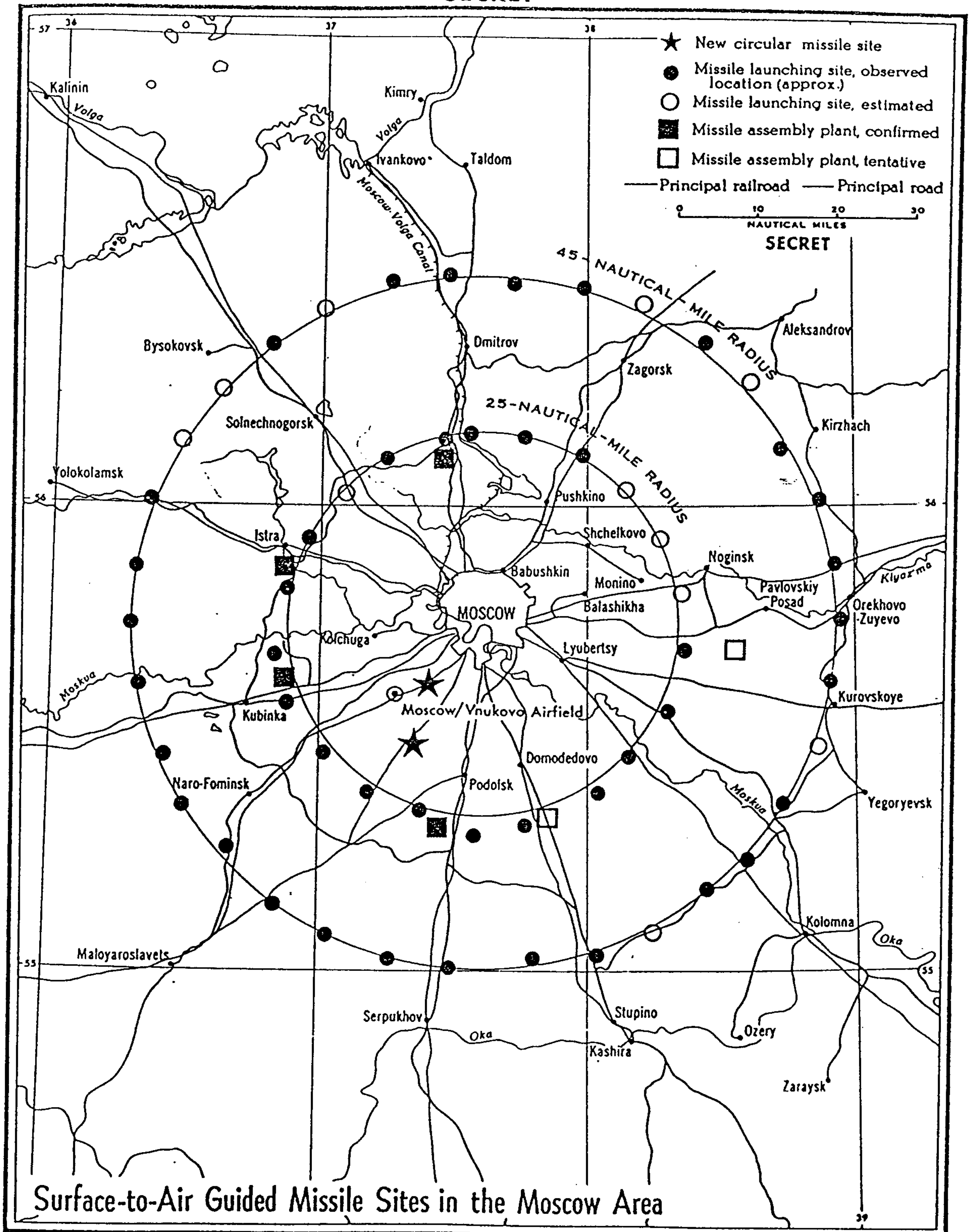

Surface-to-Air Guided Missile Sites in the Moscow Area

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Figure 1

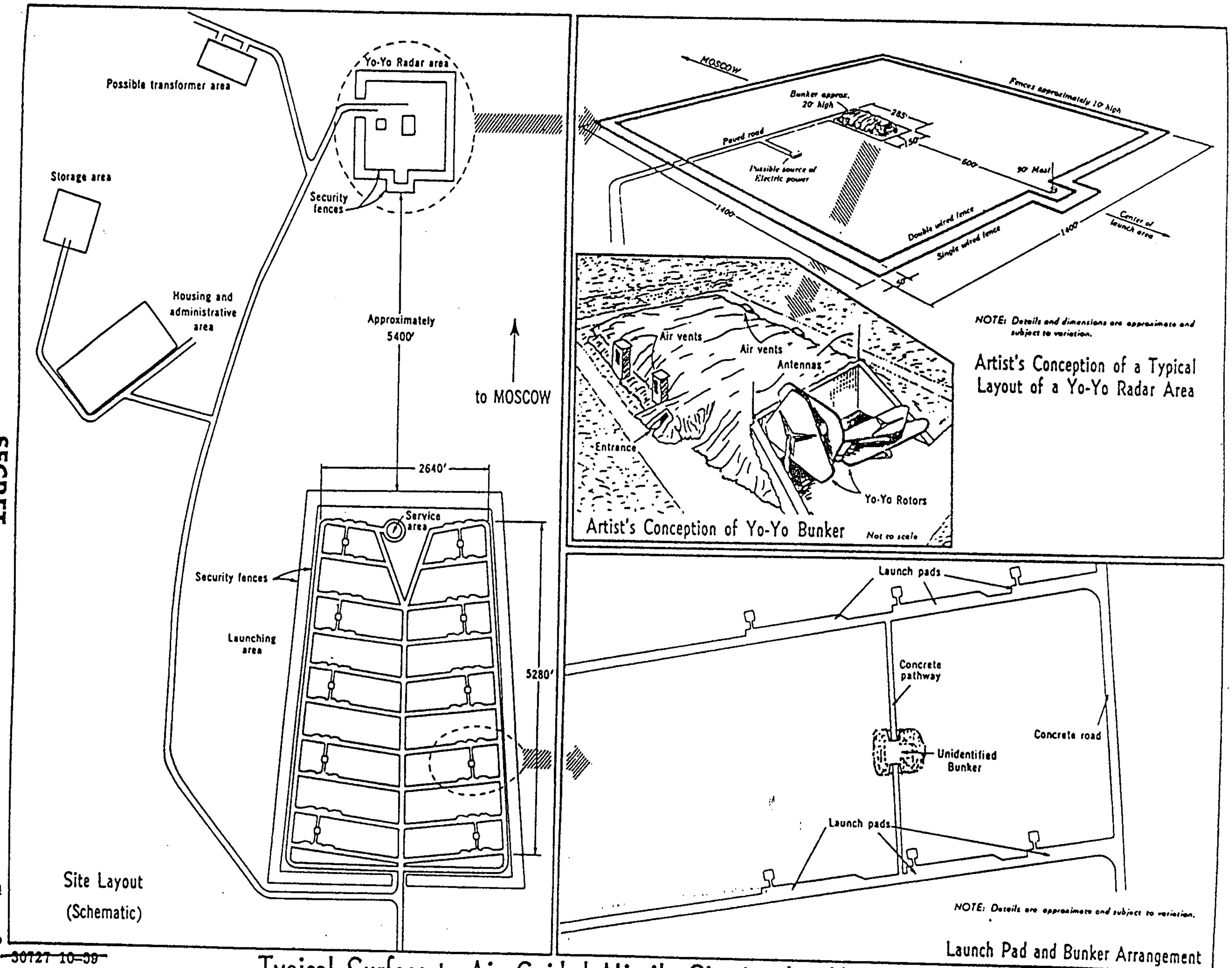

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Figure 2

Typical Surface-to-Air Guided Missile Site in the Moscow Area

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sites for backup, enables the system to direct an extremely high rate of fire against incoming targets.

21. The V-301 missile originally designed for use with this system is unboosted and employs a liquid propellant sustainer motor. While its maximum speed is on the order of Mach 2.5, it has a low initial velocity which limits somewhat its engagement capability against supersonic targets. Its maximum intercept range will vary between 20-30 n.m. depending upon the approach and the type target; for example against a directly incoming high altitude B-52 type target its range is on the order of 20 n.m. Data indicate it was designed to carry an HE payload of 450-700 pounds. We estimate its CEP to be 65-120 feet. Although probably designed for an altitude capability of up to 60,000 feet, the missile should have some effectiveness up to about 80,000 feet, particularly if carrying the nuclear warhead which it could now employ. Its minimum effective altitude is approximately 3,000 feet.

22. The Soviets will probably continue to utilize the SA-1 system at Moscow as long as it has any real effectiveness against the aircraft threat. Nevertheless, we believe that the system was selected primarily to counter the massed raid concept of the late 1940s and early 1950s. By the time the Moscow deployment was completed, it is probable that concepts of the threat to be expected had changed and that other defense techniques were considered more appropriate. Moreover, the limited azimuth coverage of each site makes the system rather inflexible, and in its present configuration it is completely immobile. The magnitude of effort involved in its deployment probably also argued against its use in less critical areas.

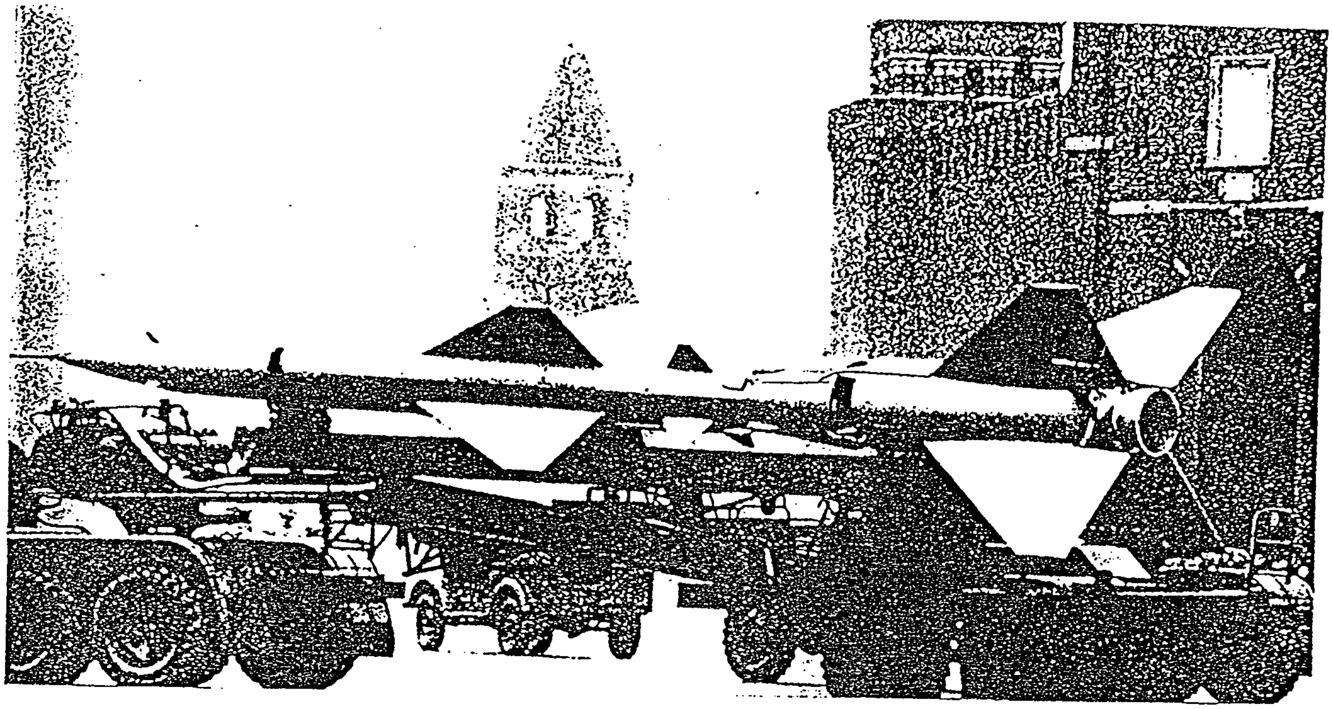
23. German returnees reported that in mid-1951 the V-301 missile was in R&D prototype production at Plant No. 301 in Khimki and by the end of 1952 production engineered missiles were being produced at Plant No. 82, Tushino, and probably at Plant No. 464, Dolgoprudnaya. Stabilization and control components (including gyro assemblies) and other subassemblies and components were produced at Moscow Aircraft Instruments Plant No. 122, Moscow Clock Plant No. 2, and an electronic plant, No. 567, also in Moscow. We estimate that current production of this missile is for replacement only and that the bulk of the production capacity is being utilized for the production of the SA-2 missile.

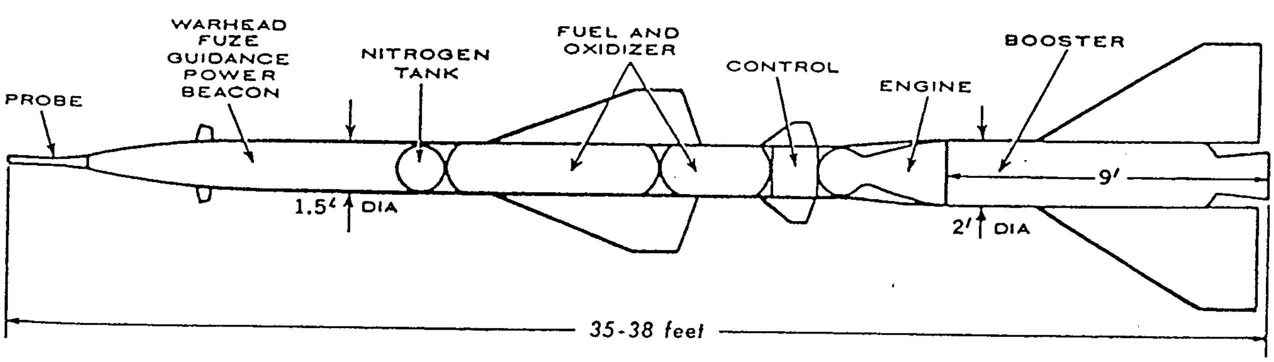
SA-2 System

24. We have recently observed the extensive deployment of a new, more flexible SAM system. The first identification of a site employing this system was at Glau, East Germany (see Figure 4) in June 1959. In retrospect, components of the system—including the Guideline missile (see Figure 3) we believe it employs—can be traced back to 1957. Recent identification of radar signals emanating from the Glau site has permitted identification of similar signals from other locales beginning in mid-1957. Based on the Moscow parade sighting of the Guideline missile and Elint intercepts probably associated with the guidance systems, we believe the system became operational in 1957.

25. Revetted SA-2 sites have definitely been identified in various stages of construction at Glau and Jueterbog, East Germany, and at Moscow, Rostov, Kiev and Sverdlovsk, USSR. In addition, we believe sites exist at many widespread locations, possibly including Central USSR (Omsk), the Far East (Vladivostok), several cities in the Black, Caspian and Barents Sea areas, and other locations in the USSR. The equipment at these sites appears to be identical and quite mobile, although those sites identified within the USSR appear of relatively more permanent construction. Basic site equipment includes a central fire control system and associated van-type trucks and trailers which probably house radar and computing equipment and power generators. Six launchers are normally but not always arranged in a roughly circular pattern of about 500 feet in diameter, with the fire control system in the center. A surveillance type radar is displaced several hundred yards from the rest of the equipment. (See Figure 5)

26. The fire control radar (nicknamed "Fruitset") consists of at least four separate antennas located on a single, mobile mount. (See





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SURFACE-TO-AIR MISSILE (GUIDELINE)
7 NOVEMBER 1957 MOSCOW PARADE

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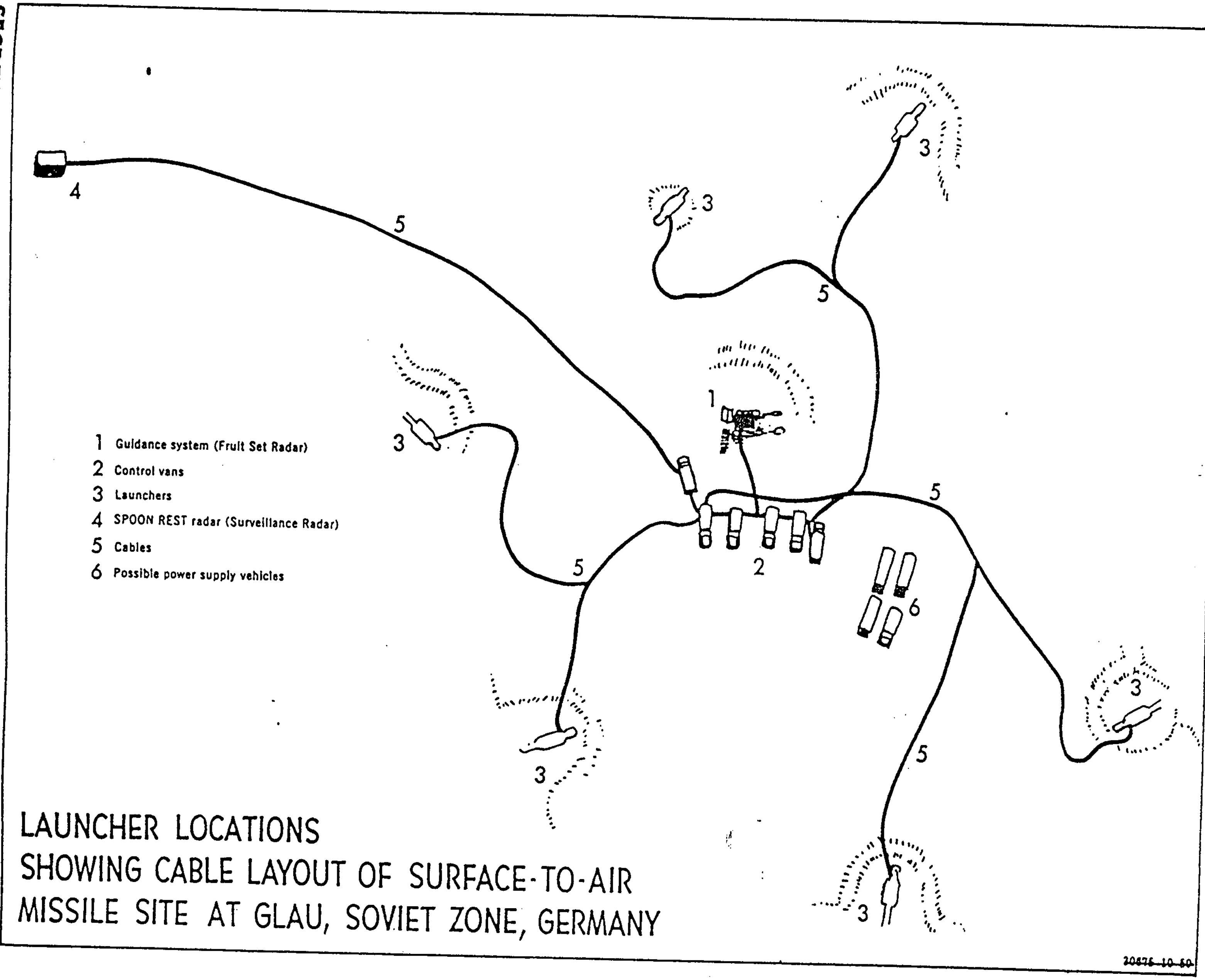

LAUNCHER LOCATIONS
SHOWING CABLE LAYOUT OF SURFACE-TO-AIR
MISSILE SITE AT GLAU, SOVIET ZONE, GERMANY

Figure 4

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Figure 5) The entire mount and antennas appear capable of rotation about a vertical axis. At least one of the dishes is capable of rotation about a horizontal axis as well. The surveillance radar (nicknamed "Spoonrest") operates in the VHF range. The launchers can probably rotate in azimuth through 360°. Each launcher can accommodate one missile on a launching arm which can be elevated to various angles. A road network is carefully laid out at each site to facilitate reloading the launchers by missile-carrying truck-trailers.

27. Although the evidence is not conclusive, the missile employed with the SA-2 system is believed to be the Guideline, a 35-38 foot missile with a solid propellant booster and probably a liquid propellant sustainer motor. (See Figure 3) This missile was displayed at the 7 November 1957 Moscow parade on a special trailer of a type recently identified at the Glau site. Guideline appears compatible with the equipment and other features of the SA-2 system; when used with it, maximum range is estimated to be 25-40 n.m. Maximum missile velocity is probably about Mach 3. The warhead is estimated to weigh 450-700 pounds and could be either HE or nuclear. Maximum effective altitude capability is about 60,000 feet, with some effectiveness up to about 80,000 feet, especially with a nuclear warhead.[1]

28. Precise estimates of miss distance cannot be made at this time because the guidance mode has not yet been determined, but we believe the CEP would approximate the 65-120 feet estimated for SA-1. Radio/radar command or beam rider are likely guidance schemes. A variation of the radar command could be a track-while-scan system. Such a scheme, similar in concept to the SA-1 guidance, would permit a multiple, simultaneous intercept capability. However, the limited number of launchers and the relatively slow reload method at the SA-2 sites seem incompatible with such a capability. At present there is insufficient data and analysis to permit firm estimates of radar range capabilities or low altitude limits. We do not believe that the system is capable of attacking targets at very low altitude (i.e., as low as 50 feet), but it is probably effective at altitudes below the 3,000 foot lower limit estimated for SA-1.

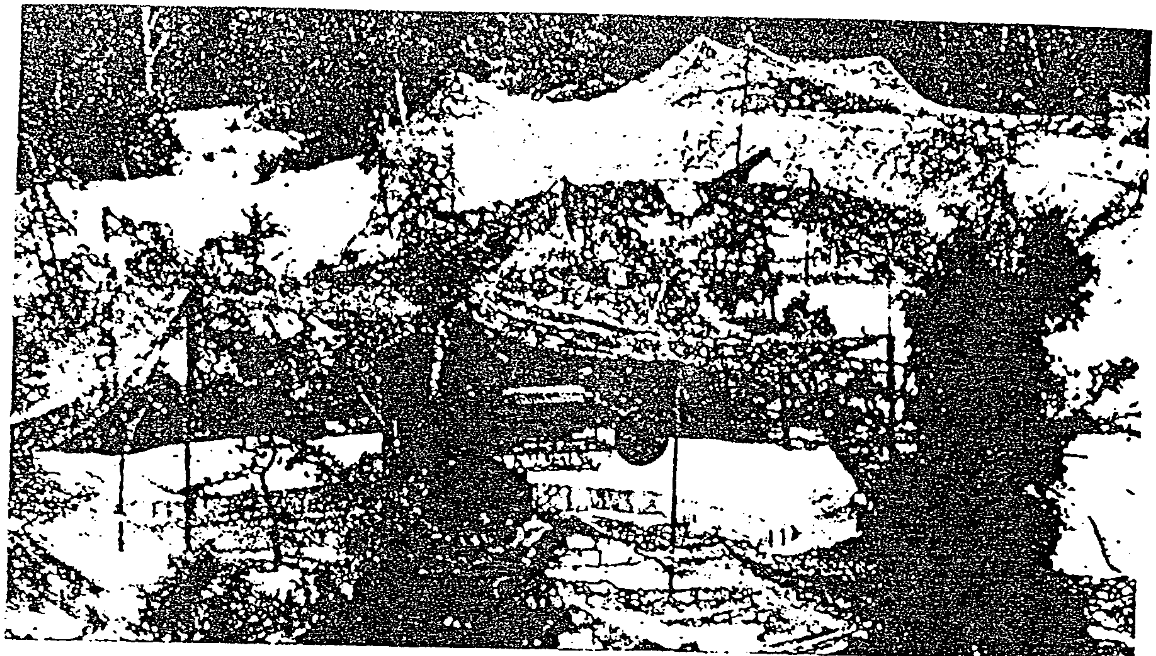
29. Three sites have been observed under construction in the Moscow area (see Figures 1, 6) 10-15 miles from the center of the city. Two of these are about three miles apart; the third is in another quadrant. These SA-2 sites are inside the inner ring of SA-1 sites. The SA-2 sites at Moscow are unique with respect to those observed in other areas, in that the six individual launcher revetments are arranged in a semicircle (see Figures 1, 6) apparently because their primary sector of fire is away from the city, with little consideration for mutual support of sites on opposite sides of the defended area. It is believed that these SA-2 sites are a backup for existing SA-1 defenses and are intended to supplement them.

30. Considering the SA-2 system as a whole in relation to the SA-1, its improvements lie partly in range capabilities and in the shorter time of flight of its boosted missile. The chief advantage of the newer system is its flexibility. It can, at relatively low cost, be deployed widely for defense of large cities, for small but important fixed facilities, and for defense of forces in the field. This flexibility is obtained at the expense of target handling capacity per site relative to the SA-1.

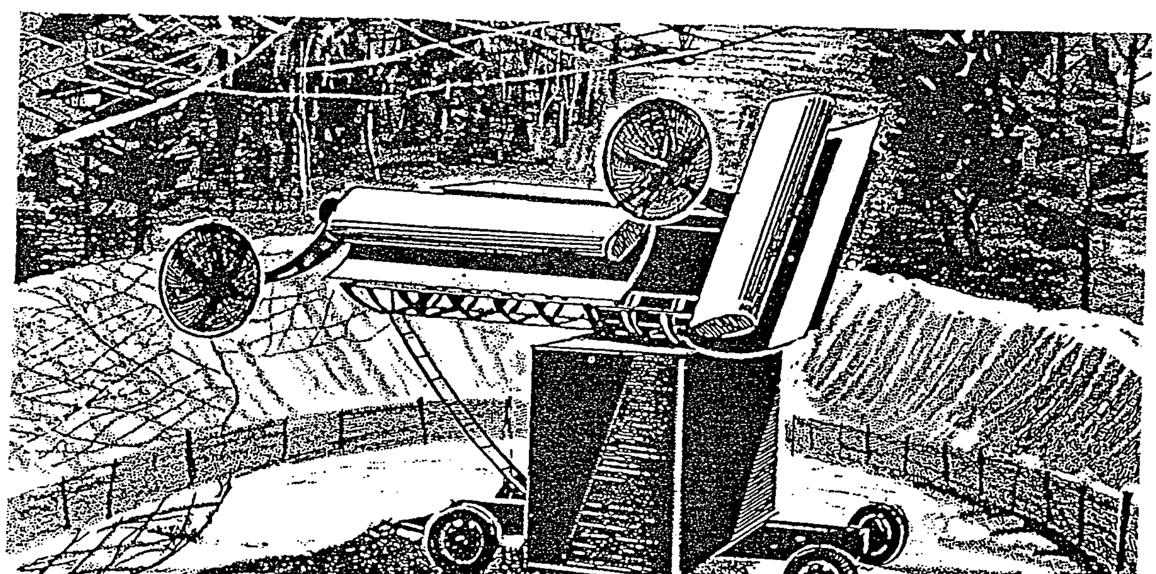
SA-3 System

31. Neither the SA-1 nor SA-2 systems would be effective against very low altitude targets (as low as 50 feet). We therefore estimate that in order to meet an urgent requirement a very low altitude system (SA-3) probably is being developed. This system may be capable of engaging both single and closely

[1] The Guideline missile, although estimated for use in the SA-2 system, could possibly also be utilized in the SA-1 system as a replacement for the single stage V-301 missile. If so, the Guideline version in the SA-1 system would probably not be identical to its counterpart in the SA-2 system. For example, although the basic air frames would be similar, the internal missile guidance equipment could be quite different. The use of such a boosted missile in the SA-1 system would increase the system capability, particularly against faster or smaller radar cross-section targets. Maximum intercept range would be 20-30 n.m.



Photograph: Surface-to-air missile guidance system, Glau, Soviet Zone, Germany. Figure 5A



~~30070 10-59~~ Perspective Drawing: Surface-to-air missile guidance system, Glau, Soviet Zone, Germany. Figure 5B

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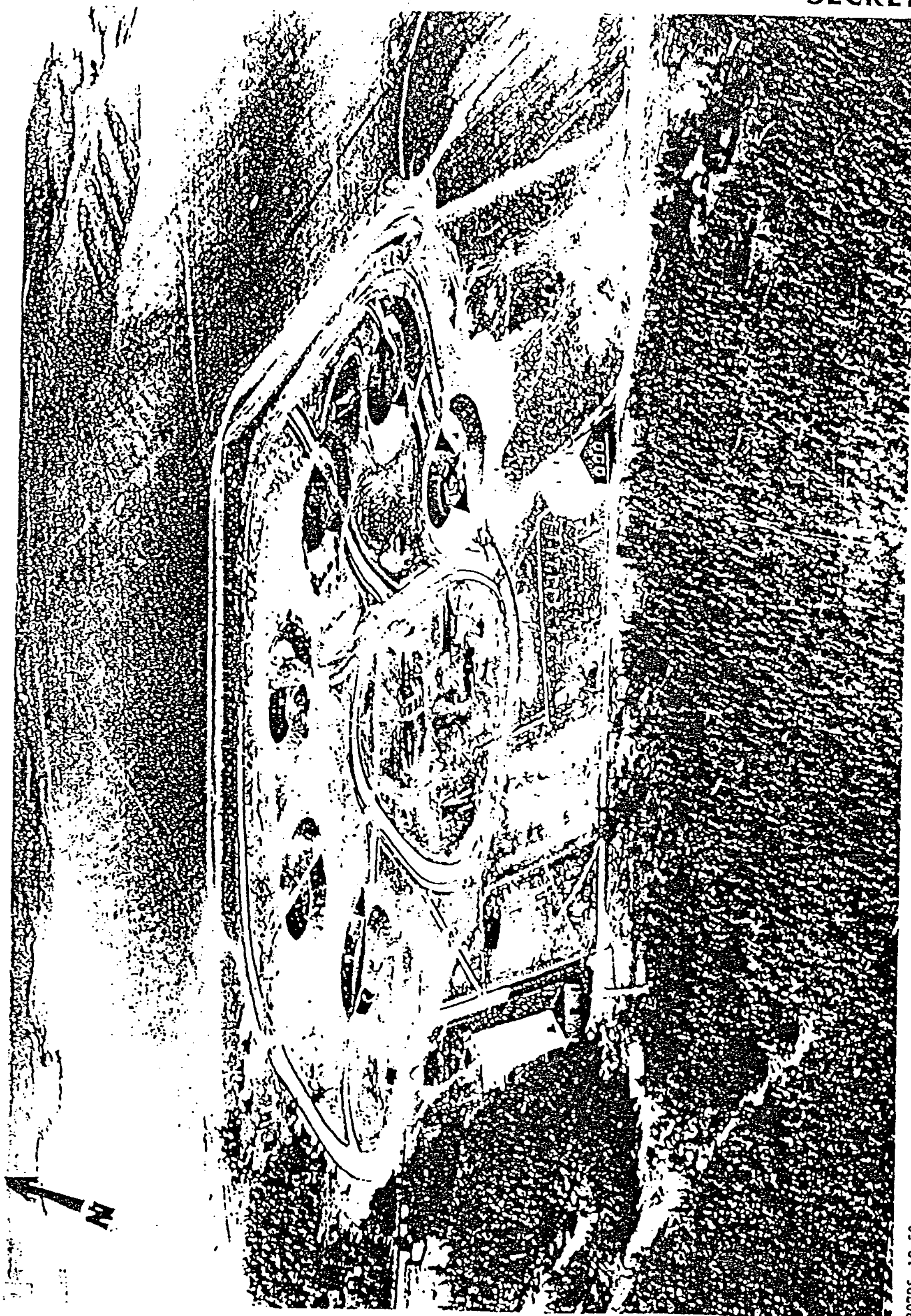

NEW TYPE SURFACE-TO-AIR MISSILE SITE NEAR MOSCOW (GLAU-TYPE)

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Figure 6

grouped multiple targets at extremely low altitudes with a CEP of 20 to 50 feet. Maximum intercept range would be on the order of 10 miles against low altitude targets and up to 25 miles against medium altitude targets. Altitude coverage could reach from 50 feet to 40,000 feet, with limited effectiveness up to 60,000 feet. Maximum missile velocity could be Mach 2 to 3. The warhead weight may be 150 to 250 pounds. HE warheads could be effectively used with this system; however, nuclear warheads, which the Soviets could have, would increase the kill probability and may be required for effective engagement under some conditions. The system could probably be deployed at static sites and have mobility compatible with that required for use with field forces. The Soviets will probably have such a system available for operational use in about 1960.

SA-4 System

32. On the basis of a military requirement and the Soviet state of the art, we estimate that a surface-to-air missile system (SA-4) with increased range, altitude, and kill capabilities will probably become available for operational employment in 1960-1961. It is estimated that this system would employ ground guidance equipment with 360° coverage in azimuth. The system could engage targets effectively at altitudes of 90,000 feet and to a range on the order of 100 n.m. with HE or nuclear warhead of 450 to 700 pounds. We estimate command guidance with active terminal homing would be employed with this system.

SA-5 System

33. We have practically no evidence with respect either to the priority or the technical approach which the Soviets are applying to the problem of an antiballistic missile system. Considering the ballistic missile threat and the technical problems involved in developing an adequate defense system, we believe that the Soviets have a high priority research program underway. We estimate that a first operational antiballistic missile capability (SA-5) could be achieved in the 1963-1966 period. The capabilities of the system would depend upon tactics and deployment, detection and acquisition methods, and the effectiveness of Western countermeasures, among other factors. The net effect of such factors is largely conjectural at this time. We can therefore conclude only that the SA-5 system would have an undetermined capability against ICBMs, IRBMs, submarine-launched and air-launched ballistic missiles. In any case, research and deployment in antimissile defenses will undoubtedly be continuous.

Other Possible Surface-to-Air Systems

34. We estimate that the above missile systems will probably be developed. Nevertheless, these do not meet all of the Soviet surface-to-air missile requirements. Depending upon the Soviet judgment of their future requirements in view of a dynamic threat, the expense of development in terms of value received and the degree of difficulty involved, we believe the following three missile systems fall within Soviet capabilities but will only possibly be developed:

a. A ground-based missile system to counter reconnaissance satellites; a system with limited capabilities (i.e., interception of satellites whose orbits had been established and whose altitudes did not exceed 200-300 miles) might be available in 1963-1965. We estimate, however, that the SA-5 could have an initial limited capability to counter such satellites and a growth potential for higher altitude capability and intercept with a minimum of preorbital data.

b. A mobile antiaircraft system capable of defending field forces against low speed, highly maneuverable aircraft (e.g., reconnaissance types and helicopters) as well as high speed drones and tactical aircraft at altitudes ranging from very low to about 10,000 feet; such a system might be available in about 1965.

c. A mobile antimissile system capable of providing field forces with at least some active defense against ballistic missiles with ranges of 50 to 1,000 n.m.; such a system might be available by 1967.

AIR-TO-AIR MISSILE SYSTEMS

35. Air-to-air missile systems will have utility as long as interceptor aircraft are important components of Soviet air defense. New information is becoming available which indicates that air-to-air missiles may now be deployed, but their specific characteristics have not been determined. There is little evidence on Soviet development of such missiles, however, with the exception of that reported by German returnees who described early Soviet development work on the AA-1 (Soviet designation ShM) during 1952. The following is an estimated Soviet development program based on estimated requirements and on scientific and technical capabilities.

36. We estimate that the USSR now has three air-to-air missile systems available for operational use:

a. AA-1 (ShM)—A 2½ n.m. beam rider limited to use with some all-weather fighters with suitably modified radar.

b. AA-2—A short-range infrared homing missile limited to tail attack and clear air mass [2] conditions. It is usable with most interceptors including day fighters. Its range varies with the radar capability and altitude of the launch aircraft, from one n.m. with day fighters to about four n.m. at altitude with an all-weather fighter.

c. AA-3—An all-weather semiactive radar homing missile of about three to six n.m. range.

37. AA-1 will probably be phased out after the next few years because of operational limitations. In 1960 a longer range missile (AA-4) capable of carrying a nuclear warhead will probably become available. The necessity for safeguarding the launching pilot from nuclear effects will require a missile range of about 15–20 n.m. in a head-on attack or five n.m. in a tail attack. To provide tactical flexibility, some AA-4 missiles will probably be equipped with infrared homing and some with semiactive radar homing. The infrared system will have greater accuracy but (as in AA-2) will require clear air mass conditions. The semiactive radar system will have all-weather capability with less accuracy; employment will be limited to certain all-weather fighters.

38. In 1963 the Soviets will probably have available a combination infrared/semiactive radar homing guidance package for the basic AA-4. Such a combination (AA-5) would provide increased resistance to jamming and improved operational flexibility for all-weather fighters.

39. In about 1965, increases in fighter and target speeds and resulting increases in the launching ranges required for safe delivery of nuclear warheads would require an air-to-air missile of about 30–40 n.m. range employing an appropriate guidance system. We consider the acquisition of such a system to be within Soviet capabilities for this time period, but its development is contingent upon trends in Soviet fighter and Western bomber forces and in Soviet surface-to-air missile defenses.

[2] Clear Air Mass: Absence of clouds and precipitation between missile and target. The term is equally applicable to day or night operations. In addition, an infrared system is also degraded by bright background such as white clouds and attack angles close to the sun.

II. AIR-TO-SURFACE MISSILE SYSTEMS

40. By 1947, the USSR had recognized the advantages of providing bomber aircraft with a stand-off capability against surface targets. First Soviet efforts resulted in an air launched antiship missile of about 55 n.m. range. In view of improved Western air defense capabilities, we believe the USSR will provide its bombers with an extended stand-off capability with an air launched missile of at least 350 n.m. Considering probable Soviet development plans for other types of missiles as well as bombers, we believe these two missiles will substantially satisfy the USSR's need for air launched missile systems in the foreseeable future.

AS–1 System

41. The USSR has had operationally available since 1956–1957 a subsonic antiship system (AS–1) with a maximum range of about 55 n.m. It achieves a speed of Mach 0.8 and can carry a nuclear or possibly HE warhead of about 3,000 pounds, with a CEP of about 150 feet against well-defined radar targets. It uses a guidance system known as Komet (a beam rider with semiactive homing—see Figure 7), the characteristics of which limit its employment almost exclusively to ships at sea.

42. Although originally designed to be carried by a BULL (TU–4), the AS–1 is compatible with the BADGER (TU–16). (See Figure 8) Because it is carried externally and its launch altitude is only about 15,000 feet, it limits the BADGER's radius capability to about 1,250 n.m. when carrying one missile or about 1,000 n.m. when carrying two. (See Figures 9, 10)

43. [

] On the basis of this and the early development date, we estimate that it has already been assigned to several BADGER units of Long Range Aviation and Naval Aviation in the Western USSR and in the Far East.

AS–2 System

44. Recognizing improved Western air defense capabilities and comparing these with the obvious limitations in the AS–1 in range and type of target, we believe the USSR has already commenced development of an improved air-to-surface missile system. Improvements would be primarily directed toward extension of range, speed and launch altitude and improvement of operational characteristics to permit employment against a wider variety of targets.

45. We estimate that in about 1961 the USSR will have operationally available an improved, supersonic cruise type system (AS–2) of at least 350 n.m. range, capable of carrying a 2,000–3,000 pound nuclear warhead. We estimate a cruise altitude of 45,000–55,000 feet, representing a significant improvement over AS–1. A missile speed of Mach 1.5–2 could be achieved with either a turbojet or solid rocket boosted ramjet propulsion system; we believe the former to be probable.

46. We are not confident as to whether this system will be used against land targets, ships at sea, or both. Different types of guidance would be required for these purposes. Utilizing all-inertial guidance, the CEP against land targets would probably be about two n.m. If fitted with terminal homing suitable for use against ships at sea, the CEP would probably be about 150 feet. For use against ships, the launching range would have to be reduced or other aircraft or ships would be required to aid in detection, acquisition, and identification of the target. We estimate that AS–2 will be adaptable for use against land targets or ships at sea with accuracies as indicated above.

47. Effective delivery of this missile could be accomplished by the BADGER, BEAR, and BISON, and presumably by future medium or heavy bombers. We estimate that AS–2 would probably weigh about 9,000–10,000 pounds. BEAR and BISON could carry two,

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A TYPICAL GUIDANCE/FLIGHT PROFILE FOR THE KOMET (AS-I)

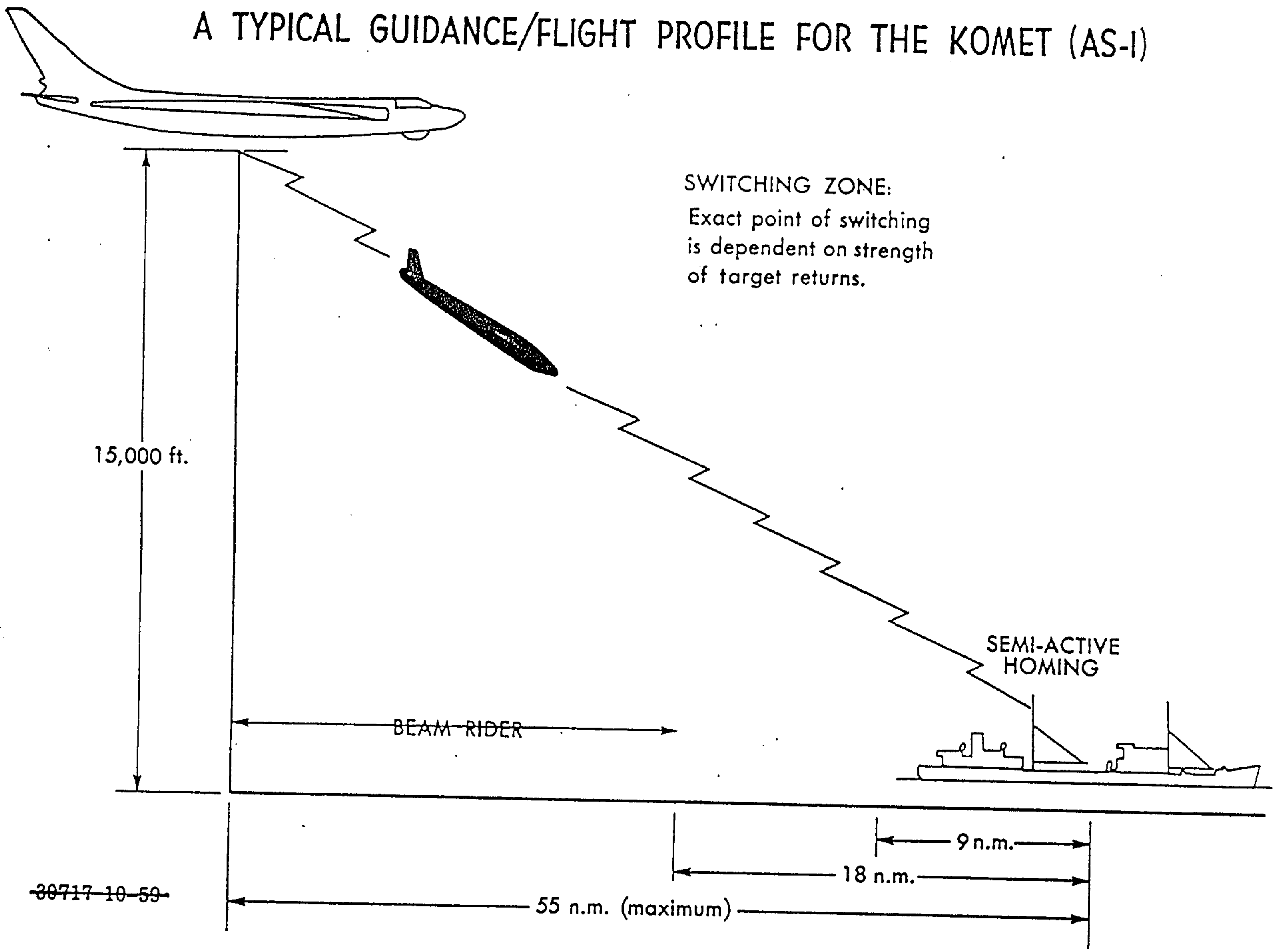

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Figure 7

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POSSIBLE AIRCRAFT/MISSILE COMPATIBILITY
(TU-16 WITH TWO MISSILES SUSPENDED)

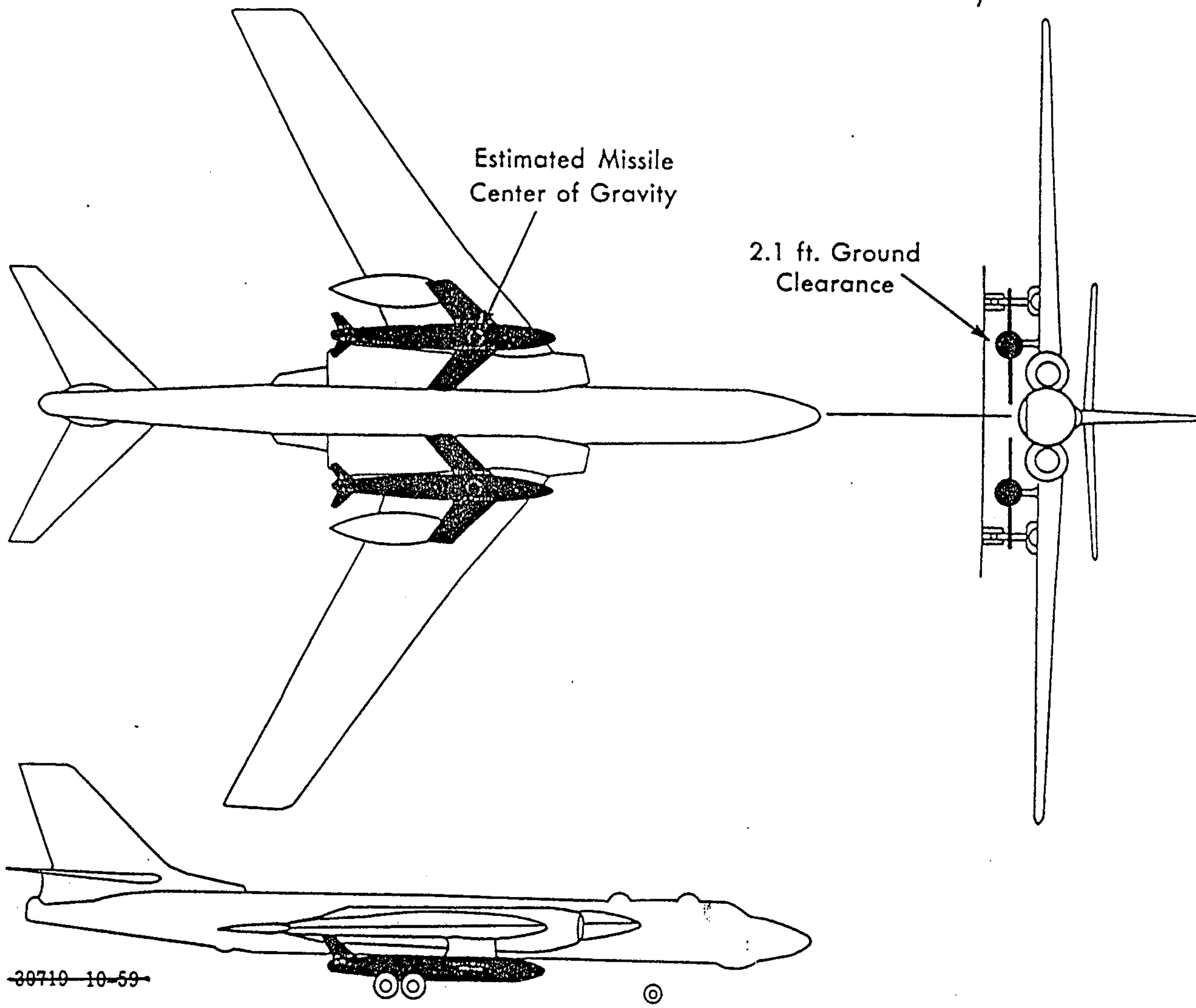

Figure 8

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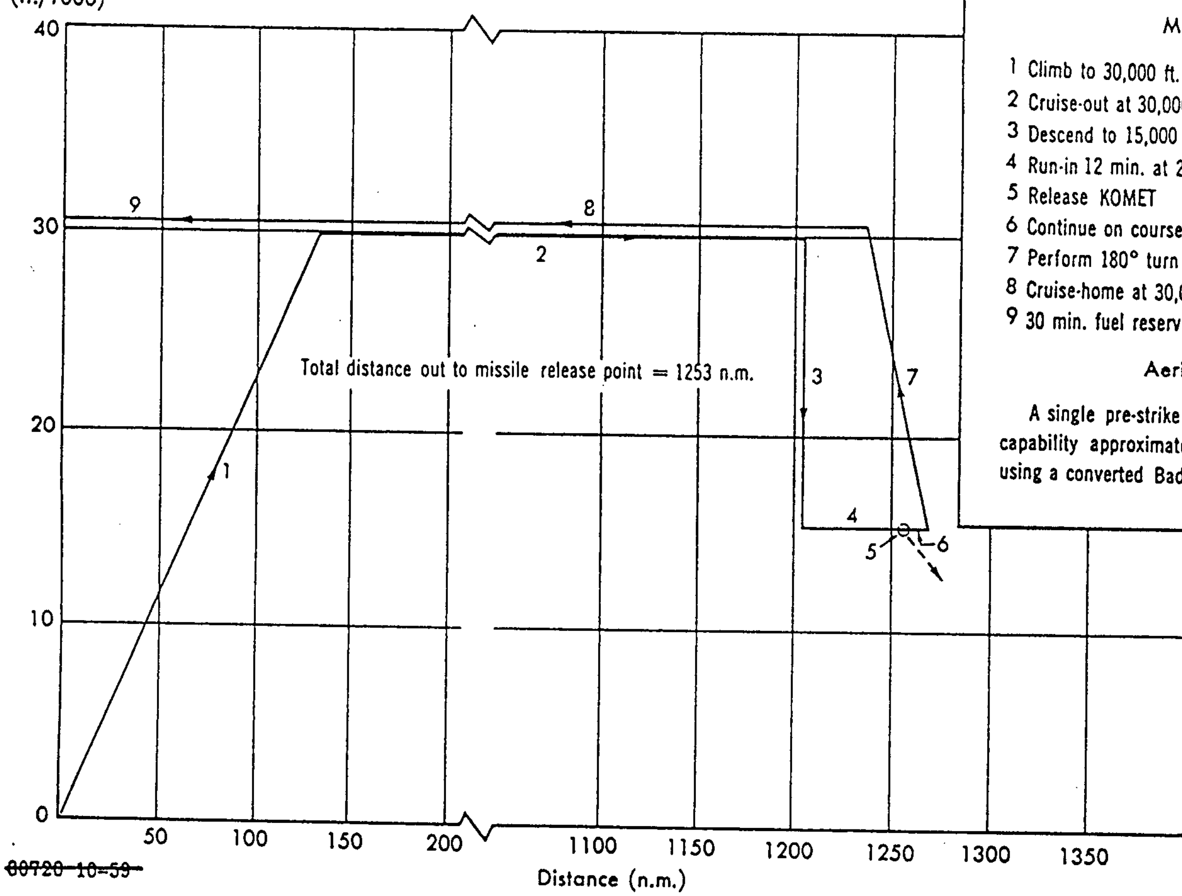
TYPICAL MISSION PROFILE – BADGER/ONE KOMET (AS-I)



Mission Legs:

1 Climb to 30,000 ft.
2 Cruise-out at 30,000 ft.
3 Descend to 15,000 ft.
4 Run-in 12 min. at 250 knots
5 Release KOMET
6 Continue on course 3 min. at 250 knots
7 Perform 180° turn and climb-out to 30,000 ft.
8 Cruise-home at 30,000 ft.
9 30 min. fuel reserve over home base

Aerial Refueling:

A single pre-strike aerial refueling will increase radius capability approximately 35%. This is on a Buddy mission using a converted Badger as tanker.

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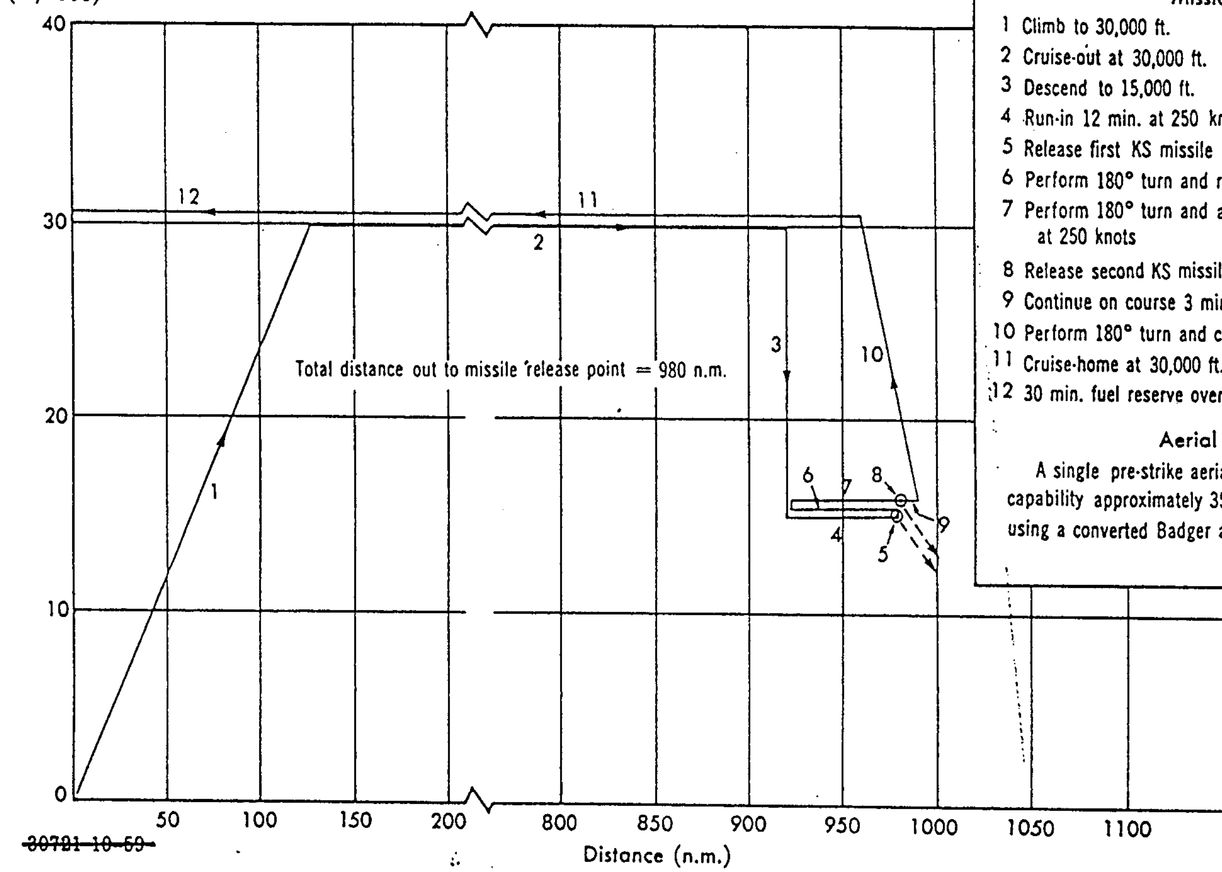
TYPICAL MISSION PROFILE – BADGER/TWO KOMETS (AS-I)



Mission Legs:

1 Climb to 30,000 ft.
2 Cruise-out at 30,000 ft.
3 Descend to 15,000 ft.
4 Run-in 12 min. at 250 knots
5 Release first KS missile
6 Perform 180° turn and run-out 12 min.
7 Perform 180° turn and again run-in 12 min. at 250 knots
8 Release second KS missile
9 Continue on course 3 min. at 250 knots
10 Perform 180° turn and climb-out to 30,000 ft.
11 Cruise-home at 30,000 ft. constant altitude
12 30 min. fuel reserve over home base

Aerial Refueling:

A single pre-strike aerial refueling will increase radius capability approximately 35%. This is on a Buddy mission using a converted Badger as tanker.

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and BADGER one or possibly two on operational missions. We calculate a range degradation of about 8–10 percent for these aircraft when carrying one such missile, and 15–20 percent when carrying two.

Special Applications and Decoys

48. The Soviets are capable of developing guidance systems for AS–1 or AS–2 designed to home on air defense or other radar transmitters. There is no evidence of present Soviet interest in such modification, and we do not consider them probable development programs.

49. Although we have no evidence, we estimate, on the basis of operational desirability and technical feasibility, that the USSR is probably developing and may now have operational an air launched decoy to simulate medium or heavy bombers. We estimate that four can be carried in a BISON or BEAR and two in a BADGER in addition to a bomb lead. The decoy would probably be powered by a turbojet engine which would permit the decoy to simulate aircraft performance. Improvements to this system would be required to maintain its compatibility with advanced bomber developments.

III. SURFACE-TO-SURFACE BALLISTIC MISSILE SYSTEMS

50. 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 n.m., 200 n.m., 350 n.m., 700 n.m., 1,100 n.m., and intercontinental ballistic missiles (ICBMs).[3] 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.

51. German scientists, technicians, missiles, and missile facilities gave the Soviets major assistance in ballistic missiles during the early postwar years. At Soviet direction, German design studies were made on missiles of ranges as great as 1,600 n.m., and there is good evidence that Soviet research paralleled some of the German projects. German assistance was no longer an important factor in surface-to-surface ballistic missiles by about 1949.

52. 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.

53. 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.

54. 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 350 n.m. or less, 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.

55. 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 in paragraphs 81 through 83.

SS–1: 75 n.m. Ballistic Missile System

56. At the 7 November 1957 Moscow parade a missile 33 feet long and 2.7 feet in diameter,

[3] As a rule of thumb, a ballistic missile can be fired to about one-third of maximum operational range without serious degradation in accuracy, and to even shorter ranges with degraded accuracy. The CEPs estimated herein are for maximum missile range.

nicknamed SCUD, was displayed mounted on a self-propelled, tracked vehicle. (See Figure 11) Photo analysis of the launching structure, coupled with the mobility inherent in the tracked carrier, indicates this missile is transportable in a fueled condition. The type of propellant cannot be ascertained with certainty; some details suggest solid propellant while others indicate the use of a storable liquid propellant. Analysis of the photographs also indicates a range capability of up to 75 n.m. with a 1,500 pound warhead. We estimate the SS–1 became operational during 1954–1957, employing a radio-inertial guidance system. An all-inertial system probably became available in 1958–1959, with either system giving a CEP of about 1,200 feet.

SS–2: 200 n.m. Ballistic Missile System

57. After World War II, the Soviets seized large numbers of German V–2 missiles which became the basis for their ballistic missile program. Test firings of this missile are reported to have occurred at Kapustin Yar as early as 1947. There is evidence that development and prototype production of a short-range, modified V–2 type missile took place at Plant No. 456, Khimki, in the late 1940s, and that serial production of this missile may have begun as early as 1951 at the Dnepropetrovsk Automobile Plant (DAZ) No. 186. We believe it unlikely that production of this missile continued for more than a few years and we do not consider it to be an operational system today.

58. Due to the operational limitations inherent in the V–2 system, we believe the USSR paralleled the above program with a second generation missile of the same range and payload characteristics. We estimate that such a missile (SS–2) became operational in 1954, with a maximum range of about 200 n.m. and a CEP of ⅓ to ⅔ n.m. Guidance could be radio/inertial or (by 1958–1960) all-inertial, but there is no evidence on this point. In light of the probability that the second generation missile was developed primarily to obtain better operational and handling characteristics, we estimate continued use of a 2,000 pound warhead as in the V–2.

SS–3: 350 n.m. Ballistic Missile System

59. We believe this missile is an outgrowth of the V–2, improved in range and accuracy by Soviet and German efforts in the years following World War II. SS–3 is probably based on the German-designed R–10 and Soviet-developed Korolov missiles, both of which incorporated a 75,000 pound thrust engine. This would give it a maximum range capability of at least 350 n.m. with a 2,000 to 3,000 pound warhead. The first two Korolov missile firings in 1949 were reported to be unsuccessful. [ ]

The SS–3 missile system is estimated to have become operational in 1954 with radio/inertial guidance and to be now equipped with an all-inertial guidance system, giving an accuracy of about ½ to 1 n.m.

SS–4: 700 n.m. Ballistic Missile System

60. 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.

61. Until recently we were unable to determine whether the largest missile in the 7 November 1957 Moscow parade (nicknamed SHYSTER for recognition purposes—see Figure 12) was the 700 n.m. missile or the 350 n.m. missile. [ ] 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.

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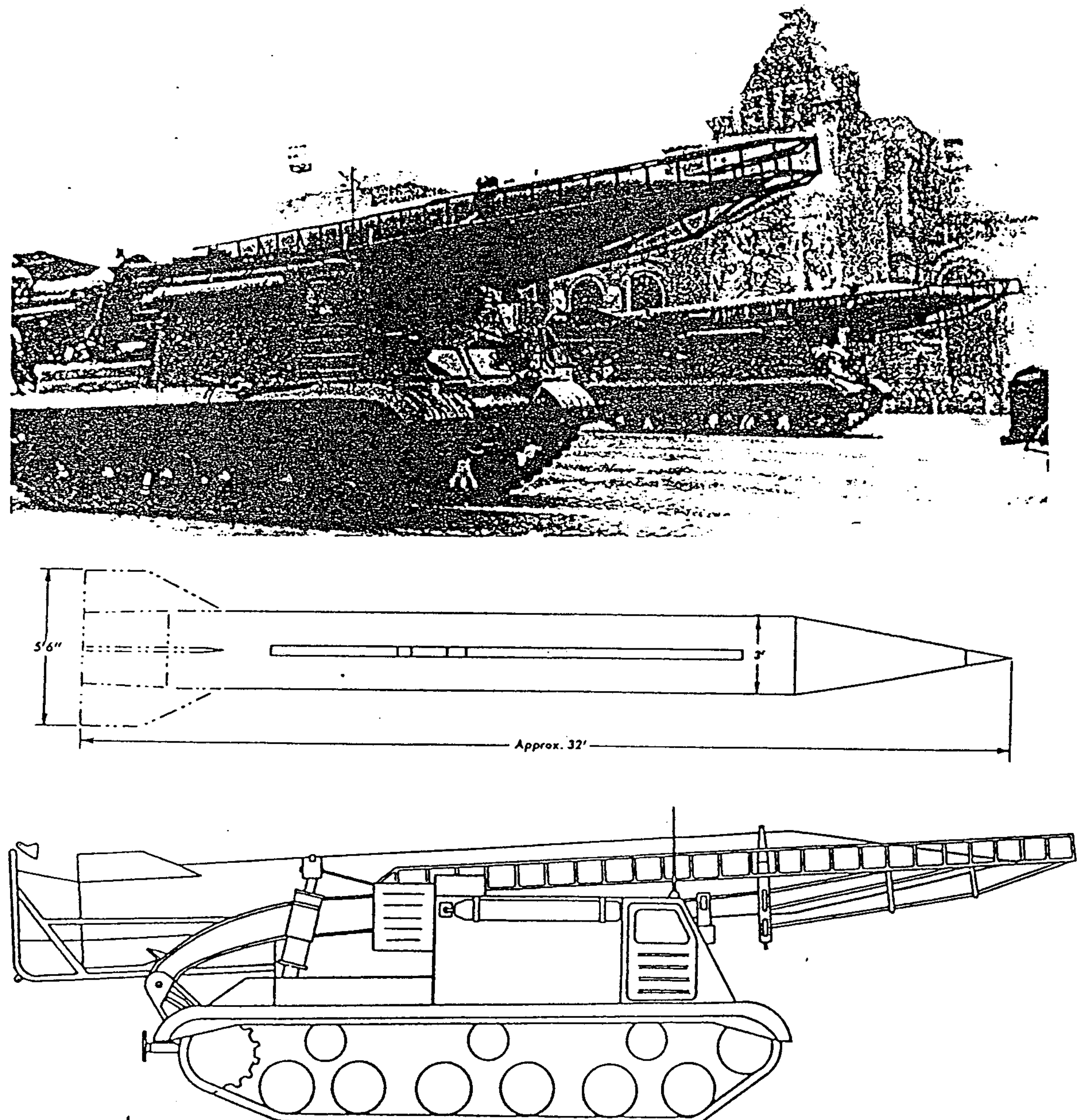

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SURFACE-TO-SURFACE MISSILE (SCUD)

7 NOVEMBER 1957 MOSCOW PARADE

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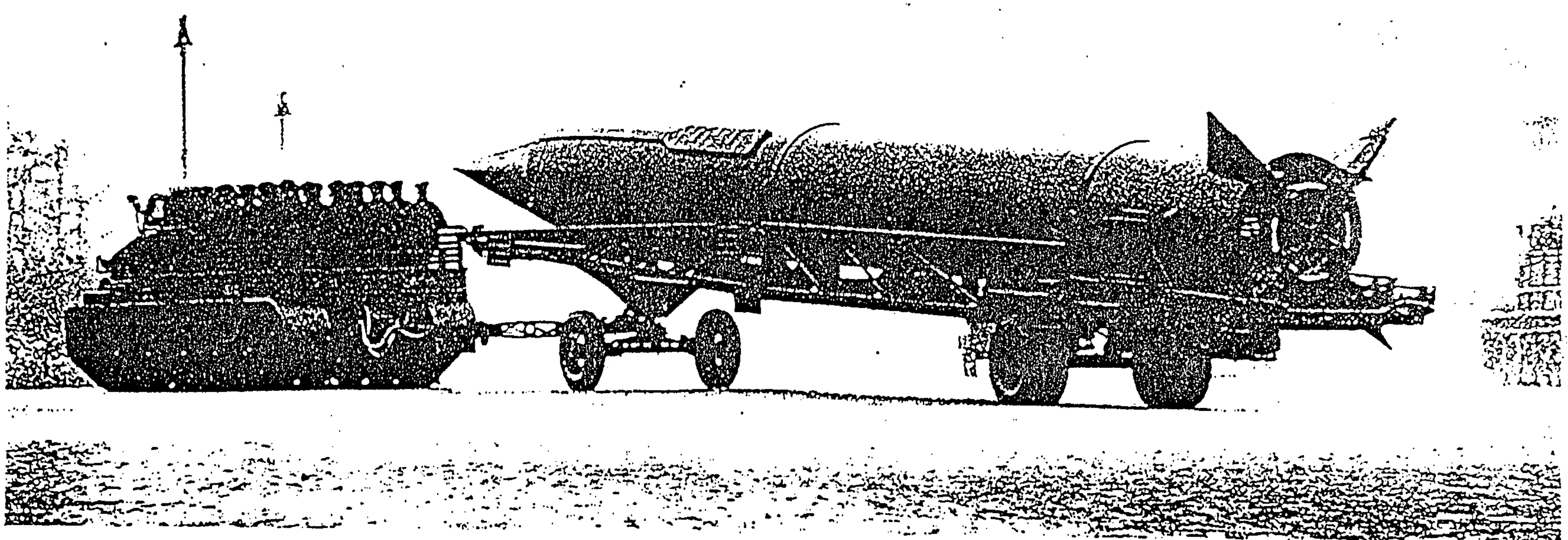
Figure 11



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SURFACE-TO-SURFACE MISSILE (SHYSTER)

7 NOVEMBER 1957 MOSCOW PARADE

62. 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.

63. [ ] We do not believe a second generation missile of this range is yet being developed. 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.

64. We estimate that this missile system is operational and in production in the USSR, and that it probably has the following characteristics:[4]

US Designation	SHYSTER—SS-4
IOC Date[5]	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 pounds 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 pounds, in a separating nosecone
Ground Environment	Road mobile

[4] For estimates of reliability and reaction times under various conditions for this and other systems discussed herein, see Sections V and VI.

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

SS-5: 1,100 n.m. Ballistic Missile System

65. We have good evidence [ ], that a missile of about 1,100 n.m. maximum range has been under test at Kapustin Yar for over two years; since mid-1957 about 50 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.

66. [ ] 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.

67. 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 pounds, in a separating nosecone
Ground Environment	Road and/or rail mobile

Intermediate Missile Systems of Longer Range

68. 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 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.

SS–6: Intercontinental Ballistic Missile System

69. 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 miltary 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.

70. 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 about 20 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.

71. *Operational Capability Date*—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.

72. 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 have been considered in relation to all other evidence and in light of variations in the meaning of "serial production," other official Soviet statements, and cold war tactics. These statements are not inconsistent with a

Revised paragraph 78 to be attached to back of page 16.

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78. We estimate ICBM guidance at IOC date as a combination of radar track/radio command/inertial which is called "radio-inertial," although an all inertial system is possible. Soviet state of the art in precision radars, gyroscopes and accelerometers leads us to estimate a *theoretical* CEP at IOC of 2 n.m. at 5,500 n.m. range for the radio-inertial system. We believe the Soviets probably will incorporate the all-inertial guidance system into their ICBM sometime during the 1960–1962 period (see paragraph 79) and could in 1960 achieve with this system a *theoretical* CEP of about 3 n.m. The data available for estimating both the above *theoretical* CEPs are far from precise. Further, under operational conditions the *theoretical* CEPs will be degraded by several factors, such as (a) re-entry errors induced by undeterminable winds and air density over the impact area; (b) geophysical errors;[1] and (c) human and experience factors. The amount of degradation which would be introduced by such nonguidance system errors cannot be firmly fixed, but we estimate that the operational CEP at IOC date for the radio-inertial system would be about 3 n.m. Should the all-inertial system be introduced in 1960, it could have an operational CEP of about 5 n.m.[2]

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[1] Geophysical errors include gravitational anomalies, geoidal uncertainties, and uncertainties of target location relative to launch point and local verticals.

[2] See the Assistant Chief of Staff for Intelligence, Department of the Army, footnote to paragraph 6.

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.

73. Evidence derived from Soviet ICBM flight tests is considered adequate to gauge the general progress of the program. We cannot state with certainty the precise timing of the IOC of a few—say, 10—series produced ICBMs. In light of all the evidence we believe that for planning purposes it should be considered that the IOC will have occurred by 1 January 1960.

74. 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."

75. *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.

76. [ ] 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 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. [ ]

77. 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.

Revised para. 78 - back of page 17

~~78. 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 79). Soviet state of the art in precision radars, gyros, and accelerometers leads us to estimate a theoretical CEP of about three n.m. at IOC at 5,500 n.m. range. However, the data available for estimating theoretical CEP is so far from adequate that this figure might be somewhat lower or higher. Under operational conditions the theoretical CEP will be degraded by numerous factors, such as geodetic errors, insufficiently known weather and wind condi-~~

Revised paragraph 79 to be attached to back of page 17.

~~TOP SECRET~~

79. We further believe that the Soviets will be able to improve the accuracy of their ICBM following IOC, and that over the next few years, and probably not later than during 1963, the operational CEP for and all-inertial system could be reduced to about 2 n.m., and the operational CEP of the radio-inertial system would be somewhat better.* Units already equipped with radio-inertial guidance probably would not be retrofitted with all-inertial system.

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* See the Assistant Chief of Staff for Intelligence, Department of the Army, footnote to paragraph 6.

tions 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 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 five n.m. at IOC date and may be better, say between 3 and 5 n.m.

79. In any event, we estimate that under operational conditions a CEP of three n.m. in 1963 and two n.m. in 1966 will be 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.

80. 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 77 could be accomplished with one basic missile.[6] 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.

81. *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.

82. 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.

83. 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

[6] 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.

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.

84. *ICBM System Summary*—In summary, the probable characteristics of the Soviet ICBM system are estimated as follows:

US Designation	SS-6
IOC Date	See paragraph 73
Maximum Range	5,500 n.m. with 6,000 pound 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	See paragraphs 78 and 79
Nosecone	Separating; heat-sink or ablative (see paragraph 77)
Maximum Warhead Weight	Probably 6,000 pounds at 5,500 n.m. range
Ground Environment	Rail mobile and/or fixed installations

Close Support Missiles

85. Considering general Soviet progress in the missile field, we believe that for several years the USSR has had the capability of making close support missiles available to ground force units. Such missiles could include: (a) a single stage missile with a range of about 5,000 to 6,000 yards, capable of delivering a 20–40 pound shaped HE charge against tanks or other hard targets with a CEP of about two feet, possibly employing wire link command guidance; (b) a missile capable of delivering a 500 pound payload to ranges on the order of 10,000 to 30,000 yards which could, with a forward observer/controller, obtain accuracy of 15–30 feet employing radio command guidance. Despite the lack of evidence, we estimate that the first of these missiles probably has been developed and is now operational. Soviet development of the second missile system is only a possibility, not a probability.

IV. NAVAL MISSILE SYSTEMS

86. Evidence indicates that first steps were being taken to modernize the Soviet Navy in 1952–1953. There is an increasing amount of evidence subsequent to 1955 that indicates an intent to equip ships with guided missiles.

87. 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. [

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SS–7: 150–200 n.m. Submarine Missile System

88. 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. Some smaller submarines have possibly been converted as well. It is estimated that 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
Type	Subsonic cruise
Maximum Range of Missiles	150–200 n.m.
Number per Submarine	2
Launching Condition	Surfaced
Guidance	Programmed with doppler assist, permitting low altitude flight profile
Accuracy	2–4 n.m. CEP under operational conditions
Maximum Warhead Weight	2,000 pounds

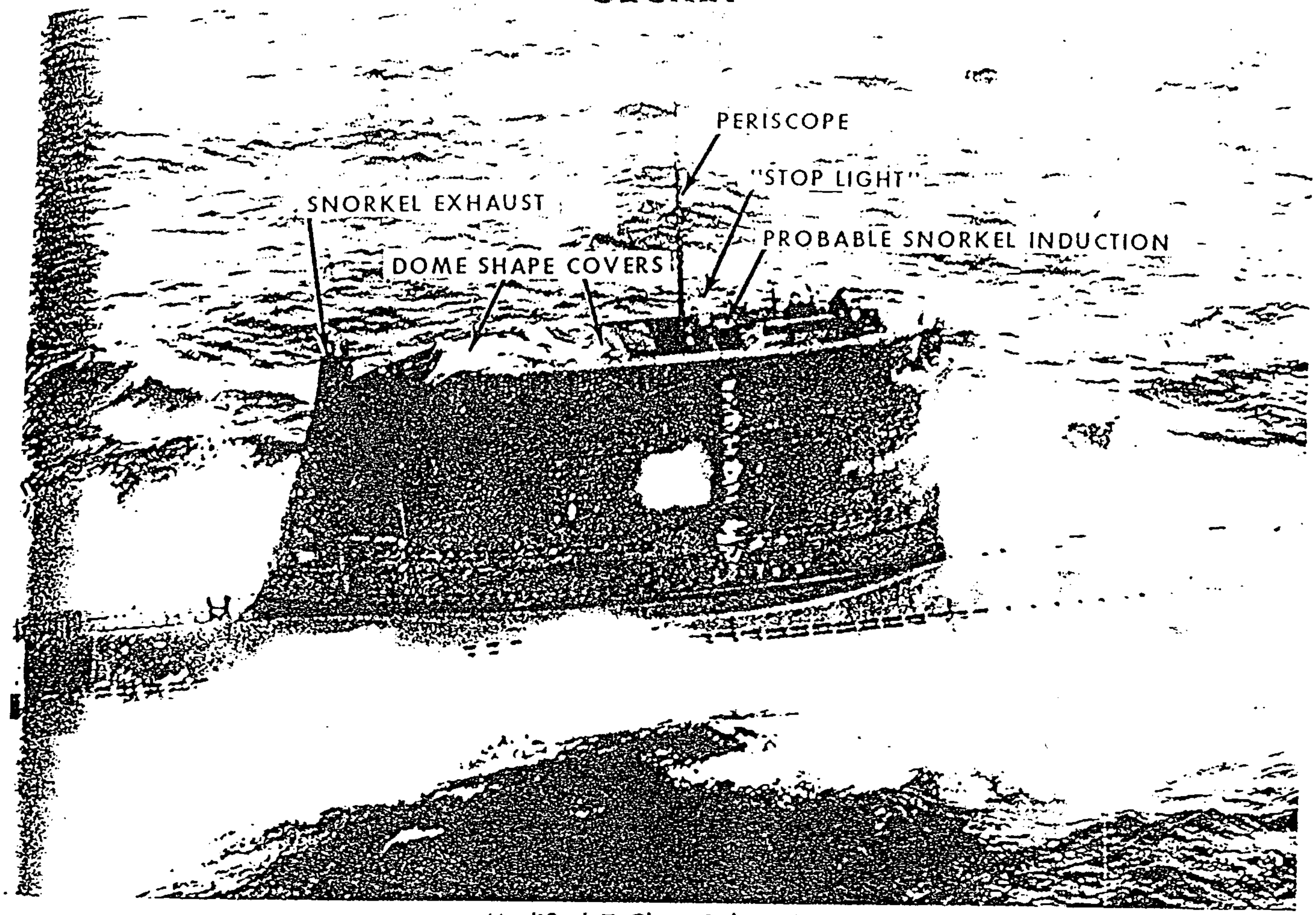
SS–9: 500–1,000 n.m. Submarine Missile System

89. Since 1956 there have been a few sightings and photographs of "Z" class submarines with greatly enlarged sails. Since 1958, three such submarines with two dome-shaped covers in the after portion of the enlarged sail have been observed in the North; we believe at least one such submarine is in the Far East. (See Figure 13) 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.

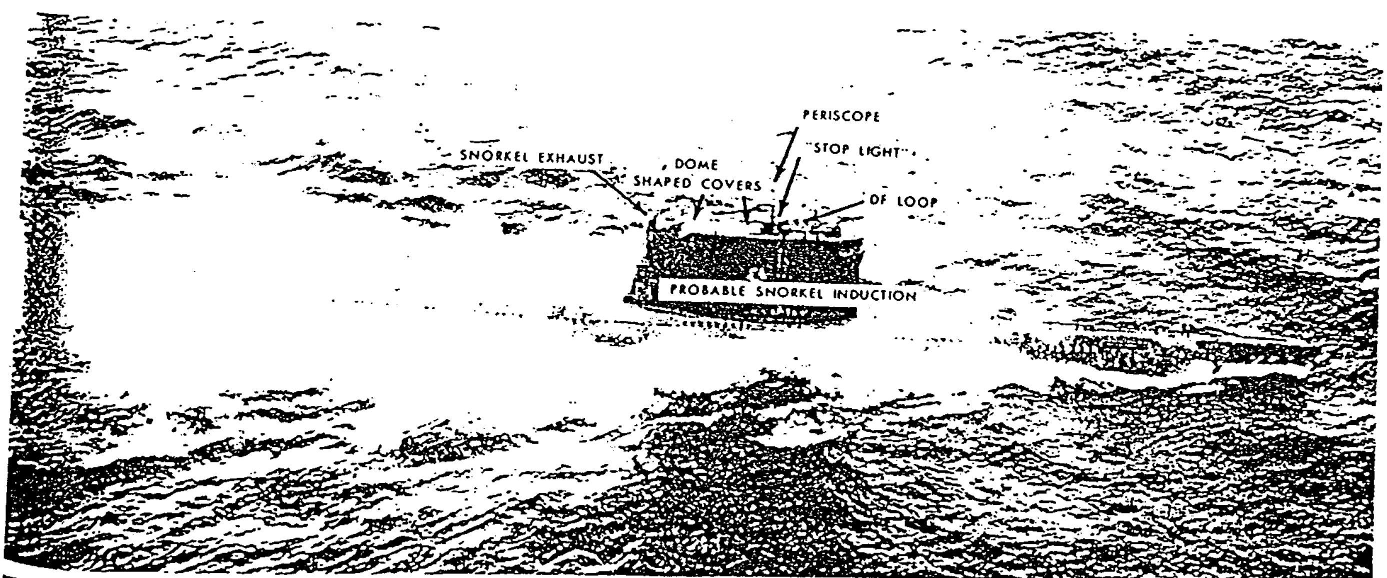
90. Such submarines could carry two missiles each, but could probably launch them only while fully surfaced. The missile might have a range of about 200 n.m., a warhead weighing about 1,000 pounds, and a CEP under average operational conditions of 2–4 n.m. at maximum range. Although we estimate these submarines may have been modified to carry and launch ballistic missiles, we are not sufficiently confident to include them as a "probable program."

91. 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
Type	Ballistic
Maximum Range of Missiles	500–1,000 n.m.
Launching Condition	Submerged or surfaced
Propellant	Solid or storable liquid



Modified Z Class Submarine



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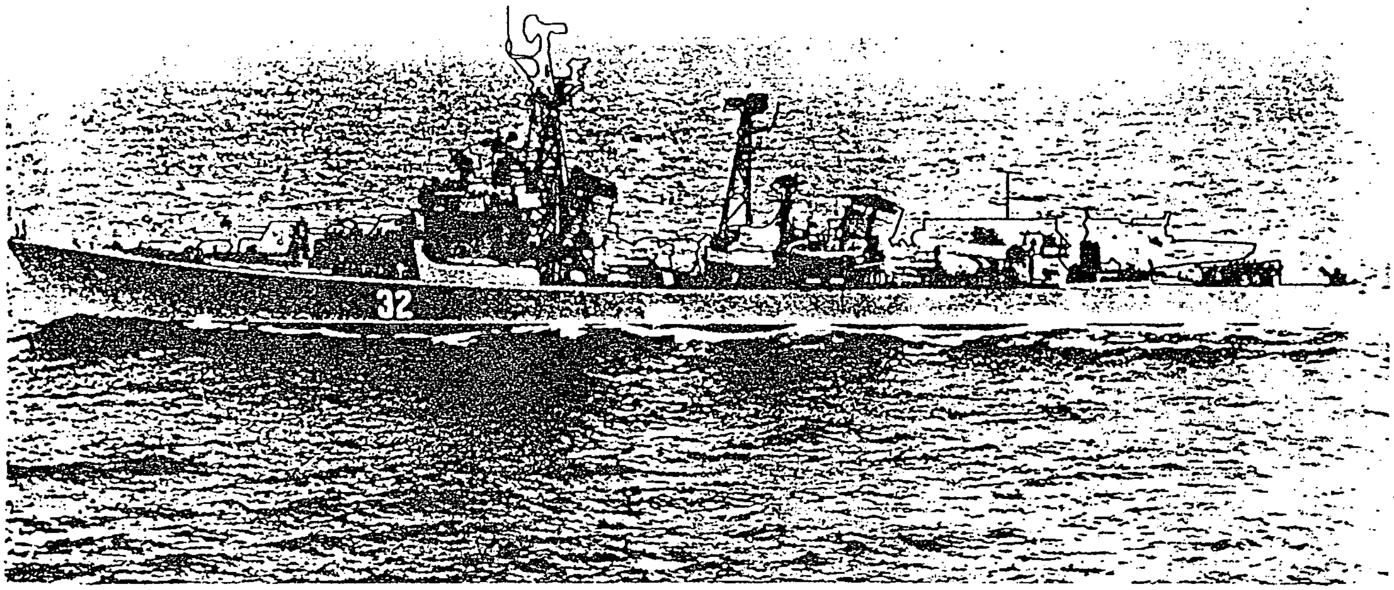
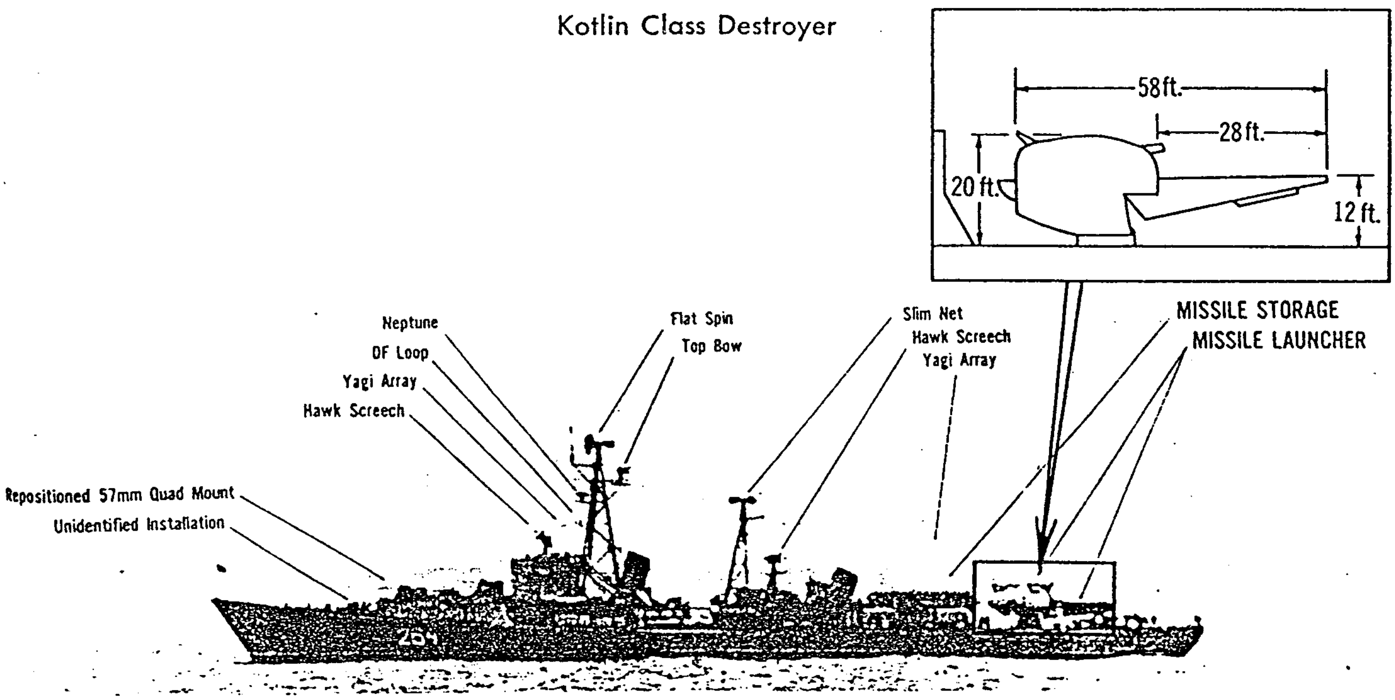
Modified Z Class Submarine

Figure 13



Kotlin Class Destroyer



Kildin Class Destroyer

Guidance	All-inertial
Accuracy	2–4 n.m. CEP under operational conditions
Maximum Warhead Weight	About 1,000 pounds
Number per Submarine	6–12

SS–8: 30–40 n.m. Shipborne Surface-to-Surface Missile System

92. Some Kotlin class destroyers have been completed with armament and electronics installations significantly different from the standard Kotlin (see Figure 14). These ships, now designated Kildin class, have neither the conventional main battery armament nor torpedo tubes. They have a large missile launcher in place of the after main battery gun mount and a missile-handling deck house just forward of the launcher. Although these were not seen until 1958, there is some evidence that they were being worked on as early as 1955 in both the Black Sea and Far East areas. More recently we have seen a new guided missile destroyer, tentatively designated Krupnyy class, which has two missile installations similar to the Kildin, one forward and one aft. In 1955–1956 construction work was stopped on four to six uncompleted Sverdlov class cruisers and several were partially dismantled. It is still not known whether these ships will be scrapped or completed. It is logical to suppose that guided missiles will be included in the armament of these and any other cruisers modified or constructed in the future. The surface-to-surface missile for armament of destroyers and cruisers is estimated to have the following characteristics:

US Designation	SS–8
Type of Missile	Subsonic cruise
Maximum Range	30–40 n.m.
Guidance	Programmed or radar track/radio command with terminal homing
Maximum Warhead Weight	2,000 pounds

Shipborne Surface-to-Air Missile Systems

93. Surface-to-air armament could include the SA–2, SA–3 and/or SA–4 adapted for naval use. Installation of these systems would require extensive alterations to existing ships. The Krupnyy and Kildin, previously noted as having surface-to-surface missiles, do not have a surface-to-air missile capability. We estimate that adaptations of the SA–2 and SA–3 would be put on destroyer and cruiser types, whereas the size of the SA–4 would limit installation to cruiser types.

SS–10: Antisubmarine Missile Systems

94. An antisubmarine missile system could be under development in the USSR without our knowledge. The USSR has the basic scientific and technical capabilities to develop ASW missile systems as well as the required detection and tracking equipment. We believe that the USSR will probably develop an ASW missile for operational use. The alternate lines of development available plus a complete lack of evidence on Soviet development of such a missile system preclude a firm estimate of specific missile characteristics. Based on requirements and the state of the art we estimate the following system. The specific characteristics of the actual weapon may vary considerably from listed characteristics:

US Designation	SS–10
IOC Date	Surface ship-launched 1962–1964 Submarine-launched 1963–1965
Maximum Range	20 n.m.
CEP	400 yards at water re-entry
Configurations	(a) Ballistic launched depth charge with 400 pound nuclear warhead (b) Ballistic launched homing torpedo with 150 pound HE warhead
Guidance	Inertial—in addition, the torpedo to employ self-contained acoustic homing
Remarks	May possibly be used against surface ship targets

Coast Defense Missile Systems

95. In carrying out its responsibility for defending the sea approaches to the USSR, the Soviet Navy maintains and operates land-based coast defense weapons in addition to its aircraft and forces afloat. It is possible that guided missiles or rockets have been or are being incorporated into this coast defense system.

Information on change to TABLE I to be attached to back of page 21.

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A similar review of the evidence relating to ICBM reliability has led to the conclusion that Table I (page 22) of the subject estimate should also be revised. We have concluded that the inflight reliability, that is, the missile's reliability after leaving the pad, lies in the range between 55 percent and 75 percent at IOC as opposed to the 60 percent now appearing in the Table. We further conclude that inflight reliability at IOC plus three years lies in the range between 70 percent and 85 percent as opposed to 75 percent now in the Table. Within these ranges 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 the reliabilities in question lie at the lower ends; the Assistant Chief of Staff, Intelligence, USAF estimates that the reliabilities lie at the upper ends and herewith withdraws his footnote on page 23 of the subject estimate. Note that figures in the Table regarding "in commission rate" and "on launcher reliability" are unchanged.

V. ESTIMATED RELIABILITIES OF SOVIET MISSILES

TABLE 1

We have little information on which to base an estimate of the operational reliability of Soviet missiles. The following are considered as possible reliabilities. For several years after an IOC, the reliability of a missile system will probably improve, and then level off. Except where noted the following reliabilities are for the period subsequent to 1963.

US DESIGNATION	IN-COMMISSION RATE [a] (percent)	RELIABILITY (percent) On Launcher [b]	RELIABILITY (percent) In Flight [c]
Air-to-Surface Systems [d e]			
AS–1	NA	90	80
AS–2	NA	80	65
Surface-to-Surface (Ground-Launched) Systems			
SS–1	NA	90	80
SS–2	NA	90	80
SS–3	NA	90	80
SS–4	85	90	80
SS–5 at IOC	75	85	75
IOC plus 3 years	85	95	80
SS–6 (ICBM) at IOC	70	80	60 [f]
IOC plus 3 years	80	90	75 [f]
Surface-to-Surface [d] (Naval-Launched) Systems			
SS–7/8	NA	80	75
SS–9 at IOC	NA	80	60
IOC plus 3 years	NA	90	75
SS–10 (ASW) at IOC	NA	80	75 (w/subsequent improvement)
Surface-to-Air Systems			
SA–1	NA	90	90
SA–2	NA	90	90
SA–3	NA	90	85
SA–4	NA	85	80
SA–5 at IOC	NA	80 (w/subsequent improvement)	75
Surface-to-Air (Naval) Systems [d]			
SA–2 (Naval)	NA	90	90
SA–3 (Naval)	NA	90	90
SA–4 (Naval)	NA	85	85
Air-to-Air Systems [d e]			
AA–1	NA	85	80
AA–2	NA	85	80
AA–3	NA	90	85
AA–4	NA	90	80
AA–5	NA	85	75 (w/subsequent improvement)

See footnotes on next page.

a Percentage of national operational inventory considered "good enough to try" to launch at any given time (considered meaningful in only a few cases). With prior preparation in-commission rate would be higher.

b Percentage of those missiles in operational units considered "good enough to try" to launch that will actually get off the launcher when fired.

c 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.

d In these categories, only those missiles considered "good enough to try" to launch will be loaded on ships and aircraft.

e The assumptions made for air-to-surface and air-to-air missiles do not include losses due to aircraft aborts which are caused by nonmissile related items.

f The Assistant Chief of Staff, Intelligence, USAF, estimates that the inflight reliability of Soviet ICBM's will be 80 percent at IOC (1 January 1960) and 90 percent three years later. This estimate is based upon the very high and well recognized reliability of Soviet short and medium range missiles, the vast Soviet experience in surface-to-surface missile launch operations, the high proportion of recent ICBM launches which have travelled the full ICBM test range distance, and comparable USAF ICBM programs.

NOTE: It is pointed out that a larger number of missiles than in national operational inventory will have been produced, the extras going to training, test, etc. The number of "extras" will vary with the type missile.

VI. REACTION TIMES FOR SOVIET MISSILE SYSTEMS

96. 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:

a. SS–1: This 75 n.m. missile, which is transported in a fueled state by a track-laying vehicle, could be fired about five minutes after reaching a presurveyed position.

b. SS–3 through SS–6: Each of these systems is estimated to have varying degrees of mobility. 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 site, which would require at least presurvey and in some cases certain fixed facilities:

(1) SS–2 through SS–5: 2–4 hours after arrival at site

(2) SS–6: 4–12 hours after arrival at site

97. The following reaction times are estimated for the SS–2 through SS–6 when the missile unit is in place at a launching site and under the alert condition indicated:

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

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

c. 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.*

98. *Air-to-Air and Air-to-Surface Missiles*—The AAMs and ASMs have a short enough reaction and reload time so that they are not the delaying factor in the takeoff of the aircraft.

99. *Surface-to-Air Missiles*—All SAMs will have a reaction time of less than a minute when alerted. The reload time will vary with the type missile system, but would be such as to provide relatively continuous fire until all missiles at the site are expended.

100. *Naval Missile Systems*—The reaction times for naval systems are estimated as follows:

	ALERT (minutes)	STANDBY (minutes)	REMARKS
SS–7	10	15	Surface launch
SS–8	1	5–10	30–40 n.m. cruise missile
SS–9	10	15	Submerged or surface launched
SS–10	1	5–10	ASW
SAMs	1	2	Reload time, 20 seconds

VII. ORGANIZATION AND CONTROL[7]

101. As in the case of other priority programs of great magnitude, basic policy decisions of the Council of Ministers guide and control research, development, and production of Soviet missile systems and the construction of operational facilities. The military, economic, scientific, and industrial organizations participating in the program receive instructions from and submit recommendations to the Council of Ministers. Within the Council itself there is evidence to indicate that a Deputy Chairman, Dmitrij Ustinov, plays a leading role in the missile production program. It is likely that Ustinov and his colleagues are advised by a Scientific Technical Council composed of scientists, industrialists and military officers who are experts in this field.

102. The Ministry of Defense controls all military aspects of the guided missile programs: e.g., the conception of military requirements; the military participation in design, testing, procurement, and production; the inspection, acceptance, storage, and maintenance of completed systems and operational facilities; the training of military personnel to operate the systems; and the formulation of strategic and tactical doctrine for their use. Within the Ministry the organization designated to carry out these responsibilities, as they apply to the equipment itself, is the Chief Artillery Directorate, which performs a similar function for many other weapons systems. The activities of the Chief Artillery Directorate and the other ministerial organizations participating in the missile program are believed to be directed and coordinated by Chief Marshal of Artillery M. I. Nedelin, who has had wide experience in the weapons field and is a former head of the Chief Artillery Directorate. Unlike other Deputy Ministers, the nature of Nedelin's assignment has been kept secret since his appointment as a Deputy Minister of Defense in 1952; in light of his background there is little doubt that he plays an exceedingly important role in the missile program.

103. Once the decision is made by the Council of Ministers to create a missile system to meet the requirements of the Ministry of Defense, a number of scientific-industrial organizations become major participants in carrying out the program. The research and development phase is centered in various research institutes, design bureaus, and experimental factories subordinate either to the Ministry of Defense itself or to facilities belonging to the state committees which handle various facets of defense production. These facilities have the capability for experimental production of major missile system components and handle the bulk of the developmental missile production. Assuming a successful development program and a decision to proceed with pilot-line production and testing preparatory to quantity production, the USSR Gosplan and the USSR Ministry of Finance have the responsibility for integrating the production and construction plans with the over-all Soviet economic program.

104. The state committees established for such critical industries as defense, electronics, aviation, and chemicals have prime responsibility for the participation of these industries and their plants in the over-all missile program. However, individual plants engaged in serial production appear to be subordinate to the regional Councils of the National Economy, which exercise executive authority over their day-to-day operations.

105. The completed missiles and their associated equipment are transferred directly from the plants to organizations of the Ministry of Defense. The Chief Artillery Directorate, in its role as principal weapons procurement agency for the Ministry, maintains plant representatives who carry out technical checks and inspections to insure that specifications

[7] This discussion of the basic organization and control of the Soviet guided missile program is based in part upon direct evidence and in part on analogy with the way the Soviets are known to handle other high priority programs of military significance.

are being met and accept items on behalf of the Ministry of Defense.

106. Soviet space research is directed by the Interagency Commission for Interplanetary Communications (ICIC) of the Astronomical Council, Academy of Sciences, USSR, the membership of which includes leading Soviet specialists in numerous fields of technology. Among the known members of this commission, personnel of the Academy of Sciences predominate. The Ministry of Defense is represented on the commission (but does not control it), and the facilities of the Ministry of Defense are utilized for launchings of space vehicles and other space research rockets.

VIII. THE SOVIET SPACE PROGRAM

Soviet Objectives

107. The USSR has announced that the objective of its space program is the attainment of manned interplanetary travel. At present, the program appears to be directed toward the acquisition of scientific and technological data which would be applicable to Soviet space activities, their ICBM program, and basic scientific research. While the space program was undoubtedly initiated to serve scientific purposes, one of the primary underlying motivations which continues to give it impetus is the promise of substantial worldwide political and psychological gains for the USSR. Military considerations may have little bearing on the decision to develop certain types of space vehicles, although the successful development of these vehicles could result in military applications. Thus we conclude that the Soviet space program has four major objectives, which will have varying priorities as the program itself progresses and as new political and military requirements develop:

a. manned space travel;
b. scientific research;
c. propaganda;
d. military applications.

Of the above, it appears now that the flight test priority has been on the scientific and propaganda objectives rather than on man-in-space or military applications.

108. The importance the Soviets attach to their space program is illustrated by the assignment of leading scientists to its direction since at least 1955, by the broad range of facilities and specialists engaged in its implementation, and by the wealth of theoretical and applied research being conducted in its support. Judging by the number and type of space vehicles launched over the past two years, however, the Soviets have not devoted as much effort to the flight test phase of the program as we had previously expected. The actual firing program has (like the ICBM test firing program) proceeded at a fairly deliberate pace. The acquisition of data and experience leading to future accomplishments has been limited by the absence of Soviet attempts to orbit additional satellites for such important purposes as recovery of capsules or determining the extent and nature of radiation belts around the earth.

109. We have no direct evidence on the priority of the over-all Soviet space program relative to that of the military missile program. We find no evidence that it has interfered with the military program and we do not believe it will be permitted to interfere in the future.

Recent Launching Activities

110. The lunar probes, or Luniks, launched in 1959 were major feats of theory and technology. Their general nature and complexity, together with their announced payload weights, represent an advance over the Sputniks, which themselves had exhibited progressively increasing payload capability and technical sophistication. The launching vehicles for all three Luniks were probably essentially the same. They used one stage more than the Sputnik or ICBM vehicles. Since the missions of Luniks I and II were probably to hit the moon, their instrumentation was probably about the same. The first failed to accomplish the mission and the second was successful. The mission of the third was primarily to acquire pictures of the previously unobserved portion of the moon's surface. Soviet released data indicates that this was successful, although the actual quality of the data cannot now be assessed. During the transit of the Lunik beneath and beyond the moon—not around the moon—there was a change in the modulation on 183.6 mc/s that could indicate the transmission of photographic data to the Soviets. Lunik III became an earth satellite with an approximate 16-day orbit. The Soviets have triggered the primary data link only when the information can best be received in the USSR, thereby preventing the West from intercepting an ap-

preciable amount of data or locating the vehicle.

111. In addition to satellite and space vehicle launchings, the USSR has conducted an extensive series of high altitude research firings. In February 1959, the Soviets displayed nose sections recovered from rockets fired vertically to altitudes of 60 n.m., 120 n.m., and 250 n.m. Live dogs have been carried in some such rockets and successfully recovered from even the highest of these altitudes, according to Soviet announcements.

112. The Sputniks and Luniks have probably all been launched from the Tyura Tam rangehead. Many but not all of the vertical rockets have been launched from Kapustin Yar. Some characteristics of the Sputniks and Luniks are given in Table 2.

113. The launching of such significant instrumented payloads is largely attributable to the availability of high thrust propulsion systems, which have more than compensated for higher structural weights and nonuse or nonavailability of miniaturized components. To date, conventional liquid rocket propellants have probably been used exclusively. Within the next few years the Soviets will probably be able to employ high energy propellants in the upper stages of their space vehicles. We believe the Soviets are interested in and are probably working on nuclear rocket engines for this purpose. However, nuclear propulsion will probably not be used for the first stage. Nuclear rocket engines may be followed by ion and photon type engines, if these can be proved practical.

114. The estimated mobility and inherent transportability of Soviet missiles which we believe comprise major elements of their space vehicles supports the feasibility of launching an earth satellite from areas other than the established Soviet test ranges. There may be some technical reasons why this would be desirable. Further, political or propaganda benefits might dictate such an attempt. For example, based on the prestige and propaganda benefits and the existing Soviet technical and logistical capability, we believe that the USSR could launch an ostensible "Chinese satellite" from the territory of Communist China. We would not expect this to be a native Chinese launching vehicle although they may design and build the instrument package.

Major Supporting Capabilities

115. For tracking space vehicles, the Soviets can employ their extensive system of optical observatories, radio telescopes, interferometers, radars, and radio direction finders. The accuracy and response time of their optical systems are adequate for determining relatively stable earth satellite orbits; the speeds of response of the interferometer, radar and the radio direction finding stations are adequate for observing their nonrepetitive trajectories. Soviet observation facilities and data handling capabilities will be adequate to carry out most of the individual space missions considered herein. However, some will have to be complemented by self-contained guidance; e.g., to effect rendezvous with a space station, or to land a man on the moon. Such missions will be handicapped to some extent by the USSR's present lack of access to land-based locations for worldwide tracking stations. Shipborne installations could alleviate but not eliminate this problem.

116. The accomplishment of more advanced space projects requires contributions from many fields of science and engineering. In the basic sciences, the Soviets have demonstrated high capabilities in related fields such as physics, mathematics, and the geophysical sciences, stemming from an extensive theoretical background, large and effective educational and research programs, and intensive efforts to keep informed about Western scientific advances. The Soviets are competent in celestial mechanics and astrobiology, they are making rapid strides to overcome limitations in astronomical instruments, and their capability in computers is adequate for space research purposes.

Capabilities to Accomplish Specific Objectives

117. The dates given for Soviet space activities estimated in this section represent the earliest possible time periods in which we

TABLE 2

SOVIET EARTH SATELLITES AND SPACE PROBES

NOTE: Most of these data are based on Soviet announcements or displays.

	SPUTNIK I (1957 ALPHA-2)	SPUTNIK II (1957 BETA)	SPUTNIK III (1958 DELTA-2)	LUNIK I [b]	LUNIK II [b]	LUNIK III [b] (1959 THETA) [a]
Scientific or Measuring Equipment Weight (lbs.).	184 (includes the structural weight).	1,120 (including batteries).	2,130 (plus about 800 lbs. of structural weight, i.e., total weight 2,925 lbs.).	797	858	959.
				A portion of the experimentation weight was affixed to the last stage rocket bodies, and a portion in special containers—a 2.7 foot diameter ejectable sphere in the case of Luniks I and II and a cylinder-truncated cone in the case of Lunik III, which was probably also separated.		
Shape	Spherical	Conical [a]	Conical [a]	The last stage of all three Luniks was probably essentially the same as that displayed at New York and other expositions. Shape: A cone or cylinder, 17½ feet long, 8½ feet in diameter. Weight of empty last stage including instrumentation: Varying slightly, about 3,250–3,400 pounds.		
Diameter (ft.) of Satellite	1.9	3.3 [a]	5.7 [a]			
Length (ft.) of Satellite		6.5 [a]	11.7 [a]			
Date Launched	4 October 1957	3 November 1957	15 May 1958	2 January 1959	12 September 1959.	4 October 1959.
Orbit Period	96 minutes	104 minutes	106 minutes	450 days (around the sun).	Impacted on moon.	Approx. 16 days (around the earth).
Perigee (st mi)	142	140	140			Approx. 30,000.
Apogee (st mi)	588	1,038	1,168			Approx. 290,000.
Inclination to Equator (degs)	65	65	65			Approx. 75.
Contents	Internal temperature, pressure instruments, transmitters, chemical batteries.	Dog; cosmic, ultraviolet, X-ray, temperature, pressure instruments, transmitters, chemical batteries.	Large variety of research instruments, transmitters, chemical and solar batteries.	Large variety of research instruments, chemical batteries, transmitters.	Instruments for measuring magnetic field of earth and moon, cosmic rays, meteorites, density of matter in space, radiation around earth and moon.	Equipment for temperature, gravitation, radiation and moon photography experiments.
Radio Frequencies Used	20 mc/s. 40 mc/s.	20 mc/s. 40 mc/s. 70 mc/s.	20 mc/s. 60 mc/s. 70 mc/s.	183.6 mc/s. 19.993 mc/s. 19.995 mc/s. 19.997 mc/s.	183.6 mc/s. 19.993 mc/s. 19.997 mc/s. 20.003 mc/s. 39.986 mc/s.	183.6 mc/s. 39.986 mc/s.

See footnotes on next page.

Table 2 (*Continued*)

	SPUTNIK I (1957 ALPHA-2)	SPUTNIK II (1957 BETA)	SPUTNIK III (1958 DELTA-2)	LUNIK I [b]	LUNIK II [b]	LUNIK III [b] (1959 THETA) [c]
Date of Last Signal Intercept...	25 Oct. 1957......	10 Nov. 1957.....	Still transmitting on 20 mc/s, 3 Nov. 1959. The main battery went dead 5 June 1958.	Soviets reported 62 hrs. reception.	*Soviet:* 38 hrs., 22 min., 42 sec. *Western:* 38 hrs., 22 min., 38 sec.	*US:* Possibly 18 Oct. 1959. *Soviet:* Unknown.
Date of Satellite Demise.......	4 June 1958......	14 Apr. 1958......	Estimated Mar.-Apr. 1960.	Indefinite around sun.	2102:24Z-13 Sept. 1959.	Unknown.

[a] Not including the last stage which did not separate in the case of Sputnik II.

[b] The West's capability to intercept transmissions from a Soviet lunar probe, especially in the lower frequencies, is very limited. Additionally, the Soviets probably trigger the transmitters while over Soviet territory, and pass only limited position data to the West.

[c] The earth satellite designation assigned Lunik III.

believe each specific event could be accomplished. We recognize that the various facets of the space flight program are in competition not only among themselves but with many other priority programs, and that the USSR probably cannot undertake all of the space flight activities described below at the priority required to meet the time periods specified. In addition, some of these missions depend upon successful prior accomplishments of other ventures.

118. *Unmanned Earth Satellites*—The USSR will continue to place into orbit satellites growing progressively in size and weight. On the basis of information from previous space flight operations, we believe that the USSR could now orbit scientific payloads weighing on the order of 5,000–10,000 pounds in a minimum (100–150 n.m.) orbit. As additional scientific information is obtained, the USSR will refine and develop new scientific instrumentation to be placed into satellites, and will explore fully those critical regions surrounding the earth to assess accurately the biological effects of radiation and other hazards which may be present. Objectives will probably include continued measurements of the gaseous compositions of the upper atmosphere and space, micrometeorites, primary and secondary radiations of all types, aurora and ionospheric characteristics and electric, magnetic, and gravitational fields. Within the next several years the Soviets can be expected to undertake relativity checks and the acquisition of astronomical data.

119. Specific military support functions which may be served by unmanned satellites include surveillance, communications relays, navigational aid to shipping and aircraft, geodesy and mapping, and early warning. Techniques to accomplish the above include photography, infrared, radio, and television. Within the general classification of surveillance satellites, there are several types which have potential usefulness to the USSR. These are a weather satellite, a satellite for warning against ballistic missile attack, an electronic surveillance satellite, a satellite for mapping, a force deployment satellite, an electronic countermeasures satellite, and a satellite for the detection of high altitude nuclear tests. Any of these missions could be undertaken to demonstrate feasibility beginning in the 1959–1960 period. However, they could probably not contribute significantly to Soviet military capabilities for several years after first feasibility demonstration.

120. There are three nonsurveillance types of military satellites which we believe will be included as Soviet military requirements. These are navigation satellites used by aircraft and surface craft to aid in position determination, communications satellites of the simple and delayed repeater types, and nonradiating satellites so positioned as to permit a complete and accurate description of the geoidal shape of the earth.

121. Currently, the USSR could place into orbit and probably recover biological specimens from satellites for the purpose of providing essential knowledge of recovery techniques and the effects of the space environment of such specimens. Several such tests would be highly desirable, if not necessary, prior to manned capsule recovery from orbit.

122. *Unmanned Lunar Rockets*—The Soviets have announced the total inflight weight of Luniks I and II to be 3,245 and 3,324 pounds, respectively, which includes the final stage empty rocket weight and 797 and 858 pounds, respectively, of scientific instruments, containers, and batteries. Given such payload capacities and the demonstrated ability to impact on the moon, we believe the USSR could orbit the moon with an instrumented satellite at any time. A soft impact on the moon requires the use of a retrorocket, more accurate guidance and a method of attitude orientation. An instrumented lunar soft landing could probably be accomplished by late 1960. We also believe that the capability demonstrated by the Luniks implies a current capability to carry out a biomedical experiment to the vicinity of the moon. As a prelude to a manned lunar landing, we believe that an unmanned experimental landing on the moon and return to earth could occur during the period 1963–1964.

123. *Planetary Probes*—Planetary probe vehicles could utilize existing propulsion units and presently available guidance components. We believe the USSR could launch probes toward Mars and Venus with a good chance for success, with the communications link probably presenting the most formidable problem. The first launchings toward Mars could occur about October 1960, when Mars will be in the most favorable position relative to the earth. More sophisticated probes could be launched about November 1962, when Mars will again be in a favorable position. On the same basis, the first launchings toward Venus could occur about January 1961, and more sophisticated probes could be launched about August 1962. The months given are those in which energy requirements are at a minimum and the guidance accuracy requirements are the least stringent. An approximate three month period on either side of those specified is practical but as one departs from these minima, penalties in payload weight and guidance accuracy are imposed.

124. *Manned Earth Satellites*—We believe that the Soviets will achieve their first man-in-space success using a capsule-type recovery incorporating a minimum of refinements. The present Soviet payload capacity is adequate to meet initial requirements. However, prior to attempting even the most elementary man-in-space ventures, the Soviets must solve various problems, many of which require a progression of space experiments. We anticipate that many of these experiments would precede even a high risk attempt.

125. Most important among problems still requiring solution are: (a) the development and testing of a suitable and a reliable rocket vehicle, and (b) development and testing of recovery techniques which will necessarily include provision for safe re-entry into the earth's atmosphere as well as the ability to control ejection and re-entry in relation to a preselected geographic area.

126. Certain biomedical experimentation is an absolute requirement for passenger survival: e.g., stabilization, temperature control, and other physiological and psychological environmental controls must be provided. It is possible that harmful radiations associated with large solar eruptions will inhibit manned space flight, but until additional knowledge of the degree and effect is acquired, no meaningful assessment can be made. Based on the limited data presently available on the Van Allen belts, it is possible that unshielded manned sustained orbital flight will be limited to altitudes under 500 miles or above 25,000 miles.

127. Intensive testing within the next six to eight months could provide sufficient scientific background to support a high risk man-in-space attempt or more normal testing for the next 18 months would provide background for a less risky attempt. An early effort resulting in failure would not necessarily risk adverse publicity because of the USSR's strict security measures. We therefore estimate that, in consideration of propaganda advantages that would accrue, the USSR could attempt to recover a manned capsule from orbit at any time by the acceptance of very great risks of failure. However, we estimate that by mid-1960 to mid-1961 the USSR could acquire sufficient experience and scientific data to recover a man from orbital flight with a fair chance of success. Glide type re-entry vehicles could make their appearance one or two years later.

128. We believe that the USSR now has the capability for manned vertical launchings and that downrange manned recovery tests could begin at any time.

129. *Manned Maneuverable Space Vehicles*—Achievement of a maneuverable manned earth satellite could follow closely upon the attainment of a minimum man-in-space capability. It is believed that in 1963 the Soviets could develop a minimum ability to change the path of a manned space vehicle. Longer lived and more maneuverable space vehicles allowing repeated path changes could be developed using conventional propellants. When a significant capability for maneuver of a manned space vehicle had been achieved, it would be possible to effect rendezvous with an orbiting vehicle. Once contact had been made and items of equipment constructed or modified in space, the Soviets could claim they had

established a manned space station. Depending on the successful prior development of the maneuverable vehicle, it is believed they could establish such a station by 1965.

130. Once the long-lived maneuverable manned vehicle using conventional propellants and large boosters becomes practicable, it would permit the construction, operation, and maintenance of initial space stations. These stations would incorporate a capability for position keeping and for making minor adjustments in position as desired. Advanced space stations suitable for sustaining life and for performing scientific or military functions for extended periods of time (several months or more) would probably use unconventional propulsion systems and closed cycle ecological systems and could be established about 1970.

131. *Manned Lunar Flights*—Contingent upon successes with manned earth satellites, the development of a new, large booster engine, and concurrent advances in scientific experimentation with lunar rockets, propulsion staging techniques and attitude orienting devices, the Soviets are believed capable of manned circumlunar flight with reasonable chance of success in the period 1964–1965; of recoverable manned lunar satellites in the 1965–1966 period; and of lunar landings and return to earth about 1970. None of the above estimated missions would, initially, require unconventional propulsion systems.

Probable Next Steps

132. Judging by the USSR's known and estimated technical capabilities, and considering the Soviet desire to achieve major worldwide propaganda and psychological impact, we believe that during the next 12 months or so the Soviet space program will include one or more of the following:

a. vertical or downrange flight and recovery of a manned capsule;
b. unmanned lunar satellite or soft landing on the moon;
c. a probe to the vicinity of Mars or Venus;
d. orbiting and recovery of capsules containing instruments, an animal, and thereafter perhaps a man.

TABLE 3

POSSIBLE SOVIET SPACE DEVELOPMENT PROGRAM[a]

SPACE PROGRAM OBJECTIVES	FIRST POSSIBLE CAPABILITY DATE
These dates represent the earliest possible time period in which each specific event could be successfully accomplished. However, competition between the space program and the military missile program as well as within the space program itself makes it unlikely that all of these objectives will be achieved within the specified time periods.	
Unmanned Earth Satellites	
5,000–10,000 pounds, low orbit satellites	1959
Recoverable (including biological) satellites	1959
Military Satellites:—The dates shown are the earliest in which feasibility demonstrations could begin. After feasibility demonstration, militarily useful systems could generally become available in two to three years.	
Surveillance: weather, mapping, and force deployment	1959–1960
Navigation, Geodesy, and Communications	1959–1960
Early Warning	1959–1960
ECM and Elint	1959–1960
Unmanned Lunar Rockets	
Biological Probe	1959
Satellite of the Moon	1959
Soft Landings	1960
Lunar Landing, Return, and Earth Recovery	1963–1964
Planetary Probes	
Mars	About October 1960
Venus	About January 1961
Manned Vertical or Downrange Flight	1959
Manned Earth Satellites—The specified time periods for manned accomplishments are predicated on the Soviets having previously successfully accomplished a number of similar unmanned ventures.	
Capsule-type Vehicles[b]	Mid-1960 to mid-1961
Glide-type Vehicles[b]	1 to 2 years after above
Maneuverable (minimum; conventional propulsion)	1963
Maneuverable (nuclear propulsion)	About 1970
Space Platform (minimum, nonecological, feasibility demonstration)	1965
Space Platform (long-lived)	About 1970
Manned Lunar Flights	
Circumlunar	1964–1965
Satellites (temporary)	1965–1966
Landings	About 1970

[a] See Table 2 for accomplishments to date.

[b] Recovery would probably be attempted after the first few orbits but life could probably be sustained for about a week.

IX. SUMMARY TABLES

PROBABLE SOVIET GUIDED MISSILE DEVELOPMENT PROGRAM

SUMMARY TABLE

PROBABLE SOVIET DEVELOPMENT PROGRAM FOR SURFACE-TO-AIR MISSILE SYSTEMS [a]

(GROUND AND NAVAL LAUNCHED) [b]

ARBITRARY REFERENCE DESIGNATION	INITIAL OPERATIONAL CAPABILITY DATE [c]	MAXIMUM EFFECTIVE ALTITUDE [d] (IN FEET)	MAXIMUM HORIZONTAL RANGE (NM) [d] / MAXIMUM SPEED (MACH)	ACCURACY [e] (CEP IN FEET)	GUIDANCE	MAXIMUM WARHEAD (LBS. AND TYPE) [f]	REMARKS
SA-1	1954	60,000 (minimum about 3,000)	20-30 / 2.5	65-120	Track-while-scan radar; radio command.	450-700 HE or Nuclear	B-200 guidance system with the single stage V-301 missile deployed only around Moscow at fixed sites. Boosted Guideline possibly also utilized in SA-1 system as a replacement for single stage V-301.
SA-2	1957	60,000 (minimum —?)	25-40 / 3	Guidance system as yet undetermined. Believe CEP would approximate the 65-120 ft. estimated for SA-1.		450-700 HE or Nuclear	System being widely deployed in Soviet Bloc, typified by Glau site and estimated to employ Guideline missiles. May be used for static or mobile defense.
SA-2 (Naval) [b]							Designated SA-2 (Naval) if adapted as surface ship armament.
SA-3	About 1960	40,000 (minimum 50)	25—med alt. 10—low alt. / 2-3	20-50	Semiactive radar homing all the way.	150-250 HE or Nuclear	Static or mobile system primarily for low altitude defense.
SA-3 (Naval) [b]							Designated SA-3 (Naval) if adapted as surface ship armament.
SA-4	1960-1961	90,000	On the order of 100 / 3.5	100	Command with active terminal homing.	450-700 HE or Nuclear	Static or transportable system to provide increased range and altitude capability.
SA-4 (Naval) [b]							Designated SA-4 (Naval) if adapted as surface ship armament.
SA-5	1963-1966	Static antiballistic missile system with undetermined capability against ICBMs, IRBMs, submarine-launched and air-launched ballistic missiles.					
Other	It is possible that the USSR will develop and place in operation a ground-based missile system with limited capabilities against reconnaissance satellites (1963-1965); a mobile system for defense against reconnaissance aircraft, helicopters, etc. (about 1965); a mobile system for field force defense against ballistic missiles (by 1967). See paragraph 34.						

[a] We evaluate this program as "probable" with varying degrees of confidence concerning detailed characteristics. Each missile listed will probably go through various stages of development which are not necessarily reflected in this table. We estimate that considerable energy will be expended in second generation longer range missiles.

[b] Adaptations of SA-2 and SA-3 would be suitable for cruisers and destroyers. The size of the SA-4 would limit it to cruisers.

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

[d] Maximum altitude is not necessarily achieved at maximum range. A limited capability will exist above the indicated altitude.

[e] Accuracy varies with target size, speed, altitude and range.

[f] Warhead includes the explosive device and its associated fusing and firing mechanism.

SUMMARY TABLE

PROBABLE SOVIET DEVELOPMENT PROGRAM FOR AIR-TO-AIR MISSILE SYSTEMS[a]

ARBITRARY REFERENCE DESIGNATION	INITIAL OPERATIONAL CAPABILITY DATE[b]	GUIDANCE	ACCURACY (CEP IN FEET)	MAXIMUM WARHEAD (LBS. AND TYPE)[c]	APPROXIMATE GROSS WEIGHT (LBS.)	COMPATIBLE AIRCRAFT: Aircraft	COMPATIBLE AIRCRAFT: Attack Capability	COMPATIBLE AIRCRAFT: Range (NM)[d]	REMARKS[e]
AA-1....	1955–1956	Radar beam rider..	20	40 HE.....	200	Flashlight and modified Flashlight.	Rear quarter 360°.	2½ (Tail) 5 (Head-on)	All-weather. Soviet designation "ShM."
						Fresco D, E.....	....	2 (Tail only)	
AA-2....	1955–1956	Infrared homing...	10	25 HE.....	175	Farmer B....... Fagot.......... Fresco A,B,C Farmer A Faceplate Fitter	.... Day Fighter....	2 (Tail only) Limited by radar range to approximately 1 nm	Limited to clear air mass[f] and tail cone attack.
						Fresco D Farmer B Flashlight	Limited all-weather	2½ Sea Level	
AA-3....	1958	Semiactive radar homing.	15	25 HE.....	200	Modified Flashlight. Fishpot Fresco D........ Farmer B Flashlight and modified Flashlight.	All-weather..... Rear...........	4-Alt 6 (Head-on) 2½–3 (Tail)	All-weather.

See footnotes on next page.

SUMMARY TABLE (*Continued*)

ARBITRARY REFERENCE DESIGNATION	INITIAL OPERATIONAL CAPABILITY DATE [b]	GUIDANCE	ACCURACY (CEP IN FEET)	MAXIMUM WARHEAD (LBS. AND TYPE) [c]	APPROXIMATE GROSS WEIGHT (LBS.)	COMPATIBLE AIRCRAFT: Aircraft	COMPATIBLE AIRCRAFT: Attack Capability	COMPATIBLE AIRCRAFT: Range (NM) [d]	REMARKS [e]
AA-4....	1960	Semiactive radar homing.	50	150 HE or Nuclear.	800	Modified Flashlight. Fishpot		15–20 (Head-on) 5 (Tail)	All-weather.
	1960	Infrared homing...	10					5 (Tail only)	Limited to clear air mass. [f]
AA-5....	1963	Combined Semi-active radar and infrared homing.	10–50	150 HE or Nuclear.	800	1963 Fighter.....	All angle capability.	15–20 (Head-on) 5 (Tail)	All-weather. Accuracy varies with guidance employed. Countermeasure resistant—(See AA-4).
Other....	It is possible that the USSR will develop and place in operation a 30–40 nm range missile for all-weather employment with HE or nuclear warhead by advanced interceptor types (1965). See paragraph 39.								

[a] We evaluate this program as "probable" with varying degrees of confidence concerning detailed characteristics. Each missile listed will probably go through various stages of development which are not necessarily reflected in this table.

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

[c] Warhead includes the explosive device and its associated fusing and firing mechanism.

[d] Range is here defined as the distance between launching aircraft and target at the instant of missile launch.

[e] Speed for these missiles has not been indicated on the chart. Mach 2 plus the speed of the launching aircraft is considered reasonable speed for all the missiles estimated except for AA-1 which probably has a speed of Mach 1.7.

[f] Clear Air Mass is here defined as absence of clouds and precipitation between missile and target. The term is equally applicable to day or night operations. In addition, an infrared system is also degraded by bright background such as white clouds and attack angles close to the sun.

SUMMARY TABLE

PROBABLE SOVIET DEVELOPMENT PROGRAM FOR AIR-TO-SURFACE MISSILE SYSTEMS [a]

ARBITRARY REFERENCE DESIGNATION	INITIAL OPERATIONAL CAPABILITY DATE [b]	MAXIMUM RANGE (NM)	ACCURACY (CEP)	MAXIMUM WARHEAD (LBS. AND TYPE) [c]	CRUISE SPEED (MACH NO.)	GUIDANCE	REMARKS
AS-1	1956–1957	55	150 feet against ships	3,000 HE or Nuclear	0.8	Beam riding with semi-active radar homing.	Antiship missile. "Komet."
AS-2	About 1961	At least 350	2 nm against land targets, 150 feet against ships	3,000 HE or Nuclear	1.5 to 2.0	Adaptable for use against land targets with all-inertial guidance, or ships at sea with terminal homing. Antiship use would require reduction in range or assistance of other aircraft or ships.	
Decoys	The USSR is probably developing and may now have operational an air launched decoy to simulate medium or heavy bomber.						

[a] We evaluate this program as "probable" with varying degrees of confidence concerning detailed characteristics. Each missile listed will probably go through various stages of development which are not necessarily reflected in this table.

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

[c] Warhead includes the explosive device and its associated fusing and firing mechanism.

~~TOP SECRET~~

SUMMARY TABLE

PROBABLE SOVIET DEVELOPMENT PROGRAM FOR GROUND-LAUNCHED SURFACE-TO-SURFACE MISSILE SYSTEMS[a]

ARBITRARY REFERENCE DESIGNATION	INITIAL OPERATIONAL CAPABILITY DATE[b]	MAXIMUM OPERATIONAL RANGE (NM)[c]	GUIDANCE	MAXIMUM WARHEAD (LBS. AND TYPE)[e]	CONFIGURATION	REMARKS
SS-Antitank....	Prior to 1958.......	About 5,000-6,000 yards	Command wire link....	20-40 HE-shaped charge.		
SS-1..........	1954-1957..........	75	Radar track-radio command/inertial with terminal correction o. all-inertial.	1,500 HE, Nuclear, CW.	Ballistic..	SCUD—Launched from self-propelled tracked vehicle. Road mobile.
SS-2..........	1954...............	200	*1954:* Radar track-radio command/inertial. *1958-1960:* All-inertial.	2,000 HE, Nuclear, CW.	Ballistic..	Second generation missile—outgrowth of V-2. Road mobile.
SS-3..........	1954...............	350	*1954:* Radar track-radio command/inertial. *1958-1960:* All-inertial.	2,000 HE, Nuclear, CW.	Ballistic..	Outgrowth of V-2. Probably based on German designed R-10 and Soviet developed Korolov missiles. Road mobile.
SS-4..........	1956...............	700	*1956-1958:* Radar track-radio command/inertial. *1958-1960:* All-inertial (retrofit optional).	3,000 Nuclear, possibly CW.	Ballistic..	SHYSTER—Road mobile.
SS-5..........	Late 1958 or early 1959.	1,100	Radar track-radio command/inertial or all-inertial.	3,000 Nuclear.....	Ballistic..	Road and/or rail mobile.
SS-6 (ICBM)...	For planning purposes it should be considered that it will have occurred by 1 January 1960.	[f]5,500	Radar track-radio command/inertial. *1960-1962:* All inertial (retrofit undeterminable).	6,000 Nuclear[f]....	Ballistic..	Could be rail mobile with rail mobile units, fixed installations or a combination of the two.

See footnotes on next page.

~~TOP SECRET~~

Paste over last item of column five (Accuracy) on page 39.

See paragraphs 78 and 79.

~~TOP SECRET~~

[a] We evaluate this program as "probable" with varying degrees of confidence concerning detailed characteristics. Each missile listed will probably go through various stages of development which are not necessarily reflected in this table. We estimate that considerable energy will be expended in second generation longer range missiles, particularly on an ICBM of greatly improved operational characteristics.

[b] Date at which one or more missiles could have been placed in the hands of trained personnel in one operational unit. In the case of the ICBM, it is the date on which a few—say 10—series produced missiles are in the hands of trained personnel at a completed launching facility.

[c] Generally a ballistic missile can be fired to ranges as short as approximately one-third the maximum operational range without serious increase in CEP and to even shorter ranges with degraded accuracy.

[d] CEP is the radius of a circle within which, statistically, one-half of the impacts will occur. Inherent missile accuracies are somewhat better than the accuracies specified in the table which take into consideration average degradation factors.

[e] 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 350 nm or less, 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 nm and over, only nuclear warheads will be employed, although we do not exclude the possibility of CW use in 700 nm 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.

[f] The current missile should be capable of delivering a warhead of 6,000 pounds to a range of about 5,500 nm if employing a heat-sink nosecone, or with a warhead reduced to the order of 3,000 pounds could achieve 7,500 nm range. Use of an ablative nosecone would permit a heavier warhead or extended range.

SUMMARY TABLE

PROBABLE SOVIET DEVELOPMENT PROGRAM FOR NAVAL-LAUNCHED SURFACE-TO-SURFACE GUIDED MISSILE SYSTEMS [a]

ARBITRARY REFERENCE DESIGNATION	INITIAL OPERATIONAL CAPABILITY DATE [b]	MAXIMUM OPERATIONAL RANGE (NM)	ACCURACY (CEP) [c]	MAXIMUM WARHEAD (LBS. AND TYPE) [d]	GUIDANCE	CONFIGURATION	REMARKS
SS-7	1955–1956	150–200	2–4 nm	2,000 Nuclear	Programmed with doppler.	Cruise type	Subsonic, low altitude. For launch from surfaced submarine.
SS-8	1958	30–40	150 feet	2,000 HE, Nuclear.	Programmed or radar track-radio command, with terminal homing.	Cruise type	For use in destroyers and cruisers.
SS-9	1961–1963	500–1,000	2–4 nm	1,000 Nuclear	All-inertial	Ballistic	For launch from surfaced or submerged submarine.
SS-10 (ASW)	Surface ship-launched—1962–1964.	20	400 yards at water re-entry.	450 Nuclear	Inertial	Ballistic launched	Primarily for use against submarines. May possibly be used against surface ship targets. Both configurations available.
	Submarine launched—1963–1965.			150 HE	Inertial with self-contained acoustic homing.	Ballistic launched, homing torpedo.	
Other	The USSR may now have in operation a few long-range conventionally-powered submarines modified to launch, while surfaced, ballistic missiles of about 200 nm range and 2–4 nm CEP. See paragraphs 89, 90.						

[a] We evaluate this program as "probable" with varying degrees of confidence concerning detailed characteristics. Each missile listed will probably go through various stages of development which are not necessarily reflected in this table.

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

[c] CEP is the radius of a circle in which, statistically, one-half of the impacts will occur. Inherent missile accuracies are somewhat better than the accuracies specified in the table which take into consideration average degradation factors.

[d] Warhead includes the explosive device and its associated fusing and firing mechanism. The weight of the structure and the heat protection of the nosecone are not included in "payload."