NIE 11-5-61
25 April 1961
~~TS 0036870~~

~~TOP SECRET~~

NATIONAL INTELLIGENCE ESTIMATE
NUMBER 11-5-61
(Supersedes NIE 11-5-59 and NIE 11-5-60)

SOVIET TECHNICAL 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, and the Atomic Energy Commission.

Concurred in by the
UNITED STATES INTELLIGENCE BOARD

on 25 April 1961. 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 (Intelligence), Department of the Navy; the Assistant Chief of Staff, Intelligence, USAF; the Director for Intelligence, 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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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. In addition, to estimate the objectives and technical capabilities of the Soviets in space. (The period covered runs through about 1966, except where otherwise stated.)

SUMMARY AND CONCLUSIONS

1. Soviet capabilities in guided missiles and space vehicles rest upon a major national effort in research and development pursued over the past 15 years. The USSR now has two major missile test ranges at Kapustin Yar/Vladimirovka and Tyuratam, an extremely large complex at Sary Shagan for the development of defenses against ballistic missiles, and other lesser test facilities (see Figure 1). The ICBM and space programs have shared facilities on the Tyuratam range. All of these facilities have been significantly expanded within the past two or three years.

2. The Soviets have concentrated on the development of only a few systems at any one time. With the possible exception of the first surface-to-air system, deployed around Moscow, there has been no indication that Soviet guided missiles were developed on a "crash" basis. The Soviets now have operationally available about 20 individual missile systems for surface, air, and sea employment. To date, they appear to have concentrated on initial satisfaction of a broad range of military requirements, and to have given little attention to second generation missile systems. Future Soviet efforts probably will place greater emphasis on development of such systems as well as the improvement of existing systems.

3. We have good evidence on the development of most of the current Soviet missile systems; our estimates of the remaining systems are largely inferred from Soviet requirements and technical capabilities. Our ability to collect and interpret information on test firings of Soviet ballistic missiles and space vehicles has been relatively good. We are reasonably confident

of our estimates of the operational availability and the general characteristics of Soviet missiles. We have less confidence in our estimates of their accuracy, reliability, and reaction time. We have little direct evidence on Soviet programs for operational deployment except for the surface-to-air systems and certain air-to-surface weapons, and even less concerning missile production.

Surface-to-Air Missiles

4. Since late 1957 the Soviets have deployed extensively a flexible and mobile surface-to-air missile system (SA-2) which appears to be the mainstay of the Soviet missile defense system against aircraft. The early Moscow system (SA-1) has been bolstered by the addition of SA-2 sites, and possibly by the introduction of the more effective SA-2 missile (GUIDELINE). Both systems are capable of interceptions at medium and high altitudes up to 60,000 feet and would have some capability up to about 80,000 feet, particularly if nuclear warheads were employed. (*Paras. 29–46*)

5. In view of the widespread deployment of the SA-2, and its potentialities for further improvement, we consider it very unlikely that the Soviets will develop an entirely new system to improve their capabilities against aircraft and air-to-surface missiles flying at medium and high altitudes. However, neither the SA-1 nor the SA-2 appears to have been designed or sited to cope with low level attacks. We estimate that in 1961 the Soviets will have available for initial deployment a surface-to-air system (SA-3) specifically designed for medium and low altitude coverage of targets down to about 50 feet. (*Paras. 47–48*)

Antimissile Program

6. There is firm evidence that the Soviets have had under way for several years an extensive and high priority program for the development of defenses against ballistic missiles. This effort is apparently directed toward development of a terminal intercept system. It is possible that the widespread and diverse Soviet activities which we have observed represent developmental programs on more than one type of antimissile system. The fixed nature of the installations and the general progression of activities towards work with longer range missiles leads us to believe that the main effort has been directed toward defense against IRBMs and ICBMs. (*Paras. 49–57*)[1]

7. We have no basis for a firm estimate for the date of first operational deployment of a Soviet antiballistic missile system or of its effectiveness against the various types of Western ballistic missiles. The timing of first deployment will be determined by the nature of the system under development, the status of the testing program, its future progress, and the timing of the Soviet decision to deploy. We believe that for political as well as military reasons, the Soviets would wish to deploy antimissile defenses for the protection of a few critical areas, even if the available system provided only an interim, limited capability. (*Paras. 58–59*)

8. In the light of these factors and the intensive Soviet research and development activities, we estimate that in the

[1] The Assistant Chief of Staff for Intelligence, Department of the Army, believes that the available evidence permits more detailed understanding and estimates of the antimissile systems under development at Sary Shagan and Uka than are reflected in this estimate. See his footnote to paragraph 57, page 14.

period 1963–1966 the Soviets will begin at least limited deployment of an antimissile system designed for use against both ICBMs and IRBMs. The earliest of these dates is contingent upon a Soviet decision to assume the high risks of starting production and deployment prior to full system tests, and therefore is considered the earliest possible date. If deployed early in the period, the capability of the system against IRBMs probably would be the more thoroughly tested. It should be noted that continuing success in research and development will be necessary if the USSR is to achieve *any* operational antiballistic missile capabilities in 1963–1966. It is unlikely that systems which could be deployed during this time period would have discrimination capabilities against sophisticated decoys. Soviet research and development in antimissile defense, perhaps including unconventional techniques, will undoubtedly continue as long as there are ballistic missiles. (*Paras. 60–62*)

9. In the course of its program to develop an antimissile system, the USSR could achieve a limited capability to destroy satellites after they have made a number of orbits. However, we believe that for some years to come the Soviets are likely to have only a marginal capability under most favorable conditions for interference with US satellites. (*Para. 63*)

Air-to-Air Missiles

10. We estimate that the Soviets have three types of short range (up to six n.m.) air-to-air missiles with HE warheads for employment with their interceptors. There is good evidence of the deployment of air-to-air missiles in the Soviet and European Satellite air forces, and possibly in the Chinese Communist Air Force. Soviet development of improved air-to-air missiles over the next few years is contingent upon trends in Soviet fighter and Western bomber forces and in Soviet surface-to-air missile defenses. (*Paras. 65–68*)

Air-to-Surface Missiles

11. A 55 n.m. air-to-surface antiship system which has been operational since 1955 is believed to be widely deployed in naval medium jet bomber units. Two additional systems are now estimated to be operational. The first is an improved antiship system which has a range of 100 n.m. The second is a 350 n.m. system, believed to have been designed for delivery by heavy bombers primarily against land targets. Both antiship missiles can be used against land targets with reduced accuracy, and the 350 n.m. system possibly could have an antiship role as a secondary mission. (*Paras. 71–77*)

Surface-to-Surface Ballistic Missiles

12. The USSR has developed a family of ground launched ballistic missiles whose ranges and other performance characteristics probably satisfy most current Soviet requirements for long range nuclear attack and for support of theater field forces. Two short range missiles, with maximum ranges of about 150 n.m. and 350 n.m., and two medium range missiles, with maximum ranges of about 700 n.m. and 1,100 n.m., have been available for operational use for the past few years. An IRBM of about 2,000 n.m. range, now under development, will increase Soviet coverage of distant peripheral targets and permit greater flexibility of deployment within the USSR. The ICBM develop-

ment program is discussed in paragraphs 16–20 below. (*Paras. 81, 93*)

13. Simplicity and ruggedness have been major criteria in Soviet development of ballistic missile systems from the short range to the ICBM classes. All systems probably employ radio-inertial guidance, achieving operational accuracies of about one-half to two n.m. depending on the range of the system. All use nonstorable liquid propellants except the 150 n.m. missile which uses storable liquid propellants. Short and medium range Soviet missiles are designed for road mobility and rail transportability. The ICBM, and probably the IRBM, are designed to be launched from fixed positions, and would be heavily dependent on the Soviet rail net. Medium range, IRBM, and ICBM systems are suitable primarily for the delivery of nuclear payloads, but short range systems may be designed to employ nuclear, HE, or CW warheads, depending on tactical considerations. (*Paras. 84–94*)

14. Our evidence on Soviet production and deployment of these missile systems is far from satisfactory. We have information pointing to several plants which may be engaged in production of ballistic missiles, but it is insufficient to establish production rates for any class of missile. Test range activities indicate the training of troop units to employ short and medium range systems, as well as continued research and development to improve the performance of the systems themselves. Our best evidence on deployment relates to medium range missiles: some 700 n.m. missiles are probably now deployed in East Germany; 700 or 1,100 n.m. missiles are probably also deployed in the several areas near Soviet borders in the Baltic, Carpathian, and Far Eastern regions. (*Paras. 88, 90, 92*)

15. Our evidence on future Soviet ballistic missiles is likewise fragmentary and inconclusive. We believe that the Soviets will strive to improve the accuracy, reliability, ease of handling, mobility, and reaction times of all classes of missiles. Among other things, this effort probably will lead eventually to solid or storable liquid propellants and to all inertial guidance. (*Para. 95*)

ICBM Program

16. We have relatively firm evidence on the Soviet ICBM test range and the test-firing program from which we have been able to derive basic characteristics of the ICBM system and—though with some probable margin of error—basic factors affecting its performance under operational conditions. In the 3½ year period since the first successful flight test in August 1957, the Soviets have launched about 35 generally successful ICBMs on the test range. Considering the observable patterns in test firing in relation to other Soviet missile programs and to the space program which has shared ICBM boosters, facilities, and experience, we conclude that the USSR has been conducting a careful and generally successful ICBM development program, at a deliberate pace rather than on a "crash" basis. (*Paras. 98, 102–105*)

17. The sum of our information is inconclusive as to the precise timing of initial Soviet ICBM deployment. However, we consider that the satisfactory development of a 5,000 n.m. ICBM by the end of 1959, the probable manufacture of production missiles beginning early in that

year, and the possible construction of launching sites in northwestern USSR in 1957–1959 are sufficient to support an estimate that as of about 1 January 1960 the first operational Soviet ICBM unit was trained and equipped with a few missiles and launchers. This is referred to as initial operational capability (IOC) date. We believe that since that time, the USSR has had at least some capability to launch ICBMs, with high-yield nuclear warheads and good accuracy and reliability, against targets in the US.[2 3] (*Paras. 124–129*)

18. For extensive coverage of US territory, 5,000 n.m. ICBMs would have had to be deployed at launch sites in northwestern USSR or in the Soviet Far East. By about mid-1960, however, the Soviets had developed a 7,000 n.m. missile which could achieve full coverage of the US from deployment areas virtually anywhere in the USSR. ICBM launch sites would necessarily be near rail lines. (*Paras. 101, 110, 124*)

[2] The Assistant Chief of Staff for Intelligence, Department of the Army, believes that by early 1960, the Soviets had developed a 5,000 n.m. missile satisfactory for emergency deployment to interim ICBM launch facilities and that a few missiles possibly were deployed to such facilities. He believes that an IOC with fully developed, deployed, operational missile launch facilities did not occur in 1960.

[3] The Assistant Chief of Naval Operations (Intelligence), Department of the Navy, believes the Soviets probably had an emergency capability to launch a few missiles from test facilities (as opposed to operational launch sites) starting early in 1960. Factors which bear against a deployed operational ICBM capability and which are mentioned in the estimate weigh heavily in his judgment. These include the lack of ICBM troop training activity, and the lack of firm evidence on operational ICBM sites. In addition, the first appearance of what appears to be an operational type site at Area C at Tyuratam which was estimated to be completed in late 1960 or early 1961 leads him to judge that operational launch sites were not available before that time.

19. We estimate that, with the present type of guidance, Soviet ICBMs would have a CEP[4] of about two n.m. under operational conditions in mid-1961, but the actual figure could be considerably greater or somewhat less. If a very high priority is assigned to improving accuracy, the operational CEP of portions of the Soviet ICBM force might reach one n.m. as early as 1963, but we regard 1965 as a more likely date for such an achievement. (*Paras. 112–113*)

20. Although it will probably continue to be modified and improved over the next few years, the present Soviet ICBM has the inherent disadvantages of a very large, nonstorable liquid-fueled system. It is probable, therefore, that the Soviets will develop a new ICBM system using either storable liquid or solid fuels, building into it compatible elements to increase flexibility and decrease vulnerability in deployment. Flight-tests of a follow-on ICBM system could begin at any time, and we believe that such a system could become operational in about 1963 or after. (*Paras. 131–133*)

Long Range Aerodynamic Vehicles

21. There are indications of current Soviet interest in long range, cruise-type vehicles. We believe that the Soviets are developing, and could have available for operational use by 1962–1963, a ground-launched, ramjet propelled vehicle, with a speed of about Mach 3, a flight altitude of approximately 70,000 feet and a range in excess of 4,000 n.m. This system could have a research role, but if employed for weapon delivery or reconnaissance it

[4] Circular error probable (CEP) is the radius of a circle within which theoretically 50 percent of the missiles reaching the general vicinity of the target will impact.

would complicate Western air defense problems. (*Para. 97*)

Naval Launched Missiles

22. *Submarine Launched.* On the basis of analysis of observation reports and photography of Soviet submarines, as well as on statements by Soviet officials, we believe that two classes of missile carrying submarines are currently operational. Both probably carry the same missile, a 150 n.m. or 350 n.m. ballistic weapon with a CEP of one to two n.m. One submarine, the converted "Z" class, can carry two missiles; the other, the "G" class, can probably carry three or four. Neither can launch when fully submerged. We believe that the Soviets probably are developing nuclear submarines capable of carrying and launching ballistic missiles while submerged. We estimate that they could have available for initial deployment in the 1962–1963 period, a nuclear submarine carrying 6–12 ballistic missiles of 500–1,000 n.m. range. It is possible that the Soviets have elected to equip nuclear submarines with missiles of the type attributed to the converted "Z" and "G" classes, in which case a few could be operational this year. We believe that the Soviets are also developing a 300 n.m. supersonic cruise missile designed to be launched from surfaced submarines. This system could be operational this year. (*Paras. 141–146*)

23. *Surface Ship Launched.* Two classes of missile launching destroyers are now operational with the Soviet fleets. They may employ either of two short range, cruise-type missiles, both of which are designed for use against ships. It is possible that a few cruisers may be modified to employ either of these destroyer launched missiles as well as adaptations of land based surface-to-air systems. The Soviets also have operational a short range missile, guided or unguided, for use in patrol craft. (*Paras. 135–139*)

Space Program

24. In seizing an early lead in space and following it with a series of dramatic successes, the Soviets have sought to bolster, both at home and abroad, claims of the superiority of their system. The USSR has sought to maximize the impact of its achievement with spectacular "firsts," on occasion timed to coincide with international political moves. Intervening shots appear to have been designed largely to provide data for these "firsts." While the Soviet space shots have collected scientific data, the scientific aspects of the program seem to have been fairly selective, and to a large degree applicable to the support of future Soviet space missions. (*Paras. 147–148*)

25. The importance which the Soviets attach to the space program is demonstrated by the assignment of leading scientists to its direction, by the wealth of theoretical and applied research being conducted in its support, and by the allocation of resources and facilities to its implementation. Space vehicles have constituted more than one-third of the total number of launchings from Tyuratam in the past 3½ years. The impressive Soviet record now includes: orbiting of the world's first earth satellite and by far the largest satellites; launching of the first vehicles to impact the moon and to photograph the reverse side of the moon; launching of the first vehicle to transfer from earth orbit to a trajectory towards a planet; orbiting and recovery of the only

earth satellites suitable for supporting manned orbital flights; and, most recently, the successful orbiting and recovery of a man. (*Para. 150*)

26. The reliability achieved in Soviet space shots has been much lower than that of the Soviet ICBM. The Soviets have achieved 14 successful launchings of space vehicles, but we believe that there have been nearly as many launchings which resulted in failures. Moreover, several of the vehicles which were successfully launched apparently did not function as planned. Most space failures were apparently caused by factors unique to the space program, such as the addition of upper stages to the basic booster and in some cases the requirement to launch at stipulated times. (*Para. 152*)

27. To date the USSR has apparently not launched any space vehicles specifically for military purposes. However, many of their space experiments have provided information which would be useful in the development of future military space systems. It would be technically feasible at present for the Soviets to equip earth satellites for such military support roles as communications, reconnaissance, navigation, or collection of weather data. We estimate that such systems could appear at any time. There is no evidence that the Soviets are developing offensive space weapons. However, the Soviets have undoubtedly undertaken research and studies in this area. Soviet success in space as exemplified by the Venus probe, the most recent successful orbiting and recovery of a man, and the capability to orbit still heavier payloads over the next few years, leads to the conclusion that the Soviets are technically capable of achieving an orbital bombardment vehicle toward the end of the period of this estimate. Moreover, the Soviet leaders might seek to derive some psychological or political advantage by hinting or even boasting that the USSR had a significant capability in such weapons. The launching of vehicles for which the Soviets claimed a military capability or other Soviet achievements in space could lend credence to such claims. (*Paras. 149, 175*)

28. We believe that the Soviets will continue to capitalize on their possession of very powerful propulsion systems. The USSR could now place in orbit a 20,000 pound satellite, and this orbital payload could be increased to about 25,000 pounds in about 1962. An instrumented lunar soft landing probably can be made this year, and additional deep space probes probably will be attempted during the next year or so. Finally, there is evidence that the Soviets are now developing a liquid rocket engine with a thrust of some one to two and a half million pounds which could be available in about 1963. Such engines could be used in clusters in the 1965–1970 time period to launch earth satellites of 50 to 100 tons. (*Paras. 167–174*)

Table I

SIMPLIFIED TABULAR SUMMARY
PROBABLE SOVIET GUIDED MISSILE DEVELOPMENT PROGRAM[a]

Arbitrary Designation	IOC Date	Maximum Range (n.m.)	Maximum Warhead Weight	Accuracy (CEP)	Other
			lbs.		
Surface-to-Surface Ballistic Missiles:					Deployment Concept
SS-1	1957	150	1,500	½ n.m.	Road mobile.
SS-2	1954	350	2,000	¾ n.m.	Road mobile.
SS-3	1956	700	3,000	1 n.m.	Road mobile.
SS-4	Late 1958–early 1959.	1,100	3,000	1½ n.m.	Road mobile.
SS-5	Late 1961–1st half 1962.	2,000	4,000	1½ n.m.	Probably fixed sites.
SS-6	1 Jan. 1960[b]–mid 1960.	5,000 7,000	6,000–10,000 6,000	1961–2 n.m.	Fixed sites.
Surface-to-Air Missiles:					Effective Altitude
SA-1	1954	20–30	500	65–120 ft.	3,000 to 60,000 ft.
SA-2	1957	25–30	500	100 ft.	2,500 to 60,000 ft.
SA-3	1961	12–15	300	20 ft.	50 ft. to 40,000–60,000 ft.
SA-4	1963–1966	Undetermined capability against ballistic missiles.			
Air-to-Air Missiles:					Conditions for Use
AA-1	1955–1956	2–5	30	20 ft.	All weather.
AA-2	1955–1956	1–4	25	10 ft.	Limited.
AA-3	1958	3–6	25	15 ft.	All weather.
Air-to-Surface Missiles:					Speed
AS-1	1956–1957	55	3,000	150 ft. against ships.	Subsonic.
AS-2	Late 1960–early 1961.	100	3,000	1 n.m. on land, 150 ft. against ships.	Low supersonic.
AS-3	Late 1960–early 1961.	350	3,000	1–2 n.m. on land, 150 ft. against ships.	Supersonic.
Naval Launched Missiles:					Deployment Concept
SS-N-1 cruise	1958	20–30 40–100 w/assist	1,000	150 ft.	Destroyers.
SS-N-2 cruise	1958	20–30 60–80 w/assist	1,000	150 ft	Destroyers.
Submarine-Launched Missiles:					
SS-N-3 cruise	1961	300	A supersonic cruise missile designed for launch from surfaced submarines.		
					Conditions for Use
SS-N-4 ballistic	1958 "Z" 1959 "G"	150 or 350	1,500–2,000	1–2 n.m.	Surfaced or sail awash.
SS-N-5 ballistic	1962–1963	500–1,000	1,000	1–3 n.m.	Submerged.

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

[b] For the views of the Assistant Chief of Staff for Intelligence, Department of the Army, and the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, on this date, see their footnotes, page 5.

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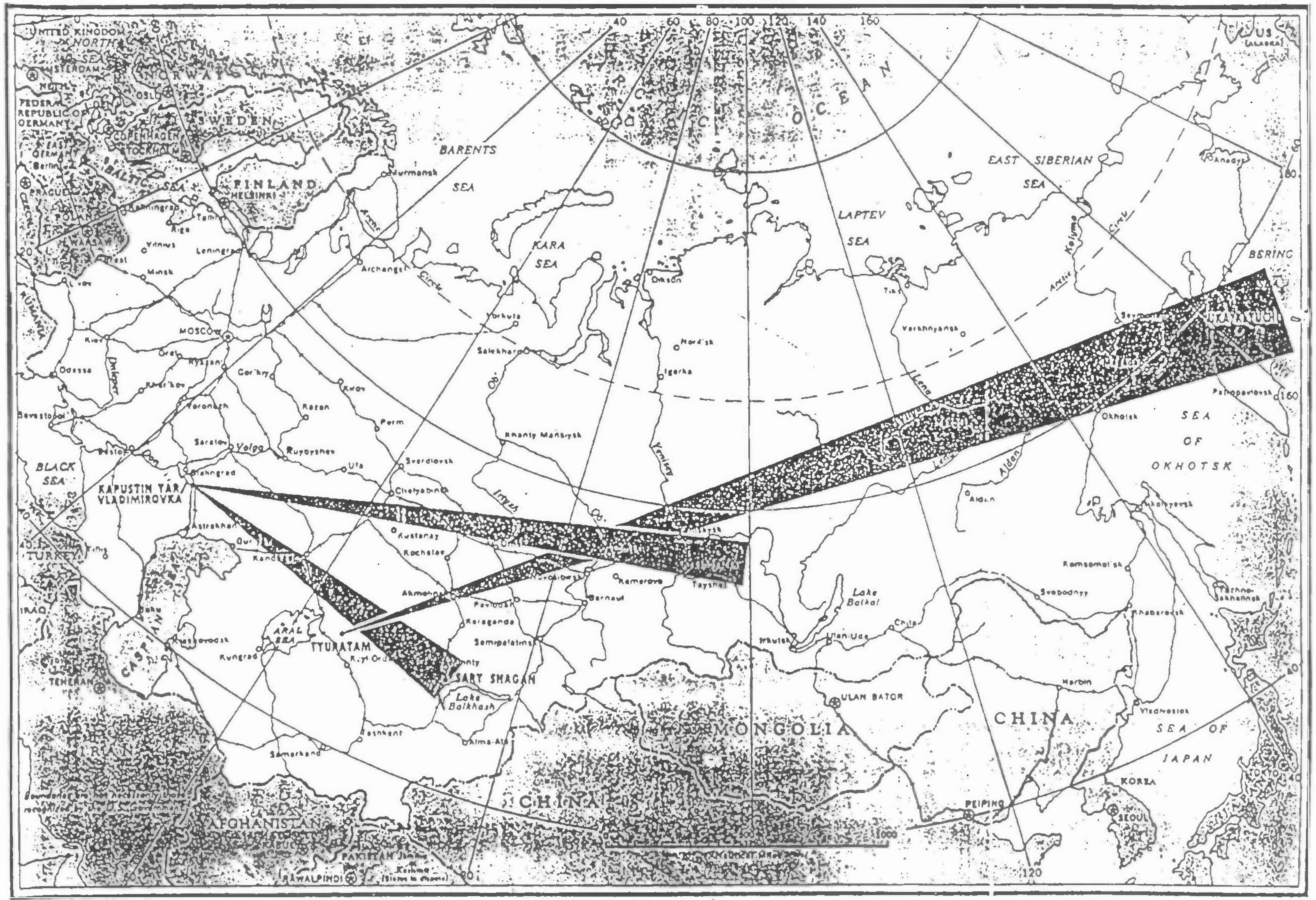
USSR: MISSILE TEST RANGES

Figure 1



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DISCUSSION

I. SURFACE-TO-AIR MISSILES

29. The Soviets have developed relatively few surface-to-air missile systems, each designed to counter a specific threat, or take advantage of scientific and technical advances to assist in solving air defense problems. German assistance gave a considerable impetus to the early Soviet research and development in this field, but made no significant contribution after about 1949.

30. The major Soviet facilities for testing surface-to-air missile systems and for training troops in their use are located at the Kapustin Yar missile test range (see Figures 1 and 2). These are centered in a complex extending over some 180 square miles which contains four launch areas, associated instrumentation and support facilities, and an installation similar in appearance to known Soviet nuclear weapons storage sites. Training facilities probably can support 3,000 SAM troops at any one time.

31. At the test range, the Soviets have followed a generally similar pattern in the development of the two SAM systems now operational. After extensive component development and testing at research facilities, a large flight test program was conducted at the test range using a launching facility specifically designed for research and development. Subsequently, prototypes of operational sites were constructed for more complete system testing and for training of operational crews.

SA-1

32. This is the arbitrary US intelligence designation of the first operational Soviet SAM system, which was deployed only in the area around Moscow. In late 1949 or early 1950, the development of this SAM system was placed on a priority basis and development time was telescoped. After testing on a partial prototype site, construction of missile sites at Moscow was begun in 1953, at about the same time as the complete prototype site was being constructed at Kapustin Yar. Deployment of the system was begun in 1954, and the entire complex was probably operational by 1956. At that time 56 sites had been deployed in a dense and costly complex around Moscow on two concentric rings with radii approximately 25 n.m. and 45 n.m. from the center of the city (see Figure 3). A typical SA-1 "herringbone" site has 60 launch positions joined by a road network (see Figure 4).

33. Preliminary tracking information probably is provided to the Moscow SAM defense by radars which are deployed around the city on a circle with a radius of about 200 n.m. Closer in, about 30 n.m. from the outer ring, a target would come within range of the tracking radar located at each site. This radar, designated "YO-YO" by US intelligence, can simultaneously track targets and scan for additional targets within a 54° arc in both the vertical and horizontal planes. Each SA-1 site is believed capable of engaging as many as 20 targets simultaneously. However, the limited coverage in azimuth means that a number of sites are required to defend a target against attack from all quarters. The SA-1 employs a command type of guidance system. It appears to be vulnerable to both chaff and electronic jamming to a degree which is heavily dependent upon the jamming techniques employed and on the skill of the SA-1 radar operator.

34. The V-301 missile originally designed for use with this system is unboosted and employs a liquid propellant sustainer motor (see Figure 5). While its maximum speed is on the order of Mach 3.5, it has a low initial acceleration which limits somewhat its engagement capability against supersonic targets. The missile carries a payload of about 500 pounds, and its CEP is estimated at 65–120 feet. Maximum intercept range will vary between 20–30 n.m. depending upon the approach and type of target; for example,

against a directly incoming B-52 at high altitude its range is on the order of 20 n.m. 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 armed with a nuclear warhead. Its minimum effective altitude is about 3,000 feet.[6]

35. There is some evidence that the GUIDELINE missile, designed as part of the SA-2 system, may be utilized in some SA-1 sites as a replacement for the single-stage V-301. The use of such a boosted missile in the SA-1 system would increase the system capability, particularly against targets which can be engaged for only a short time.

36. We have considerable information on production and logistic support for the SA-1 system. Production of components and subassemblies has been reported at a number of plants in the Moscow and Leningrad areas. Direct logistic support for the Moscow sites is provided by six assembly, storage, and maintenance facilities located near the inner ring and connected to the launch sites by highways (see Figure 6).

37. The chief advantages of the SA-1 system are its ability to handle simultaneously a large number of targets and to direct an extremely high rate of fire against them. However, it was apparently designed primarily to counter the massed air raid threat of the late 1940s and early 1950s. Even before completion of the deployment around Moscow, it is probable that concepts of the threat 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. The Soviet answer to these problems was the development of the SA-2 system.

[6] Annex E, "Estimated Present Nuclear Warhead Capabilities." (Limited Distribution)

SA-2

38. We have considerably less information on the development cycle of the SA-2 system than on that of the SA-1; however, it does not appear to have been similarly compressed. Deployment of this system was delayed until prototype launching facilities were completed at Kapustin Yar and training was underway. Based on the expansion of these facilities observed in September 1957, we believe that the system had been proved and had become operational prior to the end of that year. More than 150 operational SA-2 sites have since been observed—primarily in the USSR, but also in some of the Satellites—and many more are believed to exist. Several SA-2 sites observed in the Moscow area probably are intended to supplement the SA-1 defenses. Such widespread deployment indicates selection of the SA-2 as the standard Soviet SAM system for defense against medium and high altitude air attack.

39. A typical SA-2 site (see Figures 7 and 8) consists of six revetted launchers arranged in a roughly circular pattern of about 500 feet in diameter and linked by service roads to facilitate loading. Inside the circle are a revetted fire control system and associated van-type trucks and trailers which probably house radar and computing equipment and power generators. Displaced several hundred yards from the other equipment are an acquisition radar, an IFF set, and three revetted missile hold areas.

40. The SA-2 guidance system, like that of the SA-1, is believed to be a command system using a track-while-scan radar. This radar, nicknamed "FRUIT SET," consists of four separate antennas on a single, mobile mount (see Figure 9). Although the radar has a relatively narrow look angle, the entire mount appears capable of rotation about a vertical axis, and at least one of the parabolic dishes can move about a horizontal axis as well. Used in conjunction with the fire control radar is an acquisition radar, nicknamed "SPOON REST" (see Figure 10). SPOON REST has also been widely deployed as a gap-filler radar in peripheral areas of the Soviet Bloc. Under optimum condi-

tions, the guidance system could probably handle two targets at a time, with more than one missile in the air against each target. However, these targets would have to be within the approximate 12° radar look angle of the FRUIT SET. The SA-2 system probably is somewhat less vulnerable to countermeasures than the SA-1.

41. The missile used with the SA-2 system is the GUIDELINE, first observed in the November 1957 parade (see Figure 11). It probably has a solid propellant booster and a liquid sustainer motor, which give it a maximum speed on the order of Mach 3. The GUIDELINE carries a payload of about 500 pounds, and CEP is estimated at about 100 feet. Maximum intercept range is estimated at 25-30 n.m. but will vary depending upon type of target, approach angle, and other operational factors; for example, against a directly incoming, high-flying B-52, the range would be on the order of 25 n.m. Maximum effective altitude capability is about 60,000 feet with some effectiveness up to 80,000 feet, especially with a nuclear warhead. Low altitude capability probably will average about 2,500 feet, but variations in siting conditions and targets could result in low altitude limits as high as 7,000 feet or as low as 1,000 feet.

42. Each SA-2 site is believed to be assigned 12 missiles, of which six are probably available on launchers and six are kept on trailers parked in missile hold areas at each site. In addition, for each 4-6 sites, there is a support facility in which 12 more missiles per site are uncrated, prepared, checked out, and held in storage on trailers ready to be moved to individual sites. Unassembled missiles are also stored in the facility. A nearly completed field support facility has been observed at Ladeburg, northeast of Berlin (see Figure 12). Sites of a more permanent nature, but performing the same functions, have been observed throughout the USSR (see Figure 13). They contain assembly and checkout facilities, additional facilities for unloading and disassembly, storage areas for warheads, boosters, fuzes, fuel, and oxidizer, and a parking area for ready missiles stored on trailers. Although we have not identified nuclear storage at any of the support facilities, we estimate that the system could employ nuclear warheads.

43. The firing scheme of the SA-2 site is not known. There is some evidence that missiles may be launched in pairs, but it is also possible that they are launched singly. In either case the tracking and guidance equipment would be tied up for the approximate one and a half minute time of missile flight. Subsequently another missile or pair of missiles could be launched. Since reload and checkout are estimated to require approximately five minutes, the first launcher or pair of launchers would be ready to fire reloaded missiles just prior to (in the case of a single missile) or shortly after (in the case of pairs) the last on-launcher missile. This situation applies to the six missiles on launcher and the six additional ready missiles at the site. The time required to bring additional missiles from the support facilities, generally located at some distance from the sites, would depend upon their relative locations and the extent of prior planning.

44. The SA-2 system appears designed to cope with the threat posed by small numbers of aircraft carrying nuclear weapons rather than a massed raid threat. Flexibility and mobility are its chief advantages over the SA-1. In contrast to the massive SA-1 sites, each of which is capable of defending only a limited sector around the target area, each SA-2 site appears capable of 360 degrees coverage. The SA-2 system can, at relatively low cost, be deployed widely for defense of large cities, of small but important fixed facilities, and of forces in the field. This flexibility is obtained at the expense of target handling and rate of fire relative to the SA-1. However, the shorter time of flight of the boosted GUIDELINE missile gives the SA-2 system a better capability against high altitude and high speed targets and against targets with small radar cross sections.

45. Although all of the observed sites incorporate revetments and other fixed installations, all components of the system are mounted on wheeled vehicles and are capable of independent movement by road or rail.

Not considering travel time, we estimate that about four hours is required to take down or to set up the equipment at a site. Mobility exercises have been observed in East Germany.

46. In view of the widespread deployment of the SA-2 system and the potentialities for further improvement, we consider it very unlikely that the Soviets will develop an entirely new system to improve their capabilities against aircraft and air-to-surface missiles. Rather, we estimate that the Soviets will probably improve the SA-2 to increase its range to say 30-35 n.m., improve its ability to engage small, fast targets at high altitudes, and enhance its ECCM capabilities. Research and development work for this purpose may be underway at Sary Shagan or Kapustin Yar, and we believe that modifications incorporating improvements in the system could begin to appear this year.

Low Altitude System

47. A surface-to-air missile system designed to engage targets at low altitudes has probably been under development by the Soviets for two or three years. Photography of Kapustin Yar in late 1959 revealed a test area (see Figure 14) which contained two sites of a new type, each having four launch pads. One site, which was probably used for R and D, was complete and occupied, while the other was in the final stages of construction. The lack of revetments around the sites would allow the launchers to be trained at a low angle of elevation. Moreover, the location of the guidance radar on a tower indicates its design for use against targets at low altitudes. At least one of the R and D launchers contained two missile-like objects about 20 feet long. The site pattern suggests that the missiles are carried on a transporter (possibly tracked) which backs up to the launcher for transfer of the missiles. The missile is believed to employ semiactive radar homing all the way as a guidance system. It is probably powered by a solid propellant engine of the integral sustainer-booster type.

48. This system, designated SA-3, probably will become operational in 1961. We estimate that it will have a minimum altitude capability of about 50 feet under optimum siting conditions, a maximum altitude capability of 40,000-60,000 feet, a maximum range of 12-15 n.m., a 20 foot CEP, and a 300 pound HE or nuclear payload.[6] The system probably will be mobile, and thus suitable for defense of field forces as well as fixed targets. It probably will employ a continuous wave radar for target tracking. The acquisition radar has not yet been identified, but existing radars have a potential for use with this system. The SA-3 system probably will be deployed so as to supplement existing SA-2 defenses.

[6] Estimated payload weight is based upon analysis of photography and the estimated availability of a compatible nuclear warhead.

SURFACE-TO-AIR MISSILE COMPLEX AT KAPUSTIN YAR

Figure 2

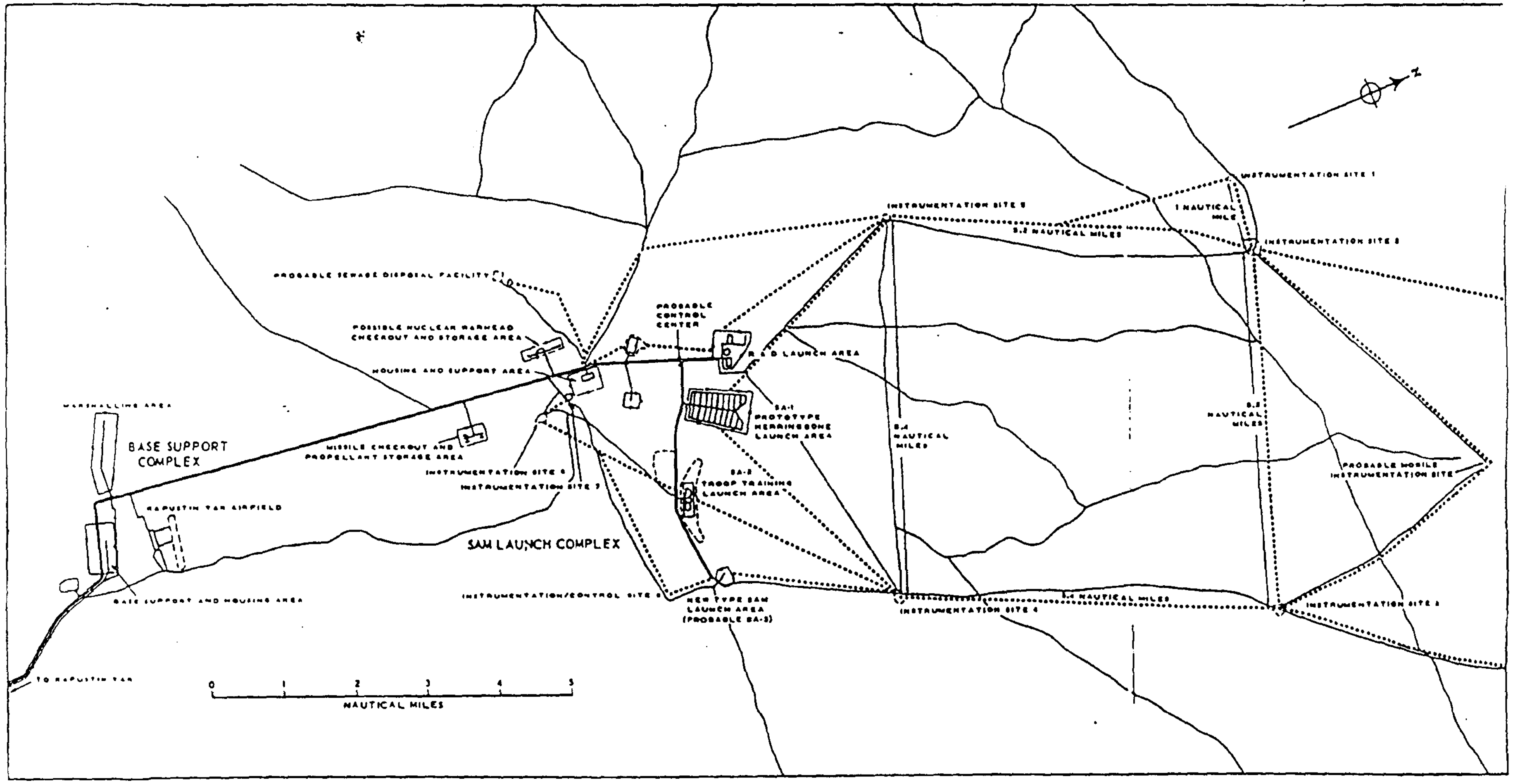

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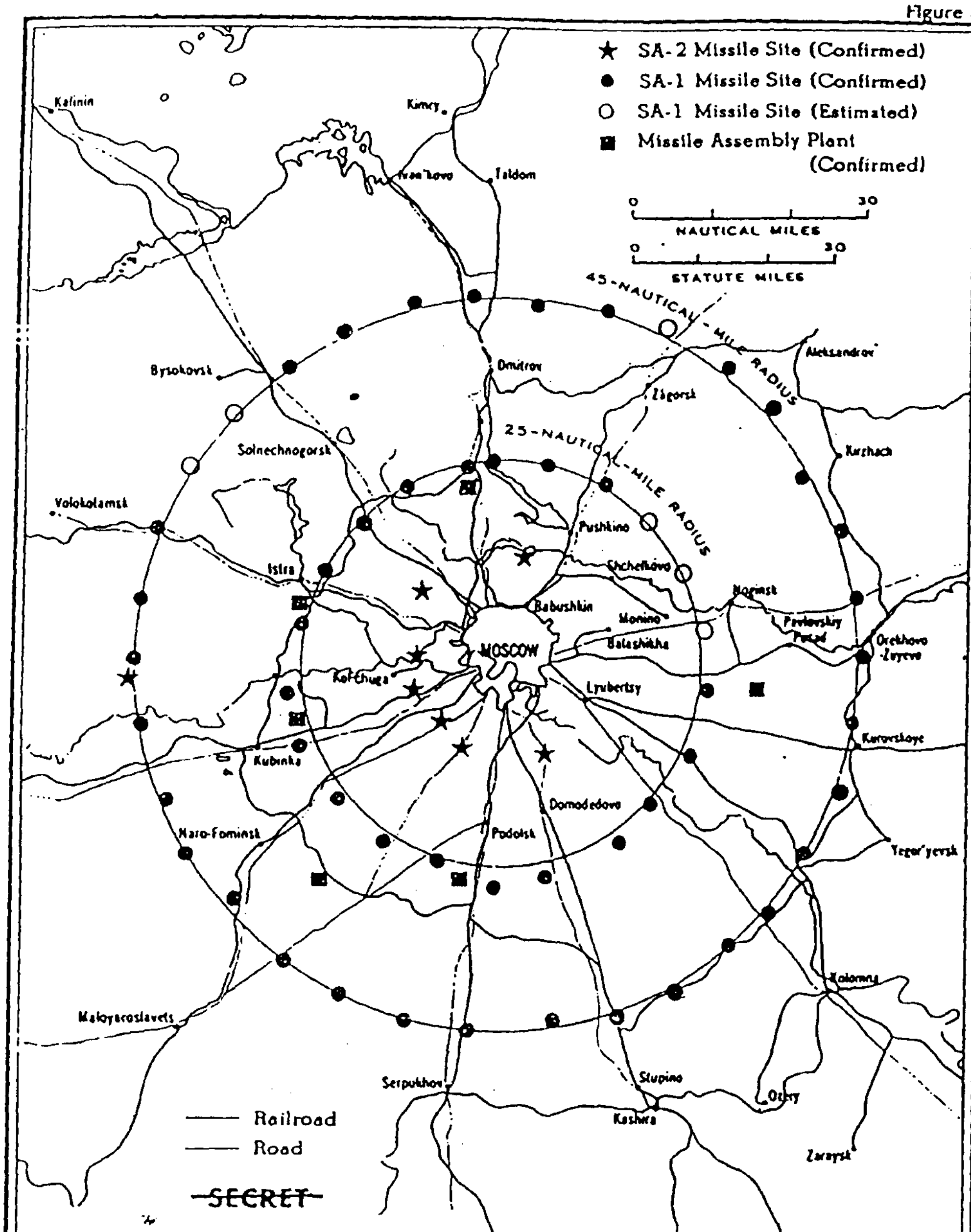
Figure 3



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

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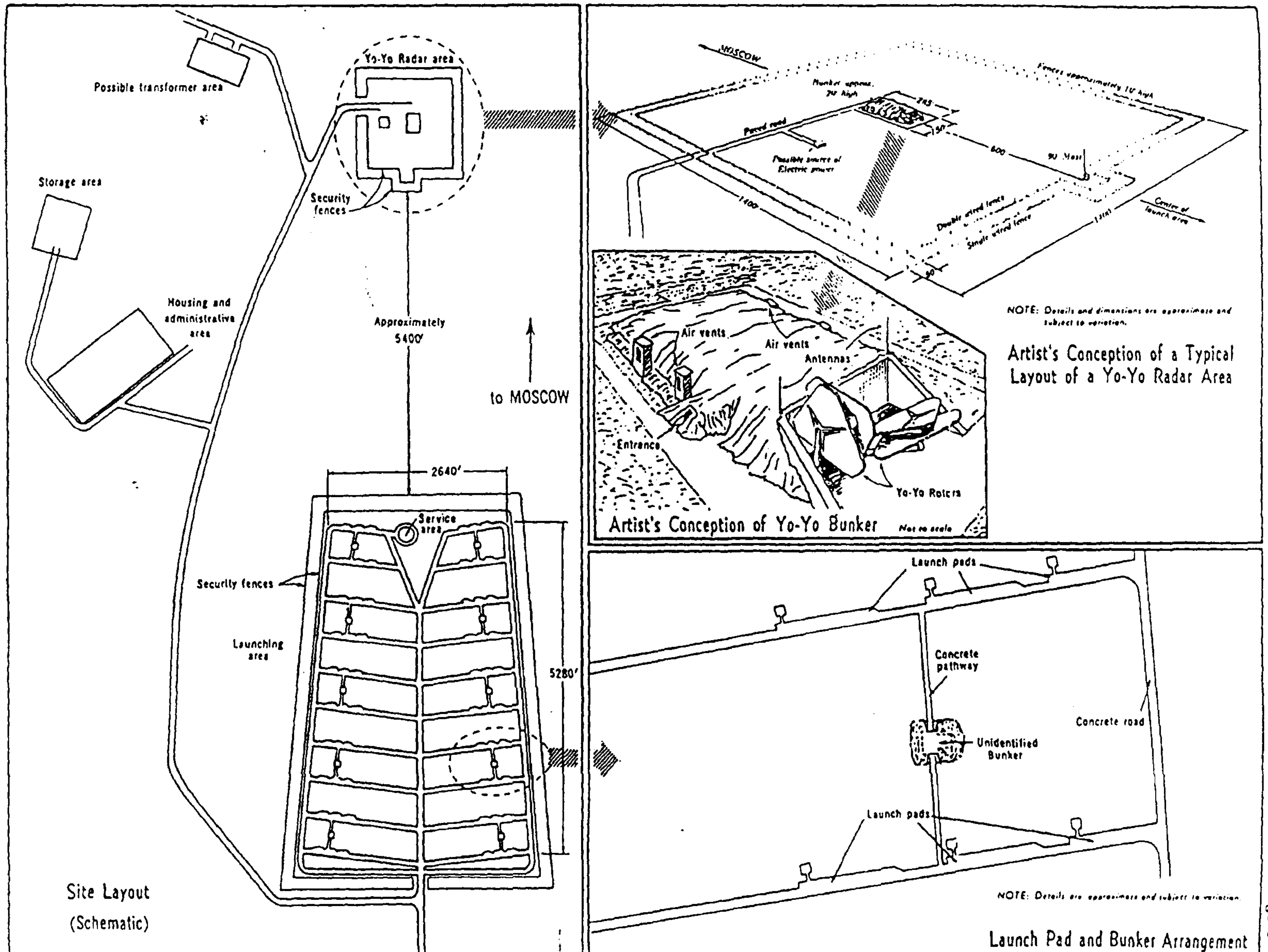

Figure 4

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Typical SA-I Guided Missile Site in the Moscow Area

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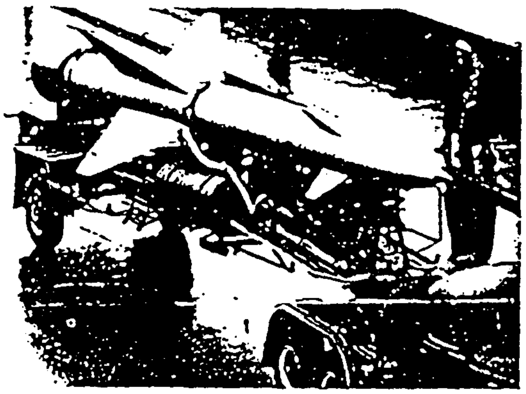
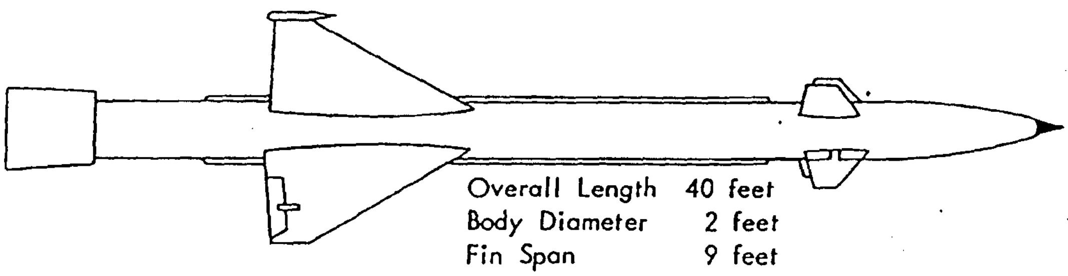
Figure 5



MOSCOW PARADE, NOVEMBER 1960

V-301 MISSILE



SA-1 ESTIMATED MISSILE SYSTEM CHARACTERISTICS

Maximum Iner Intercept Altitude	60,000 - 80,000 feet	Dependent on Target Type and Approach
Maximum Intercept Range	20 - 30 Nautical Miles	
Warhead Weight	500 Pounds	
Maximum Velocity	Mach 3.5	
Propulsion System	Kerosene and Nitric Acid	
CEP	65 - 120 Feet	

SA-1 MISSILE SYSTEM (INCLUDING V-301 MISSILE)

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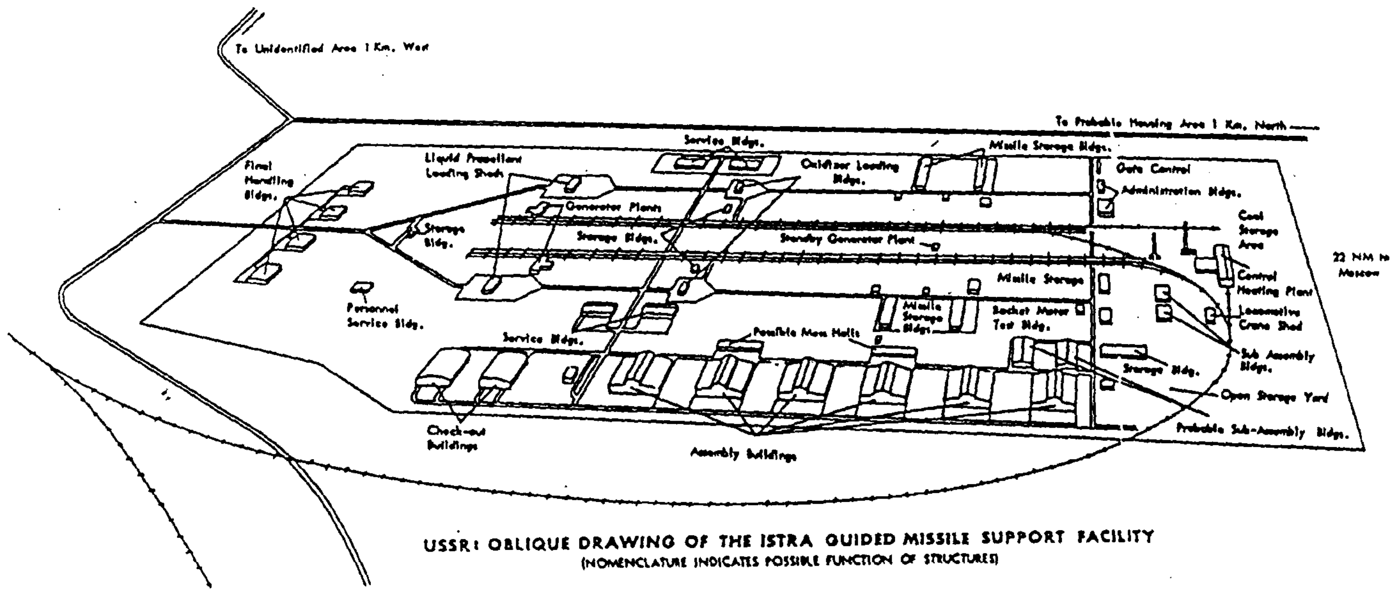
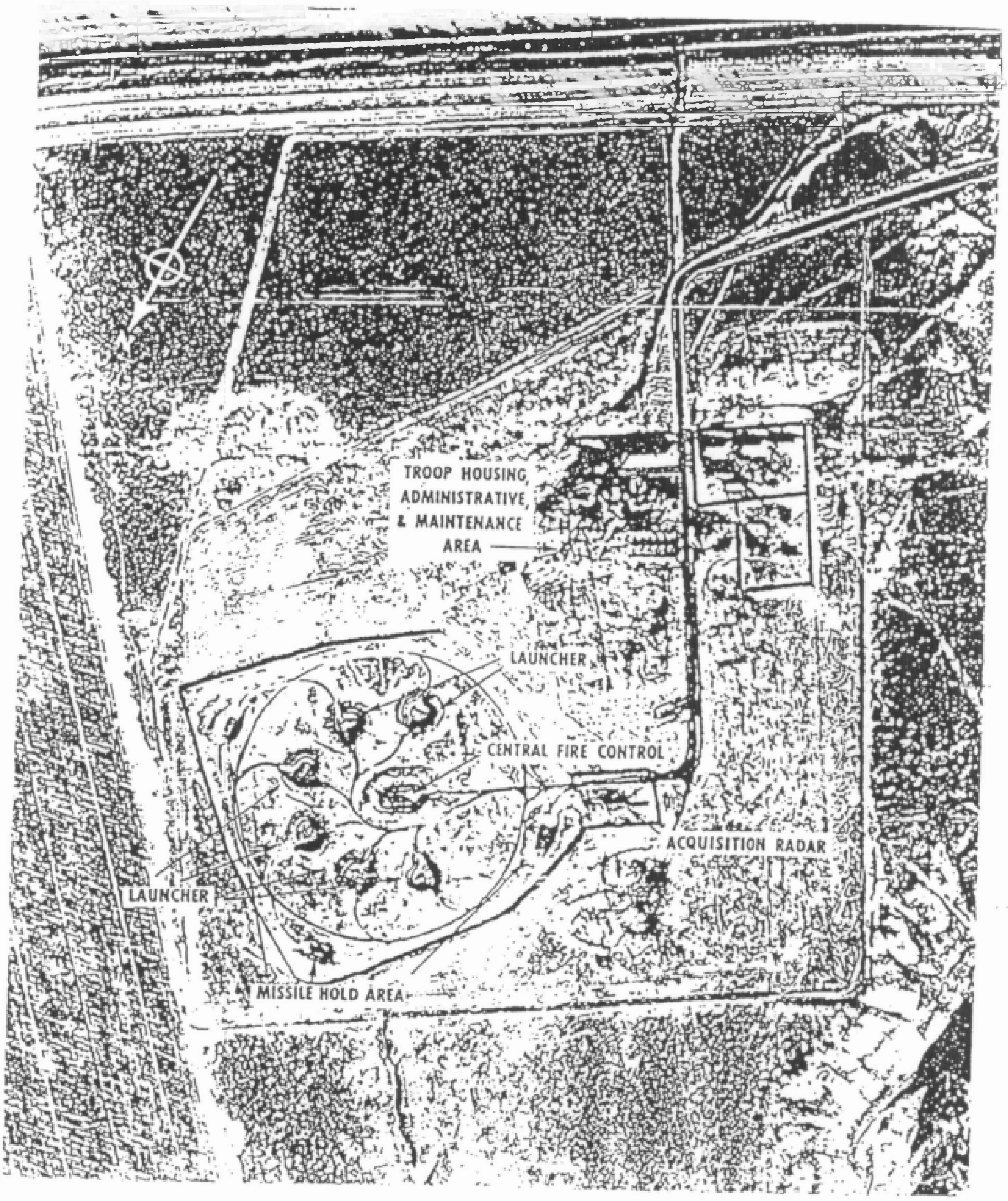


USSR: OBLIQUE DRAWING OF THE ISTRA GUIDED MISSILE SUPPORT FACILITY
(NOMENCLATURE INDICATES POSSIBLE FUNCTION OF STRUCTURES)

Figure 7



TYPICAL SA-2 MISSILE SYSTEM SITE (STALINGRAD, USSR)

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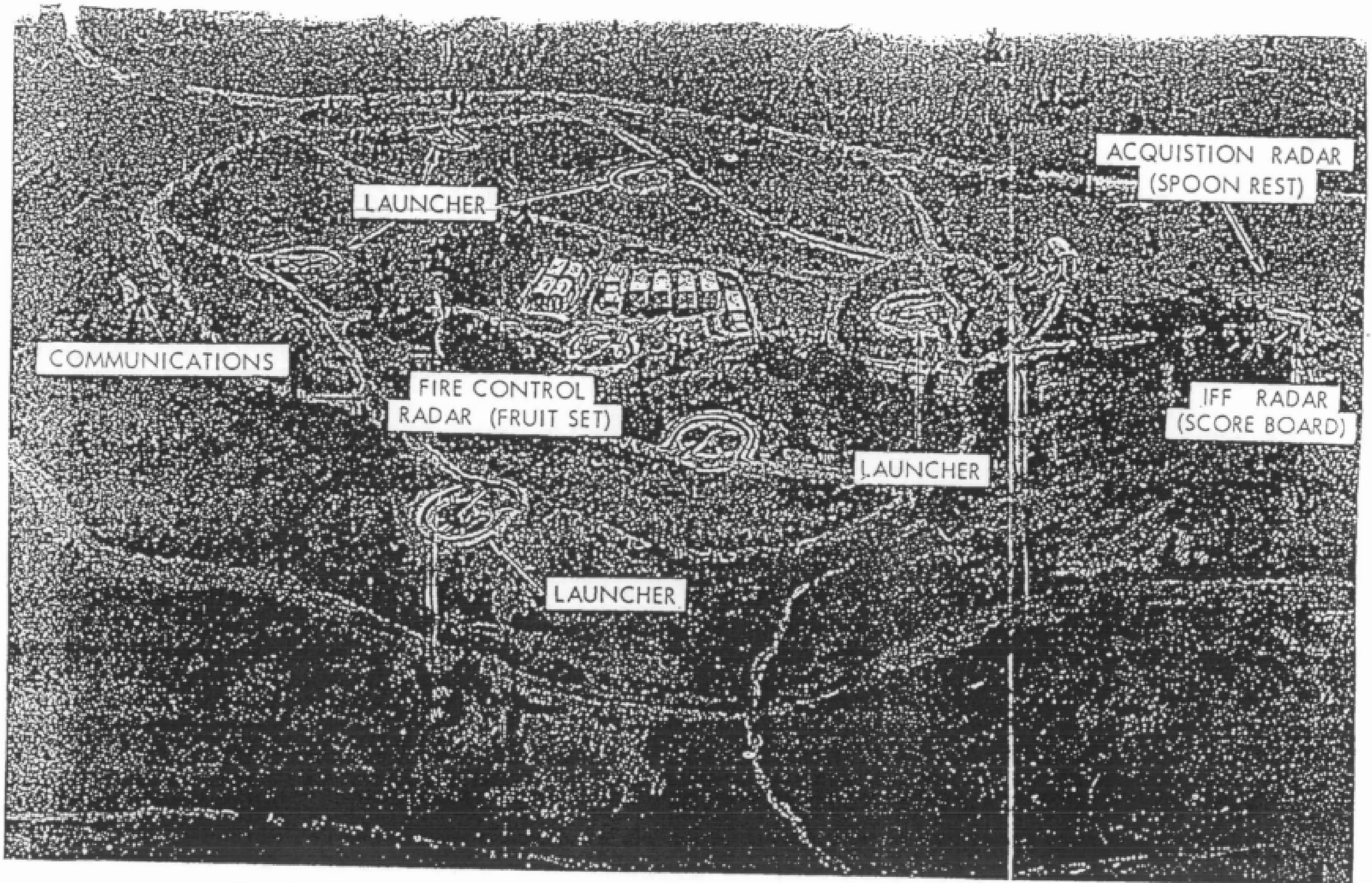

TYPICAL SA-2 MISSILE SYSTEM EQUIPMENT LAY-OUT (GLAU-EAST GERMANY)

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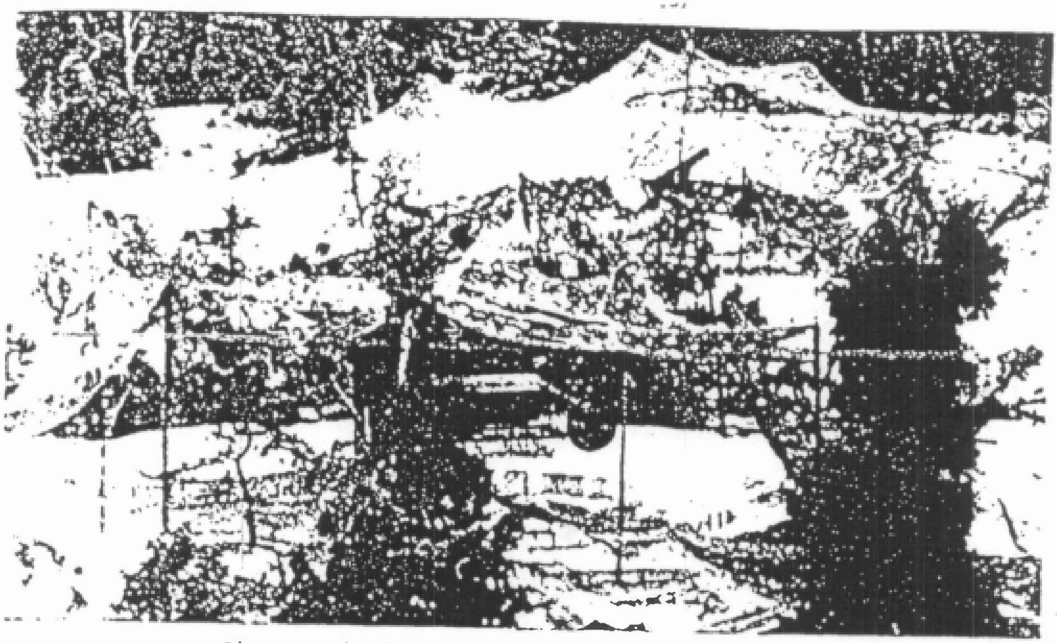
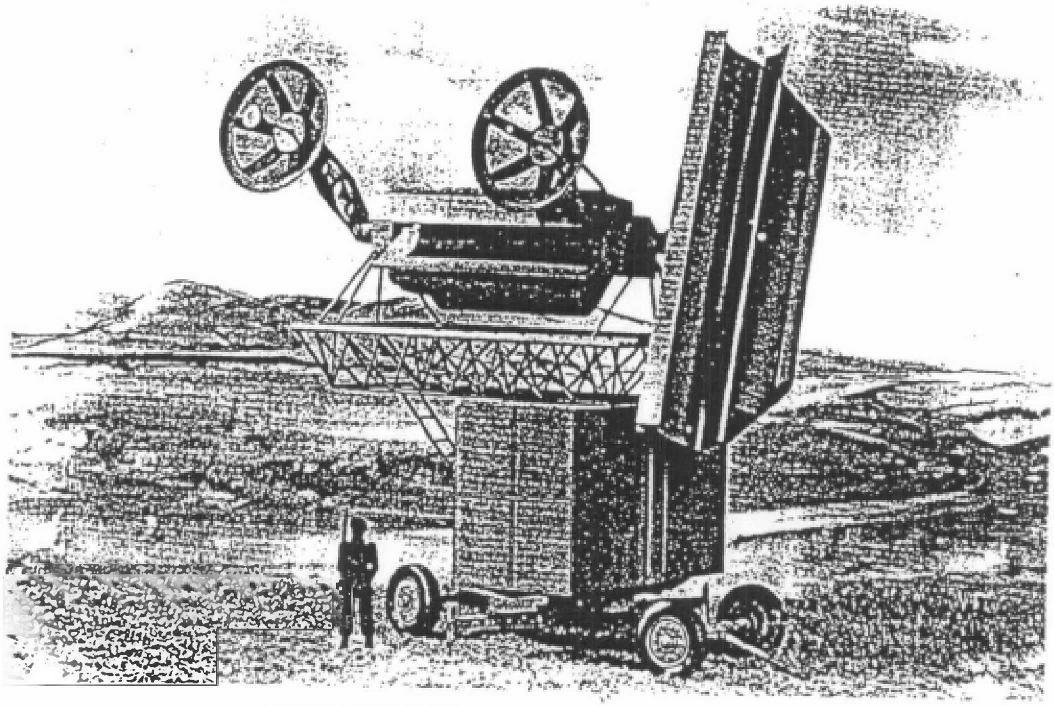
Figure 9



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

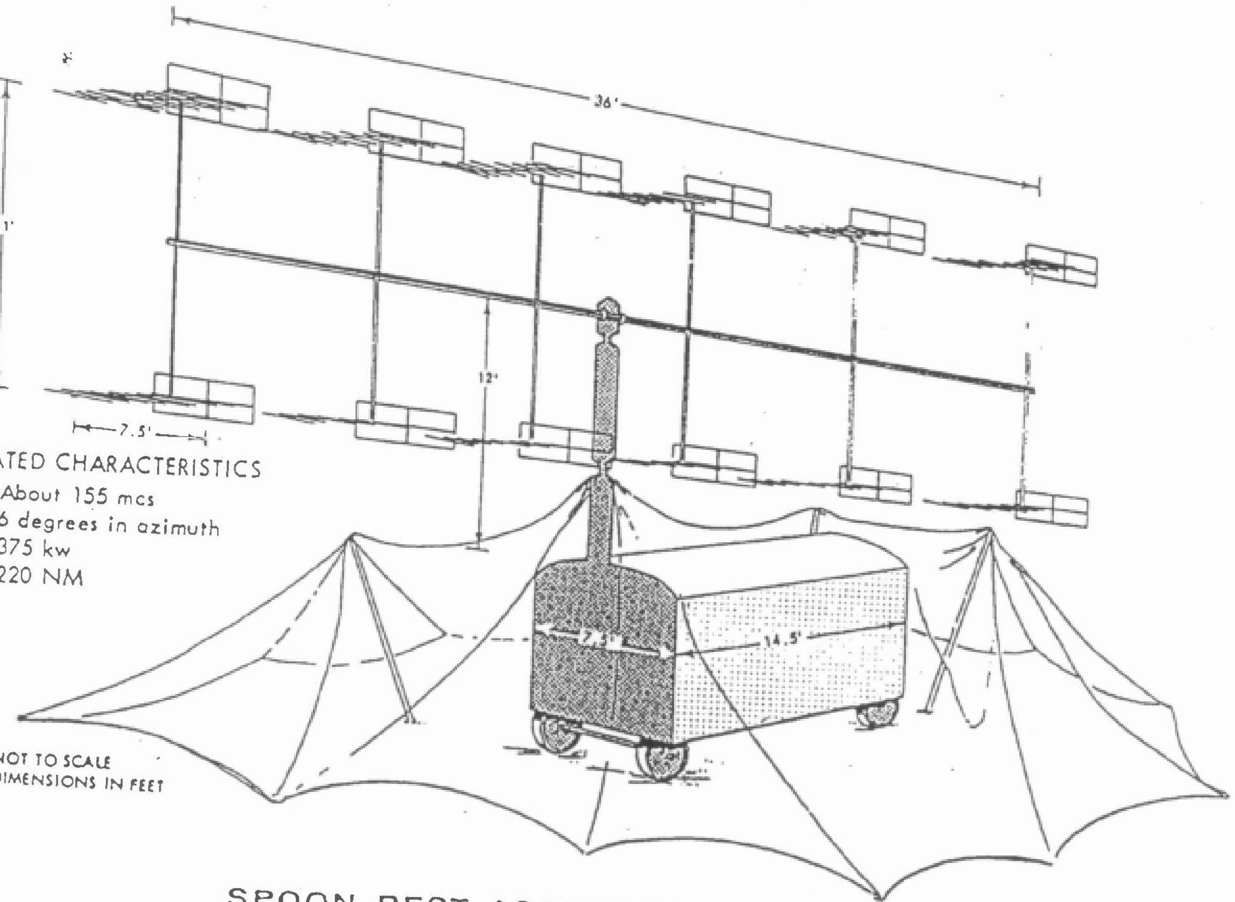


FRUIT SET-ESTIMATED CHARACTERISTICS

Frequency	2 Frequencies in S-Band
Scan Sector in Azimuth and Elevation	12-15 Degrees
Radiated Peak Power	1/2 - 2 Megawatts
Unambigious Range	60 Nautical Miles

"FRUIT SET" FIRE CONTROL RADAR

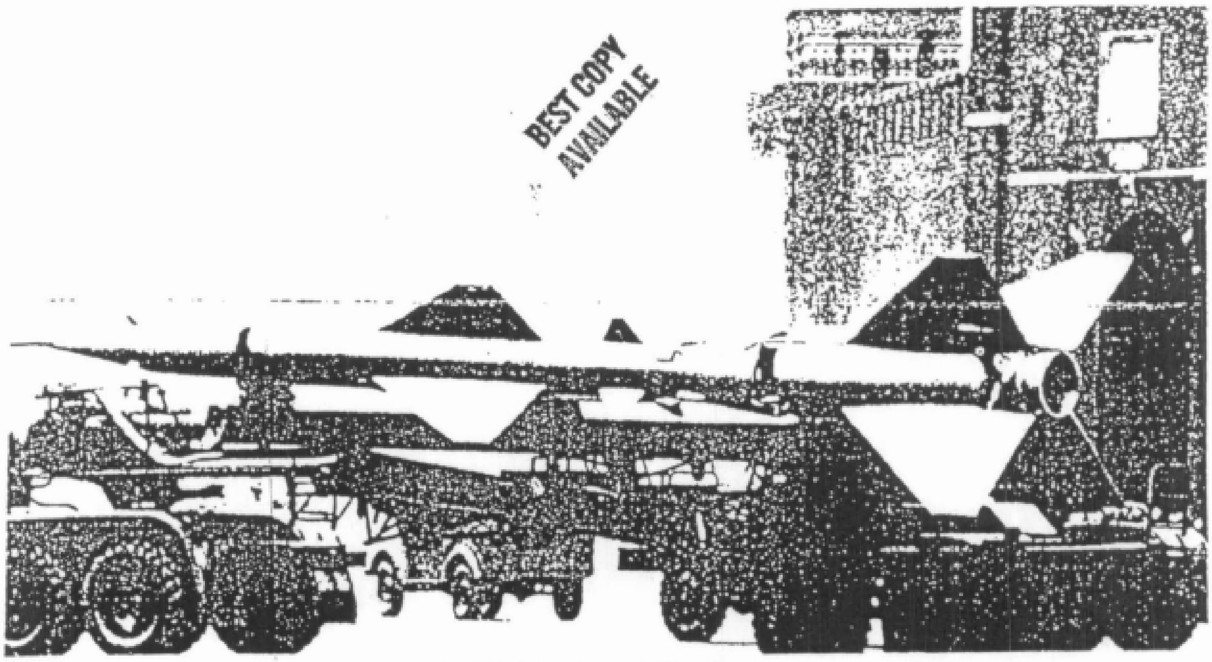
Figure 10



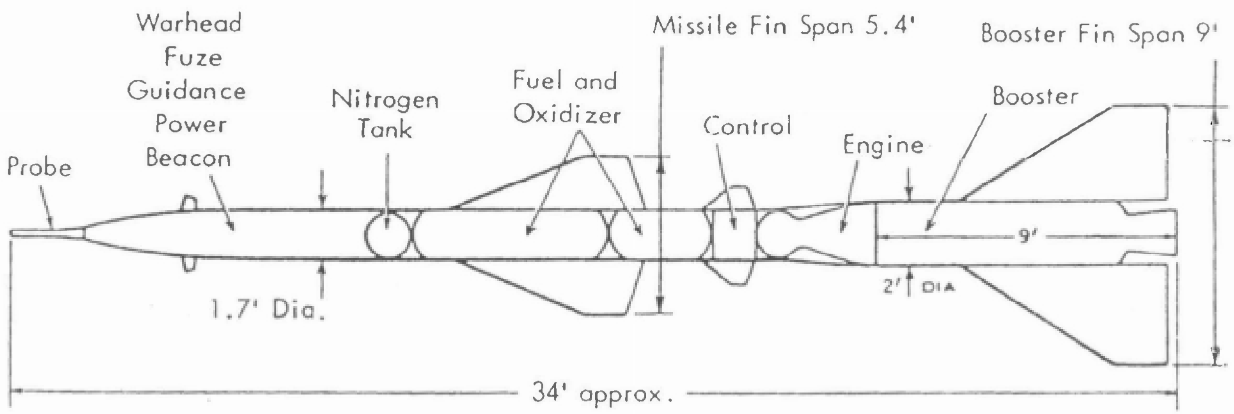
SPOON REST-ESTIMATED CHARACTERISTICS

Frequency	About 155 mcs
Beam Width	6 degrees in azimuth
Radiated Peak Power	375 kw
Range	220 NM

SPOON REST ACQUISITION RADAR



MOSCOW PARADE, NOVEMBER 1957

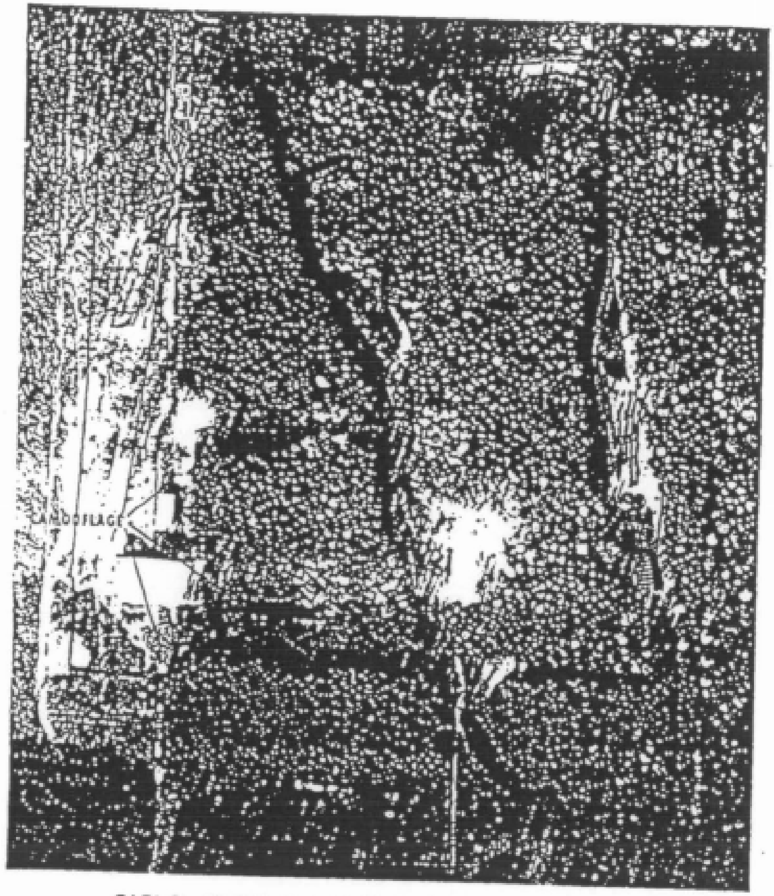


SURFACE-TO-AIR MISSILE (GUIDELINE)

SA-2-ESTIMATED MISSILE SYSTEM CHARACTERISTICS

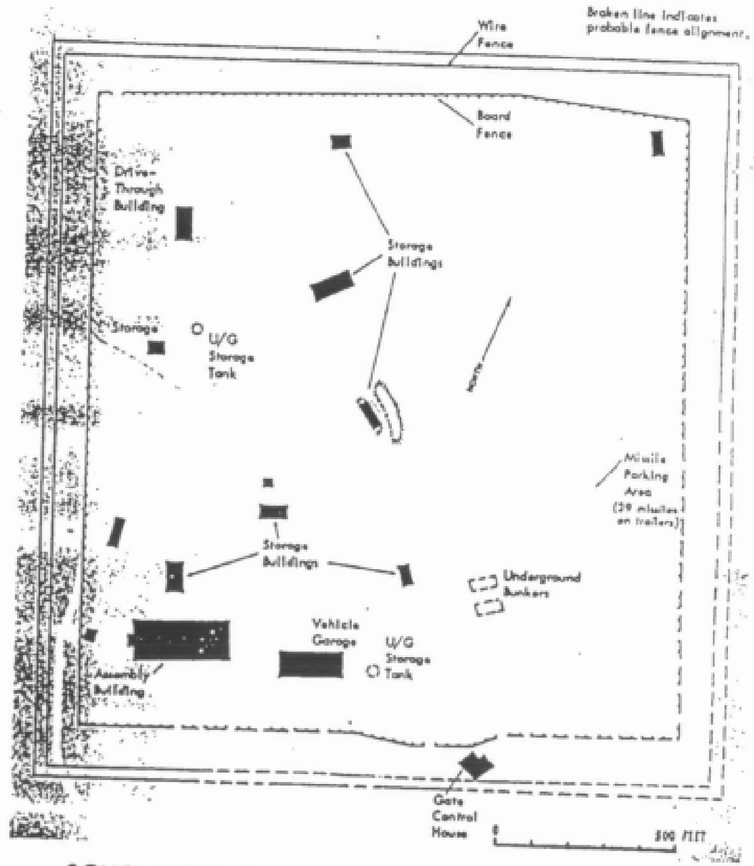
Maximum Intercept Altitude	60,000 - 80,000 feet	Dependent on Target
Maximum Intercept Range	25 - 30 Nautical Miles	Type and Approach
Warhead Weight	500 Pounds	
Maximum Velocity	Mach 3	
Propulsion System		
Booster	Solid Propellant	
Sustainer	Liquid Propellant	
CEP	100 Feet	

SA-2 MISSILE SYSTEM (INCLUDING GUIDELINE MISSILE)



FIELD TYPE SA-2 SUPPORT FACILITY
(LADEBURG, EAST GERMANY)

Figure



SCHEMATIC DRAWING OF FIELD TYPE SA-2
SUPPORT FACILITY (LADEBURG, EAST GERMANY)

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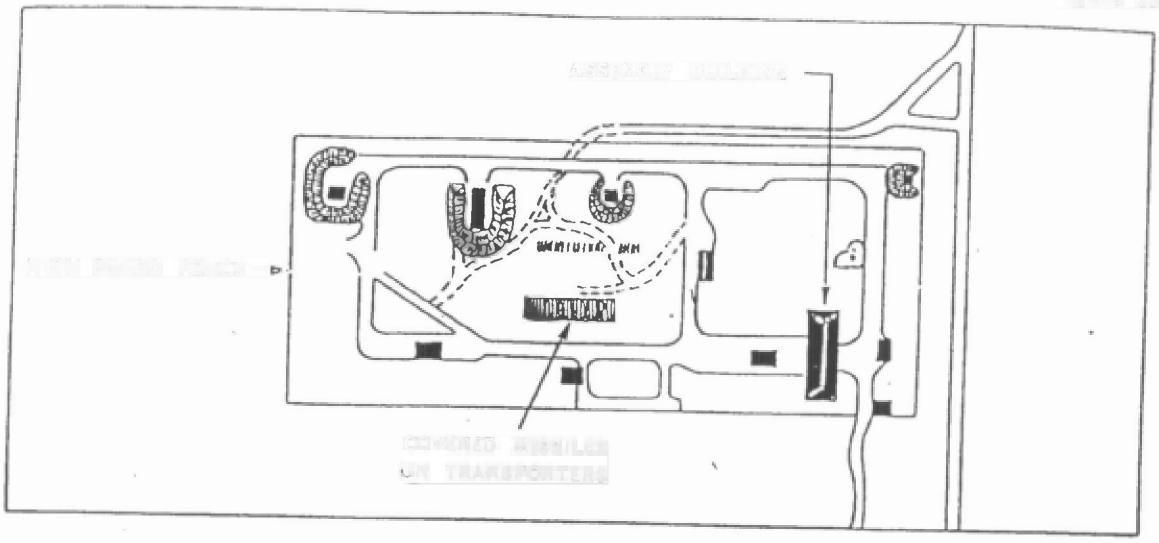
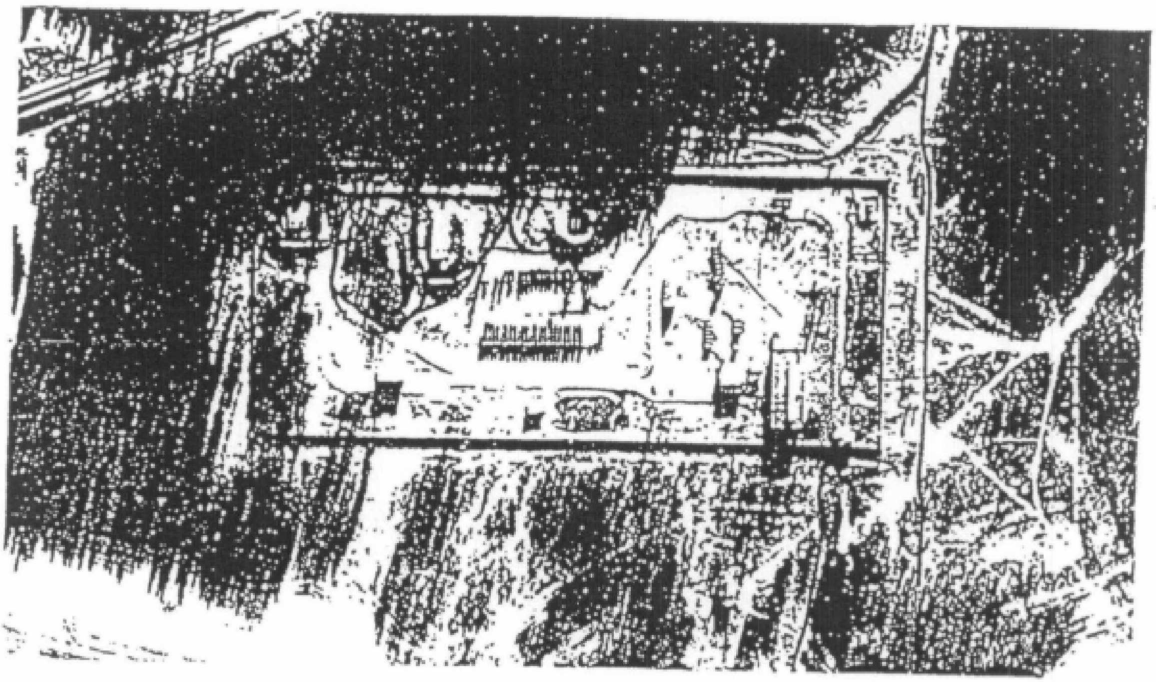
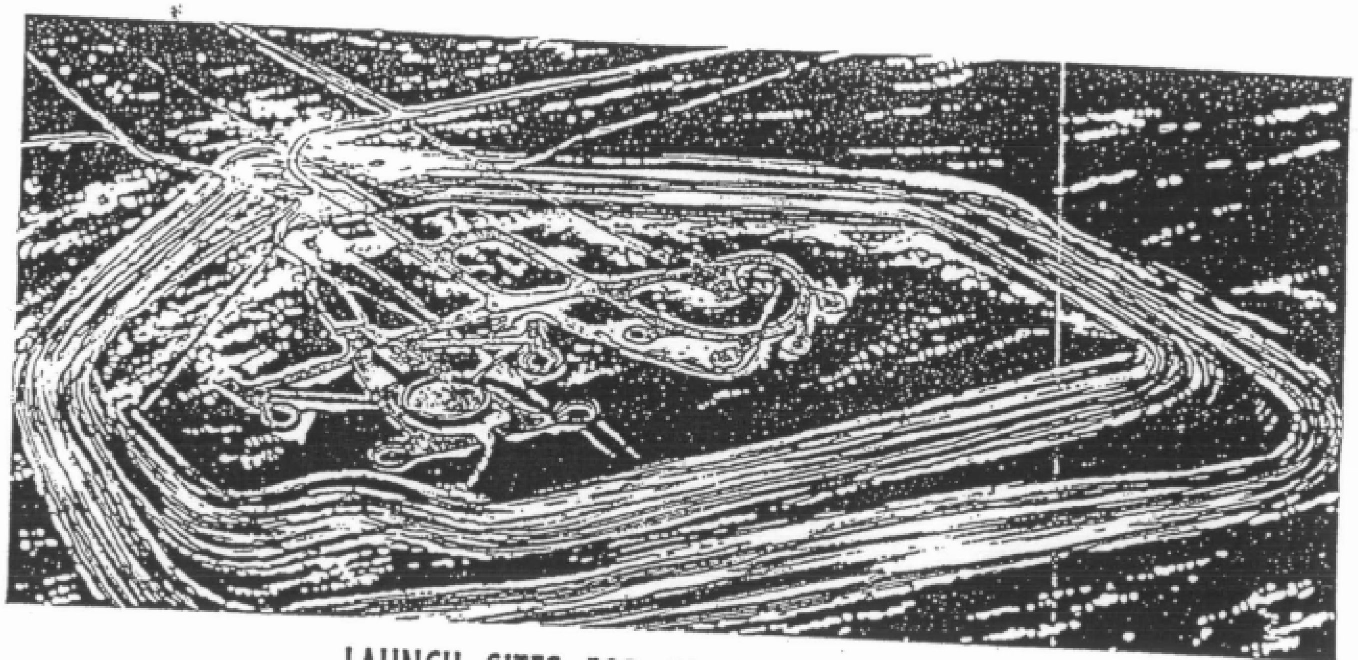
Figure [illegible]





Scale 1 inch = [illegible] feet

PERMANENT SA-2 SUPPORT FACILITY LAY-OUT
(Kuybyshev, USSR)



LAUNCH SITES FOR SA-3 MISSILE SYSTEM
(Kapustin Yar Missile Test Range)

II. SOVIET ANTIMISSILE PROGRAM

49. There is firm evidence that the Soviets are pursuing an extensive and high priority program for the development of defenses against ballistic missiles. Known Soviet interest and studies on this subject date from 1949, and an active research and development program appears to have been underway for several years. Photography of the Sary Shagan area in April 1960 revealed a large, elaborate facility which we believe to be engaged primarily in antimissile work (see Figures 1 and 15). The Sary Shagan area comprises one of the major Soviet guided missile research development and test areas, second only in magnitude to the Kapustin Yar/Vladimirovka complex.

Research and Development Activity

50. This very sizable activity covers some 8,000 square miles and contains housing accommodations for about 20,000 people. Photographic interpretation indicates that there are more than 20 major electronics and communications installations, including seven or more interferometer sites, two 500-foot antennas, a 900-foot building containing an antenna, two 54-foot diameter steerable dish antennas, and a 110-foot diameter radar dome (see Figures 16–19). These facilities are located near the 1,050 n.m. impact area of the Kapustin Yar ballistic missile test range. Close to the impact area are two complexes which contain probable launching sites: launch complex "A" includes two modified SA-2 sites; launch complex "B" contains a concrete pad 300 feet by 120 feet, which appears capable of launching large vehicles, and two semicircular concrete sites which may be launching pads of a new type (see Figure 20). Some of the facilities at Sary Shagan are three or four years old, and extensive construction work is still in progress.

51. The Soviets have installed some comparable facilities in the Uka area of the Kamchatka Peninsula not far from the ICBM impact area near Klyuchi (see Figure 21). Construction at Uka has lagged behind that at Sary Shagan by a year or two and the installation is small by comparison. Our evidence indicates that it includes one 54-foot dish, one 110-foot dome, and one interferometer. There are other instrumentation sites in the vicinity to monitor ICBM test shots to the area, and these may also contribute to antimissile research.

52. The Soviets have been collecting basic data useful for development of an antimissile system for several years. Since 1957, firings into the highly instrumented impact area at Sary Shagan have included about 100 ballistic missiles of 1,100 n.m. range, and probably a lesser number of shorter range missiles. The impressive array of facilities at Sary Shagan appears designed to investigate phenomena associated with mid-course and terminal phases of the trajectories of these missiles. Collection of similar data on the ICBM is presumably accomplished by the facilities on Kamchatka, but it is probable that considerably less data on the ICBM has been collected.

53. We believe that this investigative effort is directed toward development of a terminal intercept system. The possible launching sites, drive-through building, facilities for handling explosives, and buildings which might be used for missile fabrication or assembly, all indicate that the antimissile system under development at Sary Shagan employs a missile as the intercept vehicle. Considering Soviet state-of-the-art and the requirements imposed by the nature of the system, we believe that the intercept vehicle will be a multiple-stage surface-launched missile probably using a solid propellant booster. Judging from past Soviet practice with surface-to-air missiles, we believe that command guidance will be employed.

54. The missile probably will be equipped with a nuclear warhead.[7] At present, such warheads appear to offer the best promise for destruction of incoming ballistic missiles. Two of the nuclear devices tested by the USSR in 1958 might lend themselves to antimissile defense applications. We have no evidence of Soviet nuclear tests at very high altitudes (above 30,000 feet or in space) and believe that

[7] Annex E, "Estimated Present Nuclear Warhead Capabilities." (Limited Distribution)

they lack basic effects data on high altitude and space detonations. However, we do not believe that the lack of such data would prevent Soviet deployment of a suitable nuclear warhead for an antimissile missile.

Major Electronic Components

55. The electronic components of a terminal intercept system must be capable of the following: detecting a target; acquiring it; distinguishing or "discriminating" a missile nosecone from tankage and decoys; and tracking the nosecone as well as guiding and tracking the antimissile missile. It is not clear which of several possible approaches to this complicated problem the Soviets have selected. The precise role of each of the large radar installations at Sary Shagan has not been determined. Nor, because of the other missile and space activities conducted at and near Sary Shagan, is it certain that all of these are involved in antimissile work. From the analysis of the facilities at Sary Shagan, two broad hypotheses have emerged, one pointing to a concept employing several electronics installations, the other to a single-installation concept.

56. Under the multiple-installation concept, the major radar installations at Sary Shagan would be employed in combination to perform the electronic functions of an antimissile system. As an alternative hypothesis, it is possible that the Soviets are seeking to accomplish all the radar functions of an antimissile system with a single installation as they did in the case of the SA-1 and SA-2 antiaircraft systems. In the first hypothesis, acquisition and tracking could be accomplished by equipment with electronic components essentially complete for beginning of electronic test checkout in 1960. In the second hypothesis, the radar in the 900-foot building is the critical component and an important factor in determining the status of the program. Photography of April 1960 revealed that although the building shell itself appeared to be completed, the installation as a whole was still under construction. Testing will probably begin this year, and about two years probably will be required to complete tests of such a complex installation.

57. Admittedly, these two hypotheses do not cover the entire range of possibilities. Indeed, the widespread and diverse Soviet activities which we have observed may represent developmental programs on more than one type of antimissile system, and it is logical to suppose that the Soviets have done at least preliminary work designed to cope with the various ranges of Western ballistic missiles confronting them. Some of the installations and activities at Sary Shagan have been connected with work on a system designed for defense against short range ballistic missiles. But the fixed nature of the installations and the general progression of the activities towards work with longer range missiles leads us to believe that the primary R and D effort has been directed against IRBMs and ICBMs.[6]

Milestones in the Program

58. We believe that at the present time, the Soviets are well advanced in a program to collect basic data, conduct technical investigations, and test antimissile system compo-

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[6] The Assistant Chief of Staff for Intelligence, Department of the Army, believes that the available evidence permits more detailed understanding and estimates of the antimissile systems under development at Sary Shagan and Uka than is reflected in this analysis. Based on this evidence he believes that there are three different, but interrelated development efforts:

a. Defenses against short and medium range ballistic missiles (up to about 1,000 n.m.) which can be deployed by 1963. Evidence indicates that integrated systems tests began for one such system in late 1960. Development on these defenses is believed to be supported by one AMM launch complex at Sary Shagan and two subordinate target missile launch areas—one for 350 n.m. missiles and one for 700 n.m. missiles. The AMM launch complex contains two modified SA-2 sites, which indicates the use of mobile systems in defenses against short range ballistic missiles.

b. Multiple-installation, fixed-position defenses against IRBMs and ICBMs which can be deployed during the period 1963-1965. Based on target missile firing rates and other evidence, systematic testing of components for this system probably began in March 1959. Proving of these components against the ICBM probably began at Uka in January 1961.

c. Advanced investigations to improve AMM system equipment against all types of missile and space threats. The single installation concept is considered to be only one of these advanced investigations.

nents. Antimissile missile tests and integrated systems tests may have occurred in late 1960 or early 1961. Such tests at that time would lend support to the multiple installation hypothesis. In the single installation hypothesis, integrated system tests could not be conducted until the period mid-1962 to mid-1963.

59. The timing of the first Soviet deployment of an antiballistic missile system will be determined mostly by the current status of the testing program, its future progress, and degree of success. However, this timing could probably be accelerated by an early Soviet decision that the system then being tested would prove to be satisfactory for operational use. Such a decision must be reached a few years before an operational capability is achieved. If the Soviets are confident that their present approach will in fact result in a workable antimissile system, and if they attach great urgency to early deployment, they can accelerate this deployment by starting site construction and the production of components before they resolve all the technical problems, as they did in the case of the SA-1 antiaircraft system. Among the most serious of these problems is that of achieving the flexibility and discrimination to cope with the numerous, widely dispersed ballistic missiles of various types and ranges which the West will possess within a few years, including types with sophisticated nosecones and penetration aids.

60. We have no basis for a firm estimate for the date of the first operational deployment of a Soviet antiballistic missile system, or of its effectiveness against the various types of Western ballistic missiles. Judging by the activities at Sary Shagan and Uka, we believe that a system designed for use against both ICBMs and IRBMs could first be deployed in the period 1963–1966. The earliest of these dates is contingent upon a Soviet decision to assume the high risks of starting production and deployment prior to full system tests, and therefore is considered the earliest possible date. If deployed early in the period, the capability of the system against IRBMs probably would be the more thoroughly tested. It should be noted that continuing success in research and development will be necessary if the USSR is to achieve *any* operational antiballistic missile capabilities in 1963–1966. It is unlikely that systems which could be deployed during this time period would have discrimination capabilities against sophisticated decoys.

61. We believe that the Soviets would wish to deploy antimissile defenses for the protection of at least a few critical areas, even if the available system provided only an interim, limited capability. Such a course would be consistent with the high priority they have accorded to improving their defenses against Western nuclear strikes. Moreover, the early deployment of an antimissile system, even if its effectiveness were limited or uncertain, would almost certainly be regarded by the Soviets as having great political impact and as weighing significantly in the world balance of forces. We therefore estimate that the USSR will probably begin at least limited deployment of an antiballistic missile system in about 1963–1966.

62. Soviet research and development in antimissile defense, perhaps including unconventional techniques, will undoubtedly continue as long as there are ballistic missiles. The Soviets almost certainly will design their first system in such a way that improved components can be incorporated as they become available. Improvements might include introduction of a better intercept vehicle or better discrimination techniques. A discrimination capability against targets outside the atmosphere probably could not be achieved until sometime after 1966.

Antisatellite System

63. For some time to come, the Soviets are likely to have only a marginal capability under most favorable conditions for interference with US satellites. Even detection and tracking in the early orbits of any satellite will be difficult, especially so if the satellite is dark, unannounced, or camouflaged. It will also be difficult for the Soviets to identify the function of such a satellite. In the course of its program to develop an antimissile missile sys-

tem, the USSR could achieve a limited capability to destroy such vehicles after they have made a number of orbits. This could probably be accomplished from the Sary Shagan area in about 1963, against satellites with relatively low orbits. With an extensive effort, it might be accomplished sooner with a nuclear-armed 700 or 1,100 n.m. missile launched on collision course from a test range if the orbital parameters were established. The published information on US programs probably will provide incentive for Soviet development of antisatellite capabilities. However, we do not believe that the USSR will have a system for destruction of satellites on their first orbit until the latter part of the decade.

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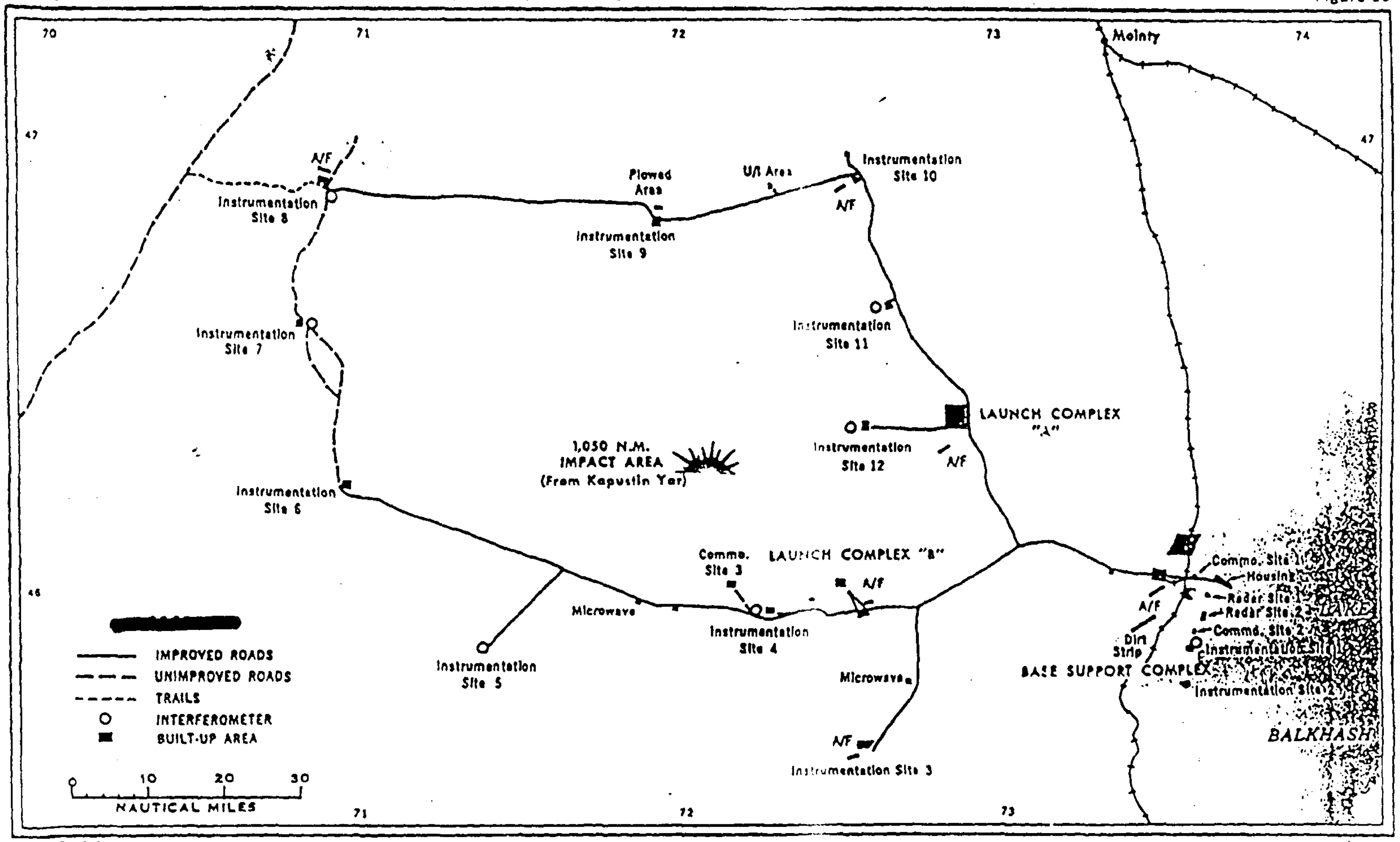
SARY-SHAGAN ANTIMISSILE DEFENSE TEST CENTER

Figure 15



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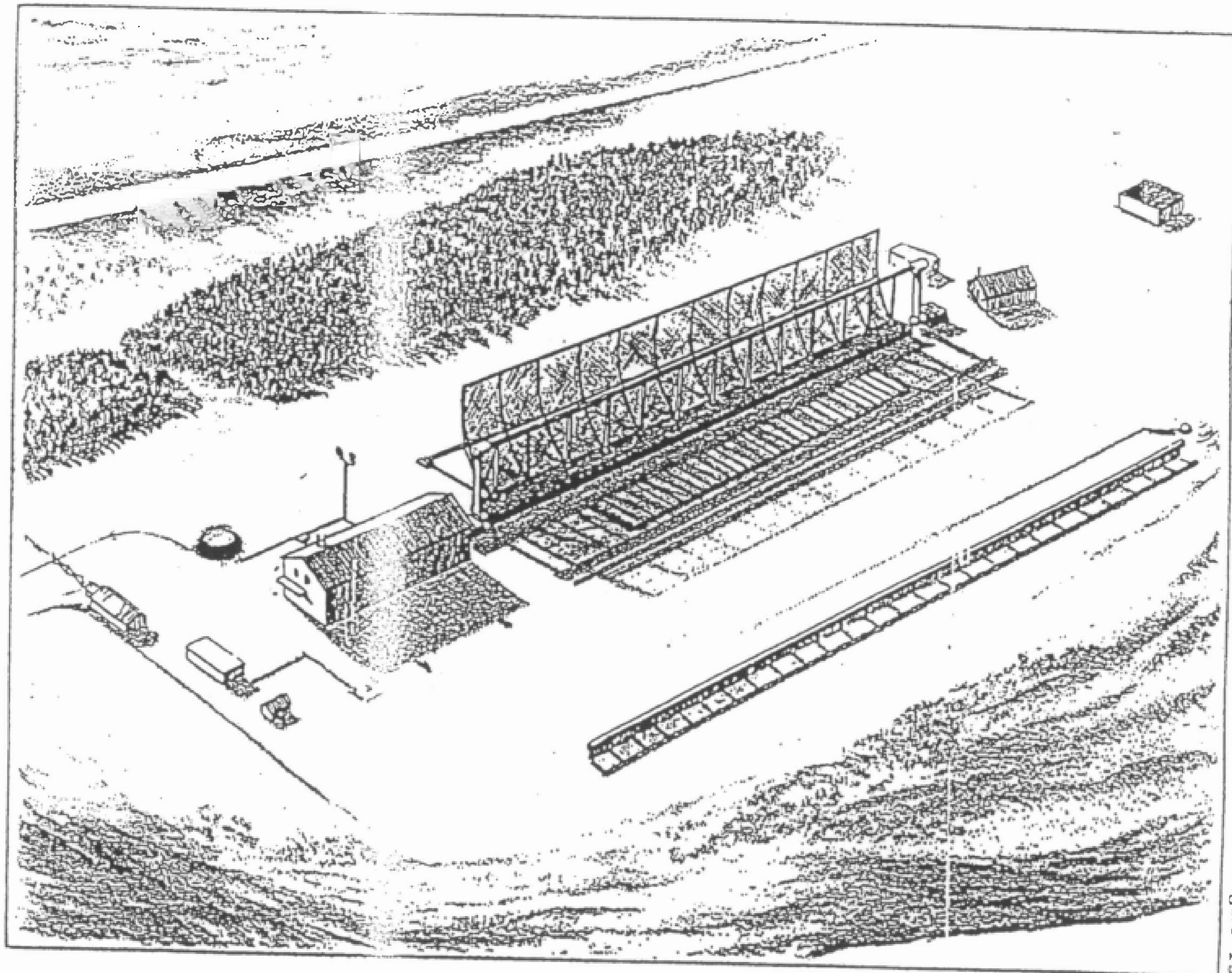

Figure 16

500 FOOT ANTENNA (Nicknamed "HEN ROOST")
SARY SHAGAN Radar Site No. 2

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Figure 17

900 FOOT BUILDING (Nicknamed "HEN HOUSE")
SARY SHAGAN Radar Site No. 1

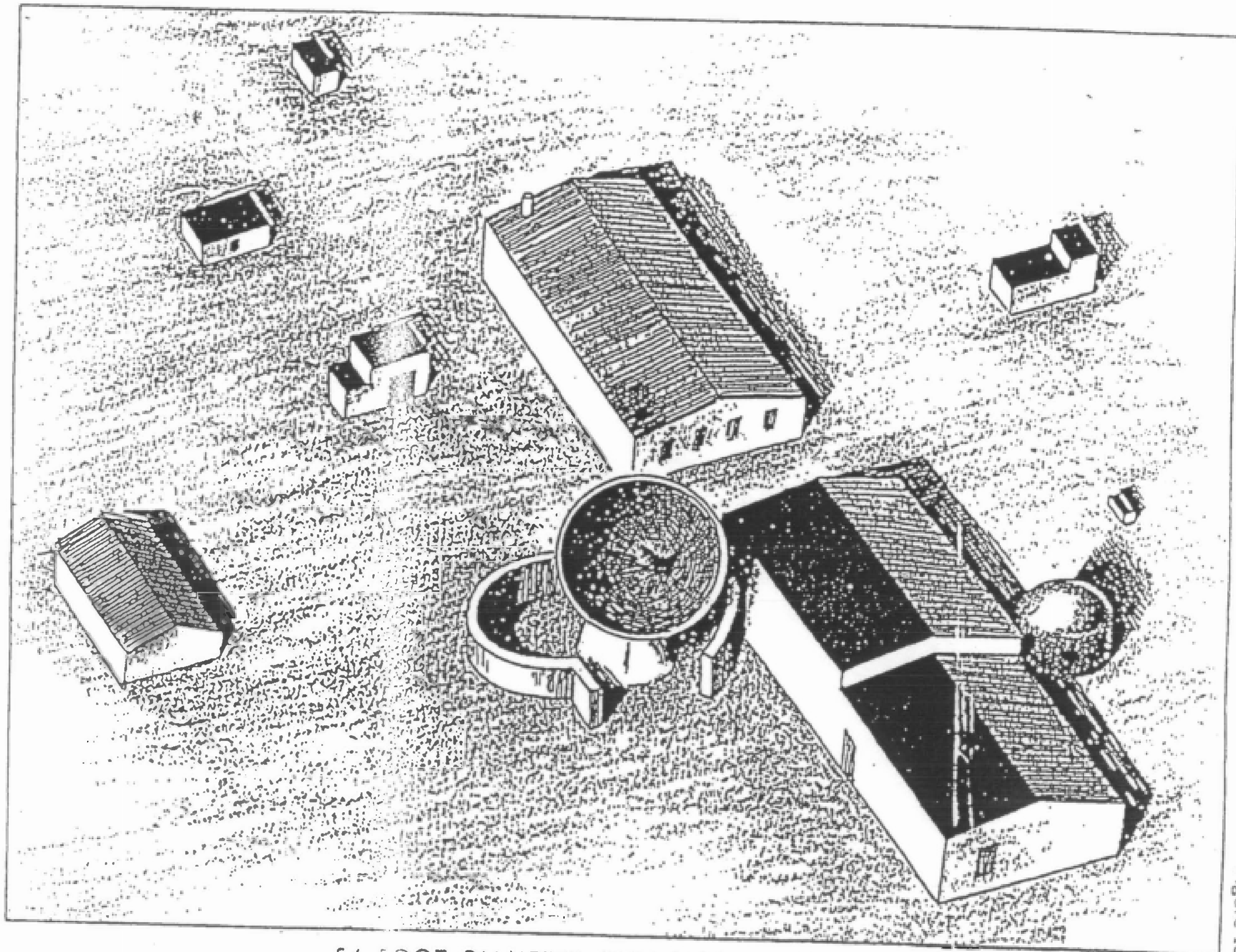

Figure 18

54 FOOT DIAMETER DISH (Nicknamed "HEN NEST")
SARY SHAGAN Instrumentation Sites Nos. 3 and 10

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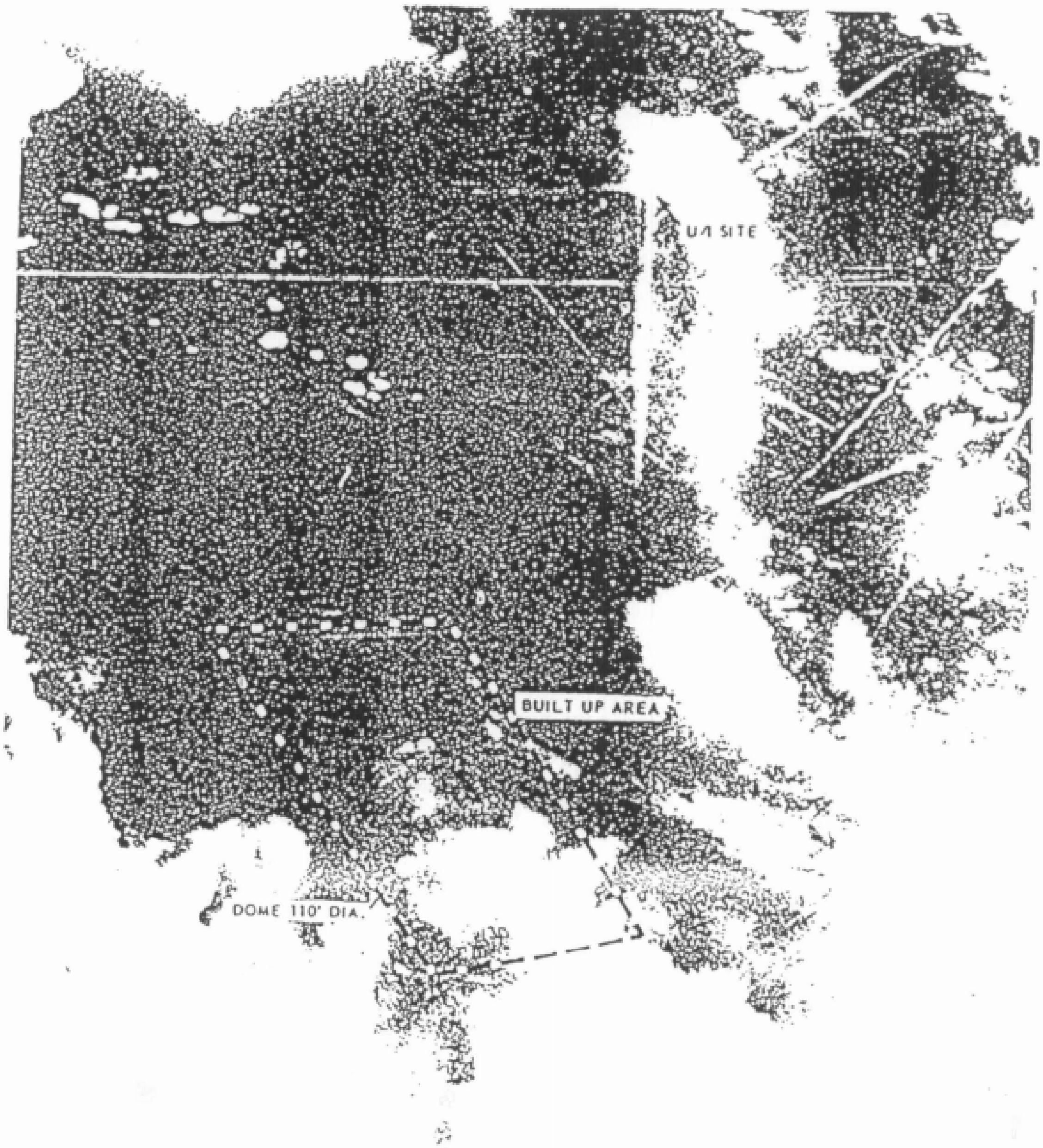
Figure



110 FOOT DOME (Nicknamed "BEN HUR"
SARY SHAGAN Instrumentation Site No. 4

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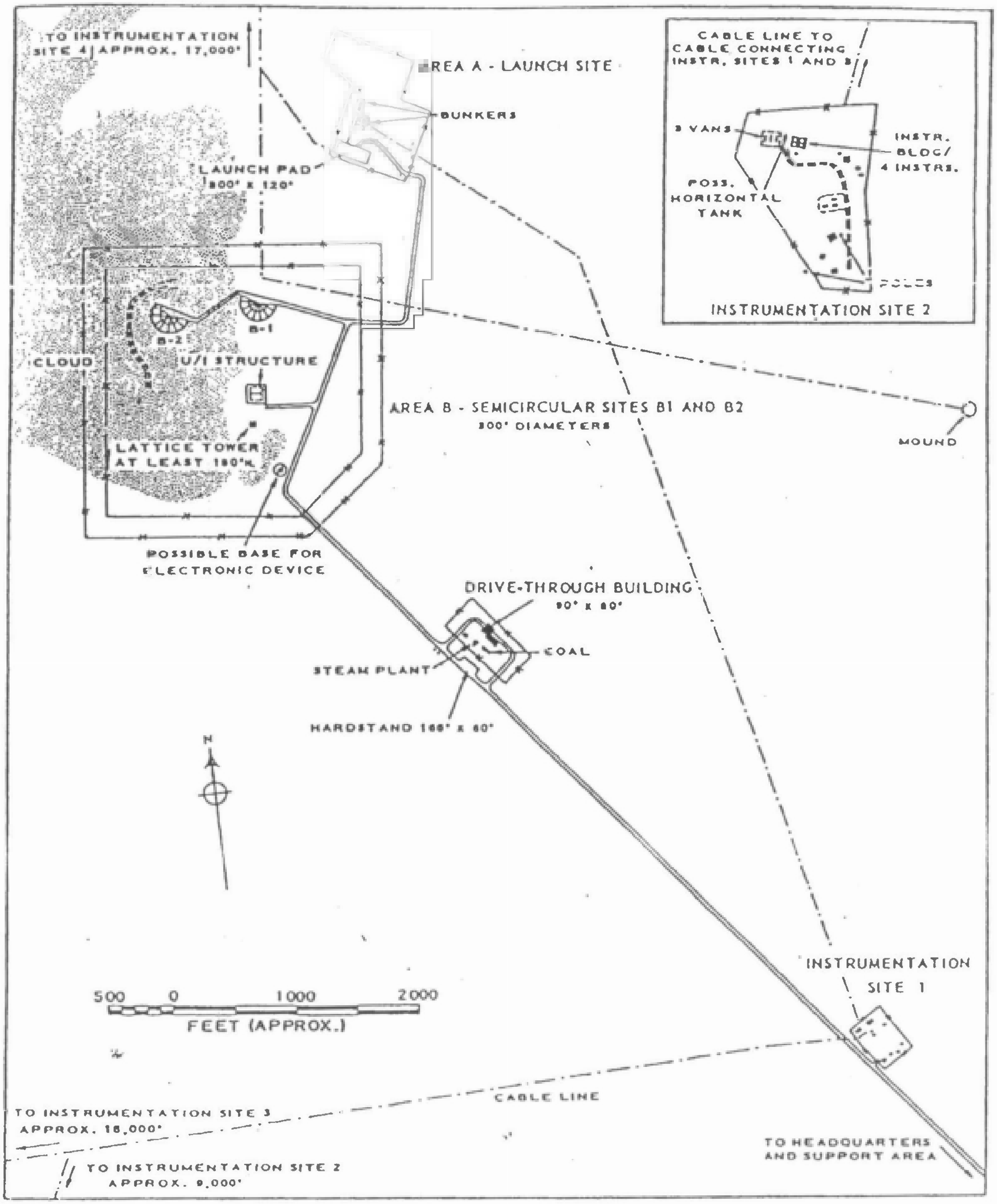
Figure 20



MISSILE LAUNCH COMPLEX B, SARY SHAGAN

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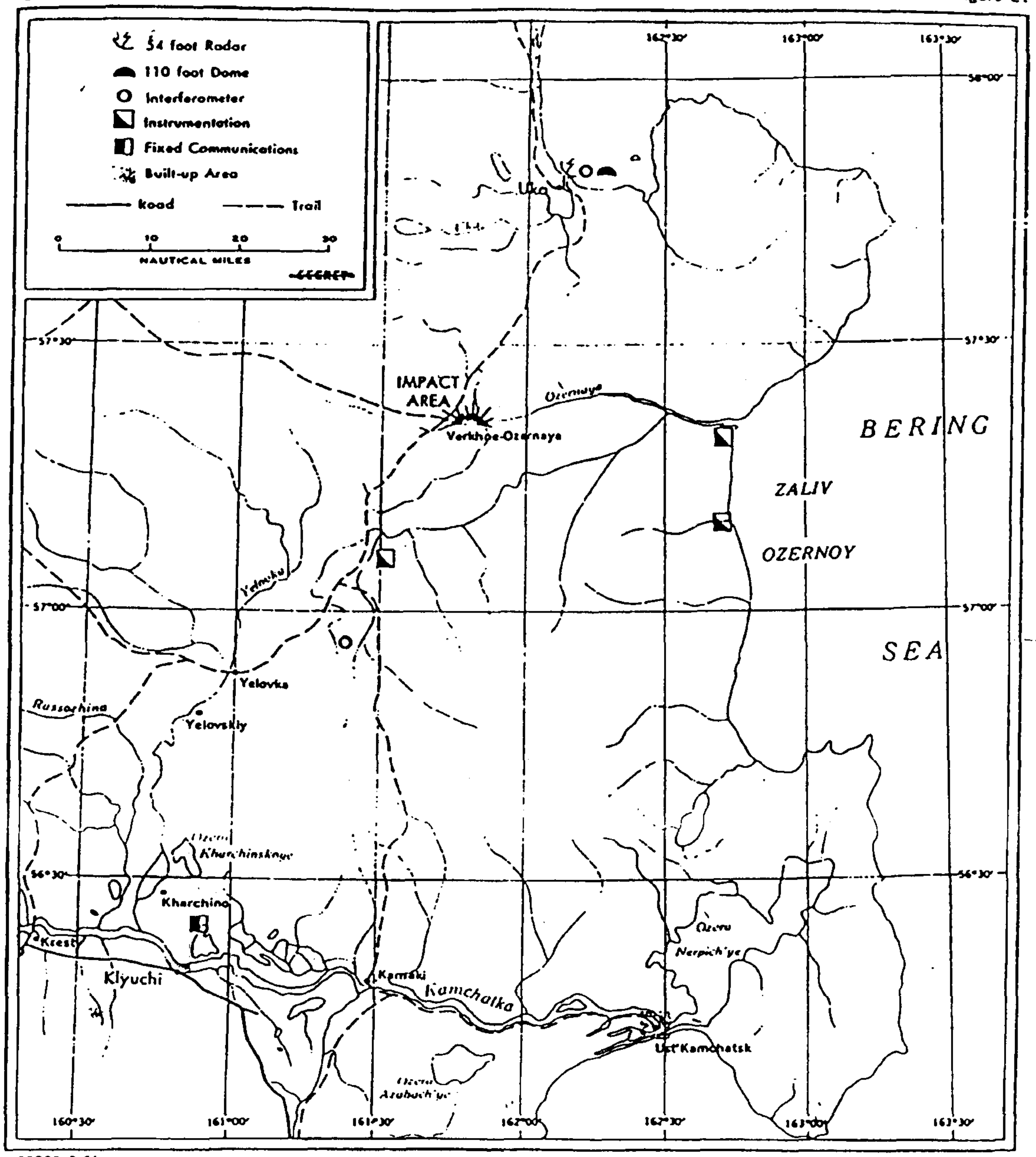
KAMCHATKA PENINSULA ICBM IMPACT AREA

Figure 21



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III. AIR-TO-AIR MISSILES

64. Evidence on Soviet development of air-to-air missiles is largely limited to reports of early experimental work on a radar beam rider missile. According to German returnees who had worked on the project, this missile, designated "ShM" by the Soviets, was under development in 1952. Testing of air-to-air missiles probably is carried on at the Vladimirovka test range (see paragraph 70).

65. In the past two years, we have received considerable evidence on the deployment of air-to-air missiles. Some Soviet fighters in the USSR and East Germany are believed to be equipped with a radar beam rider missile and to have engaged in operational training. Missiles using infrared guidance principles probably are also operationally deployed in the USSR. There is good evidence that European Satellite air forces are being equipped with the beam rider missile, and there are some indications of the introduction of air-to-air missiles into the air force of Communist China.

66. The beam rider missile probably is now standard armament for the FARMER E fighter. This aircraft may also be equipped with infrared homing missiles for use in clear weather. There are indications that some of the new Soviet fighter types—FITTER, and possibly FISHBED C and FISHPOT—are armed with air-to-air missiles. The type of missile has not been determined.

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

a. AA-1 (Soviet designation "ShM-122")—This radar beam rider is probably an improved version of the original "ShM" missile. It has a range of 2.5 n.m. and is limited to use with suitably modified all-weather fighters. Operational limitations will probably cause this missile to phase out after the next few years.

b. AA-2—A short range infrared homing missile limited to tail attack under clear air mass conditions.[9] It is usable with most interceptors including day fighters. Its range varies from one n.m. with day fighters to about four n.m. with all-weather fighters.

c. AA-3—On the basis of requirements, early German reports, and Soviet technical capability, we believe that the Soviets at one time had under development a semiactive radar homing missile with a range of about three to six n.m. for use with all-weather fighters. We estimate that such a system is now operational, but there is no evidence of its deployment.

68. Soviet development of improved air-to-air missiles over the next few years is contingent upon trends in Soviet fighter and Western bomber forces and in Soviet surface-to-air missile defenses. Improvements could include more sophisticated guidance, longer ranges, and larger payloads (including nuclear). Our present estimates of the nuclear weapons available in the Soviet stockpile do not include a warhead of a size and weight suitable for air-to-air missiles, although the possibility cannot be excluded that the Soviets have developed a warhead for such use.[10] The need to safeguard the pilot from nuclear effects would require a missile of considerably longer range than any estimated to be now available.

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[9] 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.

[10] Annex E, "Estimated Present Nuclear Warhead Capabilities." (Limited Distribution)

IV. AIR-TO-SURFACE MISSILES

69. Soviet air-to-surface missile (ASM) development began shortly after World War II when the USSR acquired a number of German ASMs as well as the technicians who had designed them. By 1949, the German team had developed a guidance system known as the "Komet" which was incorporated in the first Soviet ASM. We do not know when the testing of this system began. [ ]

70. For the most part, testing of Soviet airborne missile systems is carried on from the Vladimirovka rangehead (see Figure 22) which is adjacent to the Kapustin Yar rangehead. Research and development on large aerodynamic missiles is also centered at Vladimirovka (see paragraph 97, page 23). Facilities at Vladimirovka associated with airborne missile development include an airfield complex with facilities for assembly, checkout, and loading of ASMs and possibly AAMs.

AS–1 System

71. We believe that the first Soviet air-to-surface missile (AS–1) became operationally available in 1956–1957. It is now standard equipment in most naval BADGER units. This is a subsonic missile with a speed of about Mach 0.8 and a maximum range of about 55 n.m. It can carry an HE or nuclear warhead of about 3,000 pounds, and has a CEP of about 150 feet against well-defined radar targets. The characteristics of the "Komet" guidance system, a beam rider with semiactive homing, limit its employment primarily against ships at sea. However, it is believed to have some limited application with degraded accuracy against coastal targets.

72. Originally designed to be carried by the BULL (TU–4), the AS–1 imposes certain limitations on the BADGER (TU–16) jet medium bomber, which is now used as the launching aircraft. The missile must be carried externally, and in launching the BADGER must fly at an altitude of about 15,000 feet at greatly reduced speed. Under these conditions, the BADGER's operational radius is reduced from about 1,800 n.m. to about 1,250 n.m. with one missile or to about 1,000 n.m. with two. This radius can be increased by about 35 percent by a single aerial refueling.

AS–2 System

73. The limitations of the AS–1 system, which increase the vulnerability of the launching aircraft, probably have led the Soviets to develop a follow-on system primarily for use against ships. This system, the AS–2, probably became operational in late 1960 or early 1961. We estimate that it is capable of delivering a 3,000 pound HE or nuclear warhead to a maximum range of 100 n.m. at low supersonic speed.

74. We do not know which of several possible guidance systems is employed by the AS–2. The missile might be guided to the target by radar on the launching aircraft; it is also possible that a simple inertial or preset system is utilized. We believe that the system would use radar terminal homing against ship targets giving it an estimated CEP of 150 feet. Against coastal targets, where homing is not employed, the CEP would be about one n.m. The BADGER is the most likely carrier for the AS–2, and the system probably imposes little if any restriction on the aircraft at launch, although operational radius would be somewhat reduced.

AS–3 System

75. We believe that improvements in Western air defenses have led the USSR to provide its bombers with a more extended stand-off capability. Concurrently with the AS–2, the Soviets probably developed a longer range air-to-surface missile system, the AS–3, to become operational in late 1960 or early 1961, which can deliver a 3,000 pound HE or nuclear warhead to a maximum range of about 350 n.m. We believe that the missile is powered by a turbojet engine, and that it would cruise to the vicinity of the target at altitudes of 45,000–50,000 feet and speeds of Mach 1.5–2.

76. Because of its concurrent development with AS–2 and its greater range, we believe that the AS–3 was designed primarily for use against land targets. With all-inertial guidance, its CEP against such targets would probably be about 1–2 n.m. If used against ships, the AS–3 probably would have to employ in addition a radar terminal homing guidance system which would give a CEP of about 150 feet. In this case, however, either its range would have to be reduced or other aircraft or ships would be required to aid in detection, acquisition, and identification of the target, and possibly in guiding the missile.

77. The AS–3 probably was designed for use with the BEAR and BISON heavy bombers. We estimate that the AS–3 weighs about 9,000–10,000 pounds. The BEAR or BISON could carry two on an operational mission. 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. It is possible that the BADGER could carry this missile, but we believe it unlikely that the BADGER would be employed in this role.

78. The Soviets are also capable of developing air-to-surface missiles designed to home on radar transmitters and air-launched decoys to simulate medium or heavy bombers. These systems could now be operational, but there is no evidence of their development.

Future Developments

79. We believe that the USSR has a requirement for and may develop during the period of this estimate an air-launched missile with a maximum range of 500–1,000 n.m. and a higher survival potential than the AS–3. Either a ballistic or a cruise type missile might be developed to meet this need, and we are unable to estimate its characteristics at this time.

V. GROUND-LAUNCHED SURFACE-TO-SURFACE MISSILE SYSTEMS (EXCEPT ICBM)

80. We have more extensive evidence on the development of ballistic missiles in the USSR than on any other Soviet missile program. There have been numerous reports from German returnees who participated in the early phases of this program. Continuing and valuable information, [redacted] has been derived from observation of test activity at the Kapustin Yar range; many hundreds of ballistic missile firings have been detected.[11] The range itself has been extensively photographed. This large body of evidence enables us to estimate the progress of the Soviet development programs with considerable assurance, although our confidence in the details varies.

81. The Soviet program, conducted at high priority since World War II, has been well-coordinated, extensively supported, and staffed with capable personnel. Missiles known to have been developed or to be under development at Kapustin Yar include those with maximum ranges of about 150 n.m., 350 n.m., 700 n.m., 1,100 n.m., and 2,000 n.m. The reliability, accuracy, and other performance characteristics of these missiles are generally good. We believe that in the development of these systems maximum use has been made of proven components. The two active Soviet ballistic missile test ranges (Kapustin Yar for missiles up to 2,000 n.m. range and Tyuratam for ICBMs and space vehicles) probably have been mutually supporting with respect to component testing and experience.

82. The Kapustin Yar range extends from the rangehead, located about 60 miles east of Stalingrad, generally to the east for approximately 1,100 n.m. In 1960, a new line of fire was established to an impact area located about 2,000 n.m. from the rangehead and 500 n.m. west of Lake Baikal (see Figures 1 and 22). Testing of missiles began at Kapustin Yar in the fall of 1947. By the end of 1949, construction of permanent facilities had begun and the range probably had been extended to 350 n.m. The continued growth of the range has been confirmed by photography which shows that facilities almost doubled between 1957 and 1959. For surface-to-surface missiles, there are now over half a dozen research and development launching sites and more than 30 simpler sites used for troop training (see Figure 23). A bivouac area capable of accommodating 8,000 troops is located near these sites.

83. We believe that all short and medium range missiles (up to 1,100 n.m. range) have been produced for several years. A former automotive plant in Dnepropetrovsk probably produces propulsion systems for the 350 n.m., 700 n.m., and 1,100 n.m. missiles, and it may also be engaged in airframe production and final assembly of these missiles. However, we cannot determine the mix of missiles or the magnitude of the production program currently underway at this plant. No production facility can be associated with the 150 n.m. missile production. We have no evidence that the 2,000 n.m. missile is in production. Prototypes and test vehicles for this program probably are made at Plant No. 88, Kaliningrad, which has been the center for Soviet development of ballistic missiles since 1946. This plant probably also manufactured the initial lots of developmental 700 and 1,100 n.m. missiles and ICBMs, including boosters for space vehicles.

84. In general, we believe that for missiles with maximum ranges of 350 n.m. or less, HE, nuclear, or CW warheads will be employed depending upon nuclear stockpiles, missile accuracy, character of the target, and results desired.[12] 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

[11] For a detailed account of ballistic missile activity at Kapustin Yar, see Annex F, "Soviet Missile Test Range Activities." (Limited Distribution)

[12] For a discussion of warhead yields, see Annex E, "Estimated Present Nuclear Warhead Capabilities." (Limited Distribution)

no specific evidence relating BW and missiles research and development. In view of operational considerations we consider BW use in ballistic missiles unlikely, although possible for certain special purposes.

85. 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 1,100 n.m. and less. The size and weight of the 700 and 1,100 n.m. missiles may be such as to limit road mobility to selected first class roads. In the case of road mobile systems, it is probable that missile carriers and support vehicles are readily adaptable for rail transport. The ICBM, and probably the IRBM, are designed to be launched from fixed positions, and would be heavily dependent on the Soviet rail net.

SS–1: 150 n.m. Ballistic Missile System

86. After World War II, the Soviets began production of V–2 type missiles and initiated firings at Kapustin Yar in 1947. This missile program appears to have been dropped, however, and has been succeeded by a second generation short range missile which uses storable liquid propellants. We estimate that this missile, nicknamed SCUD and designated SS–1, became operational in 1957. Recent reanalysis of photographs of the SCUD, which was displayed in 1957 and 1960 Moscow parades (see Figure 24), indicates that it probably has a maximum range of 150 n.m. instead of the previously estimated 75 n.m. A comparison of the relative volumes of the separate fuel tanks indicates that the missile could utilize nitric acid and a kerosene type fuel. We estimate that the SCUD carries a 1,500 pound payload and has a CEP of about ½ n.m. Its guidance system probably is of the radio-inertial type, but could be all-inertial.

SS–2: 350 n.m. Ballistic Missile System

87. The Soviet Union has also developed a surface-to-surface ballistic missile (SS–2) with a range of 350 n.m. This missile is probably based on the German-designed R–10 and the Soviet-designed Korolov missile, both of which incorporated an engine using nonstorable liquid fuel and delivering about 75,000 pounds thrust. Since 1949, the Soviets have probably fired several hundred missiles to this range. The SS–2 probably reached an initial operational capability in 1954. It probably employs radar track-radio command guidance providing a CEP of about ¾ n.m. Warhead weight is estimated at about 2,000 pounds. Within about the next year, the Soviets probably will have a follow-on system with improved operational characteristics.

SS–3: 700 n.m. Ballistic Missile System

88. The USSR has developed a medium range ballistic missile system with a range of about 700 n.m. nicknamed SHYSTER and designated SS–3 (see Figure 25). A total of about 150 missiles of this range have been fired. Firings are still occurring at the Kapustin Yar range, some for troop training, some for other purposes. We estimate that the SS–3 became operational in 1956. Some SHYSTERs are probably deployed in East Germany. In addition, there are indications that this missile and/or the 1,100 n.m. missile is deployed in the Carpathian, Baltic, and Far Eastern areas of the USSR.

89. Data [redacted] have provided good evidence on the characteristics of the 700 n.m. missile. It probably employs a radio-inertial guidance system, providing a CEP of about one n.m. Warhead weight is estimated at 3,000 pounds. We believe that the SHYSTER uses nonstorable liquid propellants.

SS–4: 1,100 n.m. Ballistic Missile System

90. The 1,100 n.m. missile was first observed in the November 1960 Moscow parade (see Figure 26). The test firing of the 1,100 n.m. missile system was begun in mid-1957. Since that time, over 125 firings of this missile have been observed [redacted] These missiles were launched from Kapustin Yar to impact areas located approximately 950 n.m. and 1,050 n.m. downrange—the longer range firings to the impact area at Sary Shagan in conjunction with the anti-

missile program. The system probably attained an initial operational capability in late 1958 or early 1959. [redacted]

91. [redacted] considerable evidence on the characteristics of the SS-4. The engine probably consists of a cluster of four combustion chambers as a single unit, with a total thrust of about 150,000 pounds. There is evidence that such an engine was under development in 1955. [redacted] we believe that the SS-4 employs a radio-inertial rather than an all-inertial guidance system, and that it has a CEP of about 1.5 n.m. Warhead weight is estimated at about 3,000 pounds.

92. In November 1960, [redacted] firing to the ICBM impact area on Kamchatka from the vicinity of Sovetskaya Gavan in the Far East Maritime Area, a distance of about 900 n.m. This is the first evidence of the launching of this missile from an area other than the Kapustin Yar missile test range, and indicates that it probably is deployed in the Far East Maritime Area. There is also evidence that this missile and/or the SHYSTER is probably deployed in the Baltic and Carpathian area.

SS-5: 2,000 n.m. Ballistic Missile System

93. The latest Soviet surface-to-surface ballistic missile to be tested is a missile (SS-5) with a nominal range of 2,000 n.m. The flight test program for the SS-5 missile was initiated in June 1960, and well over a score have been fired to date. [redacted] these operations were generally successful [redacted] There have been differences between this program and the initial phases of other programs, especially in the firing rates. Other programs have begun with a short firing period followed by a lull of several months; whereas the launching tempo for this missile has been sustained. Based on the program to date, we believe this missile probably will become operational in late 1961 or in the first half of 1962.

94. Preliminary analysis [redacted] indicates that this system is probably new, rather than a simple modification or lightened nosecone version of the 1,100 n.m. or other ballistic missile. The propulsion system uses nonstorable liquid propellants, is single stage, and may have two combustion chambers. [redacted] We estimate that the guidance system is radio/inertial. We believe the accuracy will probably be at least as good as that of the SS-4 (1,100 n.m.), i.e., approximately 1.5 n.m. There are no firm data available to indicate the warhead weight, but we believe it would be between 3,000 and 5,000 pounds, with 4,000 pounds as a reasonable planning figure.

Future Systems

95. Considering Soviet technology, we believe that a wide range of improved characteristics could be incorporated in future ballistic missile systems. We have no evidence as to specific new systems which may become available during the period of this estimate. However, improvements which might be undertaken include: gross weights substantially less for a given payload than is the case for current missiles; improved guidance and control, including accuracy; storable liquid or solid fuels; and staging. In view of Soviet standardization and stress on reliability, we do not anticipate a great proliferation of models.

Close Support Missiles

96. Considering general Soviet progress in the missile field, we believe that the USSR could also have developed close support missiles for use by the ground forces. We estimate that the Soviets probably now have operational a single stage missile with a range of about 5,000 to 6,000 yards, capable of delivering a shaped HE charge against tanks or other hard targets. It is possible that they have available missiles with simplified inertial guidance components capable of delivering a 500 pound payload to ranges on the order of 5 to 15 n.m.

Ground-Launched Cruise-Type Systems

97. Recent Soviet statements, as well as other information, indicates that the USSR has a current interest in long range cruise-type vehicles. We estimate that the Soviets are developing and could have available for operational use in 1962–1963 a ground-launched, ramjet-propelled vehicle, with a speed of about Mach 3, a cruise altitude of 65,000–70,000 feet, and a range in excess of 4,000 n.m. Vehicles of this type could be employed in a research role for investigation of structures and propulsion systems in the Mach 3 region. However, such a system could be employed for weapon delivery or reconnaissance, and would further complicate Western air defense problems.

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KAPUSTIN YAR-VLADIMIROVKA MISSILE TEST CENTER

Figure 22

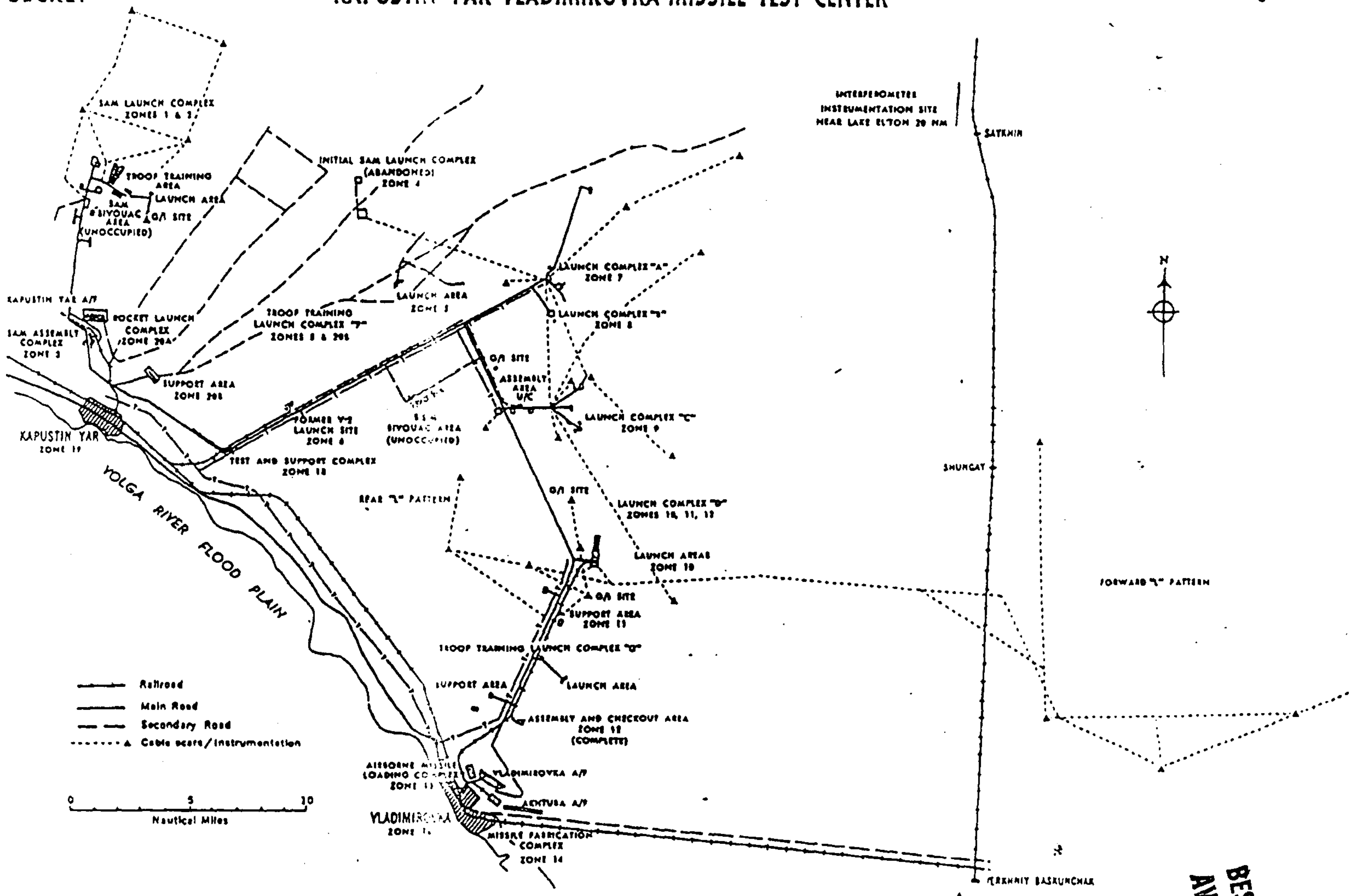

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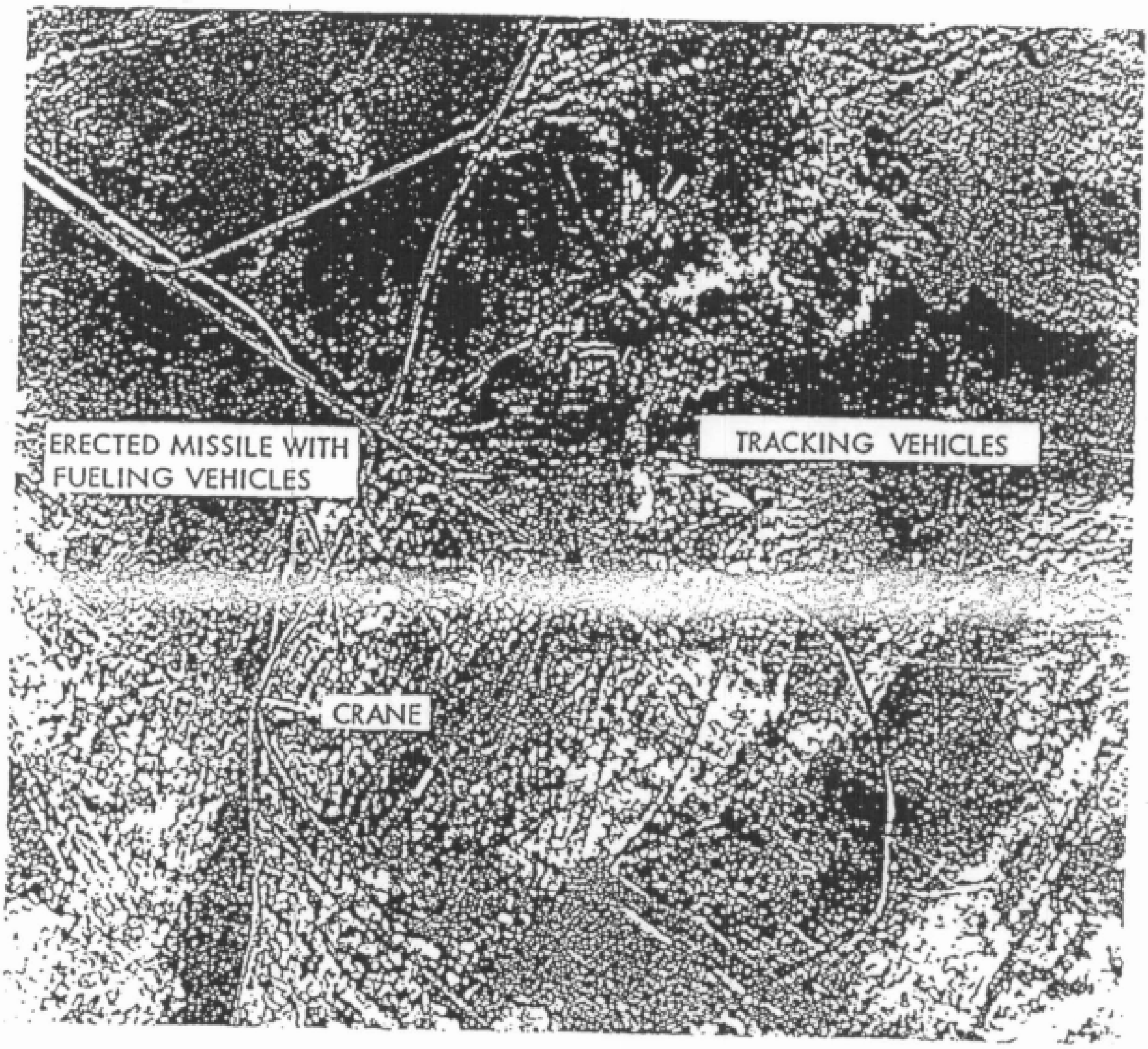
Figure 23

This photograph of a troop training area at the Kapustin Yar missile test range was taken in December 1959. The erected missile, believed to be the SS-2 (350 NM), is approximately 55 feet long and 5 feet in diameter. The mobile support equipment throughout the area is similar to German V-2 ground handling equipment.



TRAINING LAUNCH AREA, COMPLEX G, KAPUSTIN YAR

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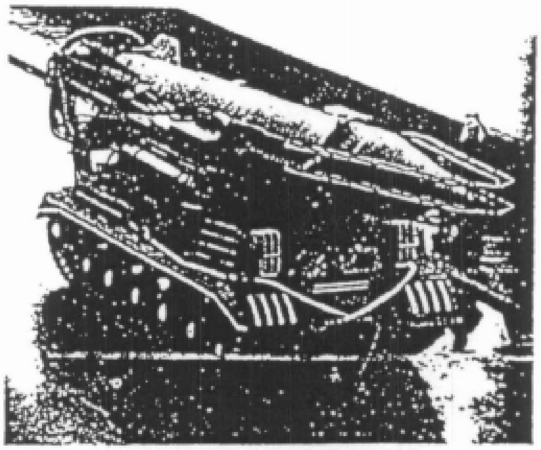
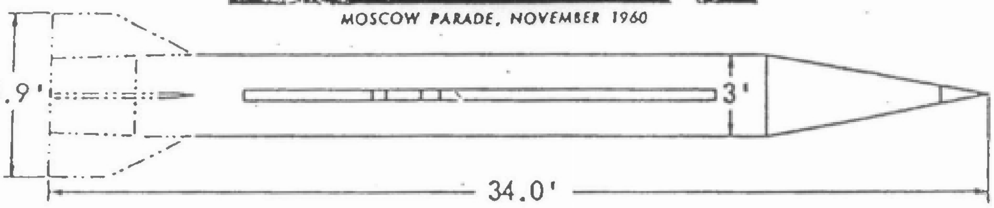
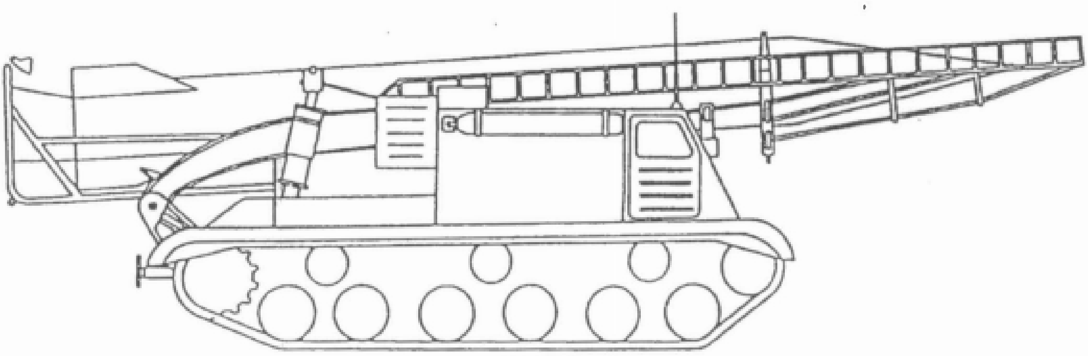


MOSCOW PARADE, NOVEMBER 1960



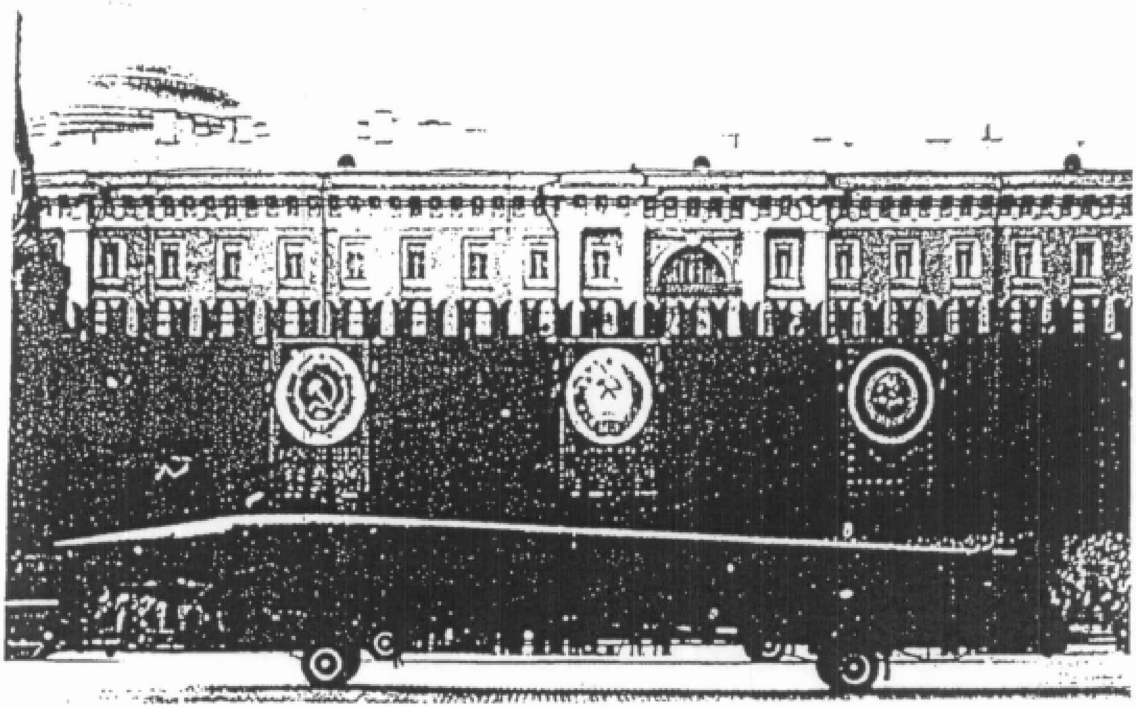


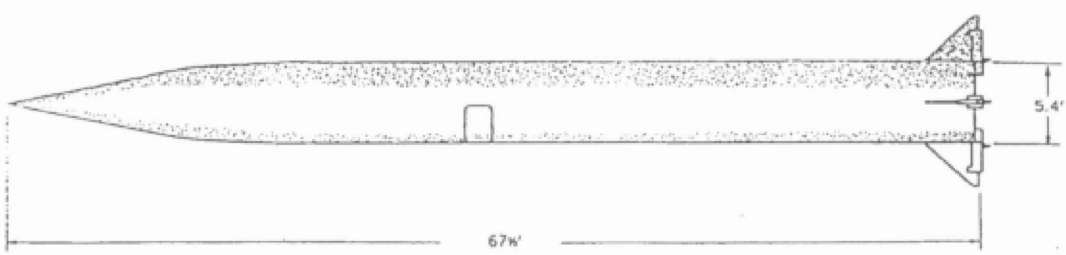
ESTIMATED CHARACTERISTICS

U.S. Designation	SCUD - SS-1
IOC Date	1957
Maximum Range	150 N.M. (with 1500 pound warhead)
Propulsion	Storable Liquid Propulsion System
Configuration	Single Stage
Guidance	Probably Radio - Inertial But Possible All-Inertial
Accuracy	About 1/2 N.M. CEP at 150 N.M.
Maximum Warhead Weight	1500 Pounds (approximately)
Ground Environment	Road Mobile With Missile in Fueled Condition

SS-1 SURFACE TO SURFACE MISSILE (SCUD)

Figure 25



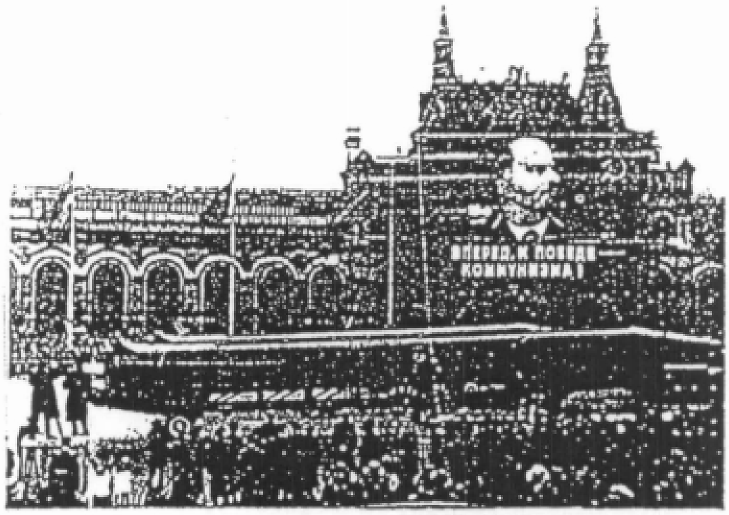


ESTIMATED CHARACTERISTICS

U. S. Designation	SHYSTER - SS-3
IOC Date	1956
Maximum Range	700 N.M.
Propulsion	Liquid, probably LOX/kerosine
Configuration	Single Stage
Guidance	Radio/inertial
Accuracy	1 N.M.
Maximum Warhead Weight	3,000 Pounds
Ground Environment	Road Mobile

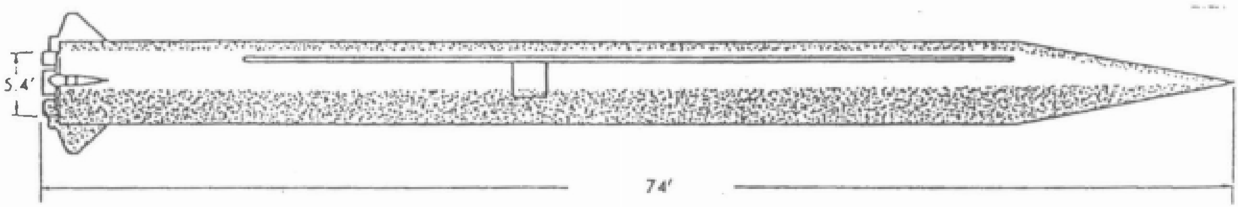
SS-3 SURFACE-TO-SURFACE MISSILE (SHYSTER)

Figure 26



MOSCOW PARADE, NOVEMBER 1960

SS-4 SURFACE-TO-SURFACE MISSILE



ESTIMATED CHARACTERISTICS

U. S. Designation	SS-4
IOC Date	Late 1958/early 1959
Maximum Range	1100 N.M.
Propulsion	Liquid, probably LOX/kerosine
Configuration	Single Stage
Guidance	Radio/inertial
Accuracy	1½ N.M.
Maximum Warhead Weight	3,000 Pounds
Ground Environment	Road Mobile

VI. ICBM DEVELOPMENT PROGRAM

98. We have relatively firm evidence on the Soviet ICBM test range and the test-firing program, from which we have been able to derive basic characteristics of the ICBM vehicle, its propulsion, nosecone, and guidance system, as well as some of the ground support and logistic requirements for its operational deployment. From these data, we can also derive, though with some probable margin of error, some of the basic factors affecting Soviet ICBM performance under operational conditions, including general ranges, accuracy, and reliability. Finally, these data can be combined with other evidence to provide a sense of the tempo of the ICBM development program and the degree of success the USSR has achieved. However, the sum of our information is inconclusive as to the precise timing of the initial ICBM deployment, and as to the scale and pace of the operational deployment program. While a full examination of the evidence and factors pertinent to the deployment program is reserved for a forthcoming estimate, it is necessary for the present analysis to include brief discussion of some of these matters.

Tyuratam Missile Test Range

99. All Soviet ICBMs and space vehicles have been launched from a rangehead near Tyuratam, east of the Aral Sea (see Figure 27). The test range extends generally to the northeast approximately 3,500 n.m. to an instrumented impact area near Klyuchi on the Kamchatka Peninsula (see Figure 1). On several occasions, in connection with certain ICBM and space launchings, the range has been extended up to 6,700 n.m. into the Pacific Ocean through the use of four Sibir-class instrumentation ships.

100. The Tyuratam test range has extensive communications, control, instrumentation, and logistic facilities, which are sufficient to support ICBM and space operations of considerably greater intensity than those which have been conducted so far. On the basis of successive photographic coverage and other evidence, three launching areas are believed to be completed:

a. In 1955–1957, when the range was first established, the Soviets installed a single, massive launch pad over the edge of a huge pit. This is termed launch area "A" by US intelligence (see Figure 28). It was used for all ICBM and space launchings from Tyuratam at least through 1959 and possibly through 1960.

b. In 1958, the Soviets began construction of a pad closely resembling the first launch area, known as area "B." It was probably ready for use in about mid-1960.

c. In 1959, they began work on a pair of simplified pads without pits, known as launch area "C" (see Figure 29). Launch area "C" was probably completed in late 1960 or early 1961.

101. The evidence from Tyuratam indicates that the Soviet ICBM system is heavily dependent on rail support. Missiles destined for launch areas "A" and "B" are delivered by rail to nearby rail drive-through buildings where extensive checkout and prelaunch assembly operations are performed. Missiles are then transported directly to the launch pad by rail, and there is evidence to suggest that propellants as well as much of the support equipment necessary to a firing are also brought to the pad in this way. Relatively little time appears to be required on the pad. On one occasion, when only one pad was completed, two missiles were launched in less than three days. Launch area "C" was photographed while under construction, and its final configuration is not definitely established. It also has rail-served checkout buildings nearby. Although a rail spur enters the pad area, it appears that missiles are to be transported from checkout buildings to pads by road. Launch sites of this type would necessarily be near rail lines, but a greater degree of flexibility, dispersal, and concealment could probably be achieved.

ICBM Test Firings

102. The first successful flight test in the Soviet ICBM development program occurred in August 1957, with the firing of a missile from

Tyuratam to Klyuchi. Since that time, we have acquired a large volume of evidence pertaining to the test range launching of ICBMs and of the space vehicles which have been interspersed with them.[13] Intelligence on this activity is acquired by a variety of technical collection means, including radar, acoustic detection, and electronic interception of missile telemetry. We are confident that virtually all successful launchings from Tyuratam have been detected, and some information is available on failures as well. We have very little evidence, however, on the development of components or on static testing associated with this program.

103. Since the beginning of the firing program, a total of about 60 ICBMs and space vehicles have been launched from Tyuratam, all of which are believed to have used basic rocket boosters of essentially the same configuration. The rate of booster utilization in actual firings was about 10 in 1958 and then increased to roughly 20 per year in 1959 and 1960. About 10 have already been utilized in the first three months of 1961.

104. Of these launchings, about 35 have been generally successful ICBMs which reached the vicinity of intended impact areas on Kamchatka or in the Pacific. To date, the inflight reliability of Soviet ICBMs on the test range has been about 70–75 percent; the reliability achieved in space shots has been considerably lower, probably because of the addition of upper stages and other complicating elements. Firings in the ICBM test program fall into four time periods:

a. A few initial firings of about 3,500 n.m. to Kamchatka between mid-1957 and mid-1958, followed by a lull of nearly six months.

b. A period of increasingly frequent firings in 1959, most of them to Kamchatka but with two shots to instrumented ships in the Pacific, about 4,700 n.m. from the rangehead, in October 1959.

c. A period of less frequent firings in the first half of 1960, including four to instrumented ships at a range of about 6,700 n.m. in January and July, followed by another lull of nearly six months.

d. A resumption of frequent firings to Kamchatka in early 1961.

105. The total number of ICBM launchings over this 3½ year period is small by comparison with Soviet practice in medium and short range missiles. [redacted] Many of the Soviet space shots have occurred during the lulls in ICBM firings, and it is apparent that the ICBM and space programs have shared available boosters, test range facilities, and experience which has been mutually supporting. In light of these factors, we conclude that the USSR has been conducting a generally successful but careful ICBM development program, at a deliberate pace rather than on a "crash" basis.

Physical Characteristics

106. From the extensive data which have been acquired, US intelligence has reasonable confidence in its general description of the Soviet ICBM system, despite the fact that no qualified Western observer has ever seen a Soviet ICBM. Most of our evidence is from the monitoring of test firings and photography of range installations, but we have acquired valuable supporting information from many other sources, including, for example, [redacted] a Soviet lunar probe. In general, we find that the Soviet ICBM system differs in important respects to US missiles.

107. *Configuration.* The Soviet ICBM and space booster is a very large vehicle, with a gross takeoff weight of some 450,000–500,000 pounds and a total thrust at takeoff of about 750,000 pounds. This thrust is attained through the use of five main rocket engines which burn nonstorable liquid propellants. The ICBM is either 1½ staged or parallel staged—that is, all engines are ignited at

[13] For a detailed account of ICBM test activity at Tyuratam, see Annex F, "Soviet Missile Test Range Activities." (Limited Distribution)

takeoff but four of the five engines, and perhaps fuel tanks as well, are jettisoned at altitude. The vehicle itself is probably of heavy, airframe-type, welded aluminum construction.

108. *Nosecone and Payload.* The Soviets have developed and tested ICBM nosecones of two different weight classes, one extremely heavy and the other somewhat lighter. Both are designed for high speed re-entry. The payload is protected from the heat of re-entry by a type of ablative material which is different from that used on any current US nosecone. The very heavy nosecones, varying in weight from 13,000 to 15,000 pounds and capable of carrying maximum payloads of 6,000 to 10,000 pounds, were used on ICBMs launched from Tyuratam in the first two phases of the firing program. This class of nosecone was tested extensively in firings to Kamchatka in 1959, and was probably proof tested to 4,700 n.m. into the Pacific in October of that year. Most of the firings in the 1960 phase of the program used a lighter nosecone weighing approximately 8,000–9,000 pounds, capable of carrying about 6,000 pounds of payload. This nosecone was proof tested to 6,700 n.m. into the Pacific in July 1960.

109. It is probable that the initial development of a very heavy nosecone was made necessary by the great weight required for high-yield nuclear warheads when the Soviet ICBM was first on the drawing boards, and by the Soviet state of the art in re-entry techniques at that time. Subsequent advances in Soviet nuclear technology probably provided a high-yield warhead suitable for use in a lighter weight nosecone.[14]

110. *Range.* Nosecone weight is critical to the range of the Soviet ICBM. Given the basic similarity of the boosters used in all Tyuratam launchings, a Soviet ICBM with a very heavy nosecone would have a nominal maximum range of about 5,000 n.m. This range is subject to variations of some hundreds of miles depending on missile trajectory, the latitudes of launching sites and targets, and direction of fire in relation to the earth's rotation. Soviet ICBMs with heavy nosecones could achieve extensive coverage of US territory only if they were deployed in northwestern USSR or in the Soviet Far East. An ICBM with lighter nosecone, however, would have a nominal maximum range of about 7,000 n.m., subject to the same variations. Soviet ICBMs of this type could achieve full coverage of the US from deployment areas virtually anywhere in the USSR, including Tyuratam itself.

Performance Under Operational Conditions

111. The data available for estimating Soviet ICBM accuracy and reliability under operational conditions are far from adequate or exact. We have taken into account the growing body of evidence on Soviet test range results and on Soviet state-of-the-art in critical system components, at the same time attempting to minimize the use of analogies to US missiles. But even if we had exact data from the test range and had examined the Soviet components, the estimate of system performance under actual wartime conditions would still require assumptions as to the capabilities of the troops, the readiness of the units at the time of firing, and the precise circumstances of employment, none of which can be known with certainty in advance.

112. *Accuracy.* The Soviet ICBM guidance system uses radio and inertial elements, in a manner which differs in some respects from US techniques. Inertial components within the missile control most of the powered phase of the missile's flight, with corrections made by ground-based radio command only in the last seconds before burnout. The data available to us are not sufficient to permit more than an approximate determination of the CEP of the Soviet ICBM system. We estimate that with the present type of guidance, Soviet ICBMs would have a CEP of about two n.m. under operational conditions in mid-1961, but the actual figure could be considerably greater or somewhat less. The figure given is intended as an approximation for an entire ICBM force, with crews of various levels of competence firing against targets at various ranges.

[14] For a discussion of warhead yields, see Annex E, "Estimated Present Nuclear Warhead Capabilities." (Limited Distribution)

113. The CEP of the Soviet ICBM system will probably continue to improve, at a rate dependent in part on technical factors and in part on the priority the USSR attaches to it. With a very high priority assigned to accuracy, and therefore to the necessary troop training and introduction of more refined components, the operational CEP of portions of the force might reach one n.m. possibly as early as 1963, but we regard 1965 as a more likely date for such an achievement. However, major portions of a Soviet ICBM force would not necessarily be trained or retrofitted for highly refined accuracy. The Soviets probably would regard the present level of accuracy as sufficient for many types of potential targets.

114. There is no evidence of the development of all-inertial guidance for use in large Soviet ballistic missiles. However, the greater flexibility which could be achieved with this type of guidance may induce the Soviets to introduce it into their ICBM system, despite the probability that its accuracy would be somewhat inferior to that of radio-inertial guidance. If so, all-inertial guidance could be introduced for operational use in 1963 or after.

115. *Reliability*. We estimate that as of mid-1961 some 70–85 percent of the USSR's ICBMs on launcher would be "ready missiles"—that is, both the missile and the launcher would be in commission and ready to be committed to a launch countdown. The lower limit of this range approximates the percentage which might be maintained ready in continuous peacetime operations for an indefinite period. The upper limit might be achieved if the Soviets prepared their force for an attack at a specific time designated well in advance, i.e., maximum readiness. The ready missile rate is expected to improve for a year or so and then level off. Ranges comparable to those given above might approximate 85–90 percent in 1963.

116. With respect to reliability on launcher and in flight, we estimate that as of mid-1961, some 60–75 percent of the USSR's ready ICBMs could successfully go through countdown, leave their launchers at scheduled times or not later than 15–30 minutes thereafter, and detonate in the vicinity of assigned targets—that is, within about three CEP's of their aiming points. As in the preceding paragraph, the upper limit would be more likely to be achievable if the Soviets had provided time for peaking their forces on launcher prior to an attack at a specific time. These percentages might increase to 70–80 percent in 1963.

117. A general approximation of the total reliability of a Soviet ICBM force can be made by combining the factors discussed above. On this basis, we estimate that if they were employed in about mid-1961, some 40–65 percent of the total number of Soviet ICBMs on launchers would detonate in the vicinity of assigned targets within about 15–30 minutes of scheduled times. A comparable estimate for 1963 is 60–70 percent. In theory, half of those missiles detonating in the vicinity of their targets would fall within the CEP. As indicated in paragraph 111 these estimates are based on imprecise data and involve assumptions of unknown validity regarding the conditions under which the force might be employed.

118. *Reaction Times*. The Soviet design philosophy, particularly with respect to the fueling techniques employed at operational launch sites, will critically affect ICBM reaction times. Assuming that rapid reaction time has been a Soviet objective, we estimate the following minimum reaction time for ready missiles under the three alert conditions indicated:

Condition I: Crews on routine standby, electrical equipment cold, missiles not fueled. Reaction time: 1–3 hours.

Condition II: Crews on alert, electrical equipment warmed up, missiles not fueled. Reaction time: 15–30 minutes.

Condition III: Crews on alert, electrical equipment warmed up, missiles fueled and topped. This condition probably could not be maintained for more than an hour or so. Reaction time: 5–10 minutes.

119. *Retargeting Techniques*. It would be technically feasible for the USSR to have developed retargeting techniques to minimize the degradation in the effectiveness of an ICBM force caused by reliability factors. The

obvious way of achieving a given level of assurance of neutralizing a specific number of targets is simply to salvo the total number of missiles theoretically required. This might involve firing more than one missile against each target. With retargeting, however, the same theoretical assurance could be achieved with fewer missiles by salvoing, say, only one missile against each target, determining whether or not that missile proved unreliable on launcher or during the powered phase of its flight, and directing additional missiles against only those targets left uncovered because of failures. This would require the availability of standby missiles on launchers, which had been counted down and into which alternate trajectory data could be inserted as needed. Standby missiles not used in retargeting could be employed against additional targets or could be held in reserve.

120. There is no evidence that the Soviets have actually built a retargeting capability into their ICBM system, but we would not expect to have evidence of this type. In light of its potential advantages, we regard it as possible that the Soviets have developed a capability for retargeting. Provided that standby missiles were ready on their own launchers and counted down along with those of the first salvo, the Soviets could probably detect failures, retarget, and launch additional missiles with delays of no more than 10 to 20 minutes.

121. A refinement of the retargeting technique, called reprograming, could be employed in an attack designed to strike targets or warning lines as nearly simultaneously as possible. This technique involves the launching of first salvo missiles on extremely high trajectories so as to lengthen their time of flight; standby missiles can then be launched on lower trajectories which will tend to compensate for the delays incurred by retargeting. This would require major modifications to the ICBM system, and testing of a type we could expect to detect. No such testing has occurred. We believe that the Soviets do not now possess a reprograming capability, but with a high priority effort the technique could probably be developed and checked out by about 1963.

122. Even more highly refined retargeting techniques are theoretically possible, such as the determination of probable missile impact points while the missiles are en route to the target. On the basis of such a determination, the degradation in system effectiveness caused by guidance errors could be reduced. Because of their considerable cost and the complications they would introduce, the Soviets are not likely to employ such techniques.

123. *Techniques to Evade BMEWS.* Although we have no evidence of Soviet interest in developing a capability to evade BMEWS, the Soviets theoretically could, if they desired, evolve measures for countering BMEWS even when this early warning system is fully installed in 1963. It is probable that with a few tests they could prove out a capability to fire their current ICBMs on somewhat lowered trajectories at certain selected targets, taking advantage of a few gaps in the planned BMEWS coverage. With substantial modifications, the current Soviet system could acquire a capability to reduce the chances of BMEWS detection by using extremely low or extremely high trajectories, but CEP would probably be degraded to 5–10 n.m. With more substantial modifications, the present system could probably deliver a 3,000 pound warhead to a range of about 16,000 n.m., a distance sufficient to permit southern trajectories from the USSR to the US, but CEP would probably be degraded to at least 10 n.m. The modifications envisaged above would require considerable testing which would probably be detected. While the USSR could probably develop these techniques by about 1963, their operational advantages seem so marginal that we regard them as unlikely.

Milestones in the Program

124. The evidence derived from flight testing is adequate to gauge the general progress of Soviet efforts to prove out the configuration, propulsion, guidance, and nosecone of their ICBM system. In the first two periods of the test-firing program, through 1959, the Soviets launched a total of 20 generally successful ICBMs, most of them to the land impact area on Kamchatka where they could make de-

tailed measurements on accuracy and reentry effects. The intensive second period of test firings was climaxed by the probable proof testing of heavy nosecone missiles to 4,700 n.m. into the Pacific. In light of these test successes, the time elapsed since the beginning of the firing program, the wealth of Soviet experience with shorter range missiles, and the additional data on booster performance provided by the space program, we believe that the Soviets were in a position to consider their 5,000 n.m. ICBM satisfactory for initial deployment by the end of 1959. With the additional results from the third period of the firing program, they were probably in a similar position with respect to their lighter nosecone, 7,000 n.m. missile by about mid-1960.

125. The establishment of an operational capability, however, requires not only a certain confidence in the weapon system—it also requires that missiles, trained personnel, and launching and ground support facilities be available for operational use. The last of these would require the longest lead time—probably 18 months to two years for initial sites.

126. Concerning the availability of missiles, we believe that in early 1959, the USSR began the manufacture of production ICBMs—that is, complete missiles of an operational type, which, however, could also be modified for use as space boosters. ICBMs produced prior to that time are believed to have been prototypes, manufactured at a scientific research institute near Moscow, whereas other Soviet industrial plants have apparently been involved in the manufacture of production missiles. We base these judgments on Soviet progress in missile development, on information about plant activities, and especially on the increased availability of missiles indicated by the doubling of the rate of ICBM and space launchings in 1959. These evidences lend credence to assertions by Khrushchev and other Soviet leaders that "series production" of ICBMs began early that year. We still do not know the actual rate of production. However, normal Soviet practice in other military and industrial programs points to the probable availability by late 1959 of at least some ICBMs above and beyond the numbers expended in firings.

127. As for operating personnel, we have not yet identified any ICBM-related training activity [redacted] possible that some such training was accomplished in conjunction with test firings. In any case, much of the necessary training would be done without firing at all. Normal Soviet practice with other missile systems, however, seems to call for fairly extensive training [redacted] usually at special facilities constructed at the rangehead. These facilities support the training activity and are also used to check out the operational handling and launching equipment. The newly-constructed launch area "C" at Tyuratam can be interpreted as such a facility. It probably also represents the approximate configuration of an operational launching facility.

128. We are still unable to identify positively any ICBM launching facilities other than those at the test range. Nevertheless, there are a number of locations on which we have evidence pointing to the existence of launching facilities, either completed or under construction. There are at least three suspect rail-served locations in northwestern USSR, the area most suitable for deployment of a 5,000 n.m. missile. Construction activity at these locations was apparently underway in 1957–1959, suggesting that some sites were prepared concurrently with the development of the missile. Fragmentary information on possible construction of ICBM sites in other areas, while very limited, is consistent in timing with the development of a 7,000 n.m. missile.

129. On balance, we consider that the development by the end of 1959 of a 5,000 n.m. ICBM satisfactory for initial deployment, the probable manufacture of production missiles beginning early in 1959, and the possible con-

struction of launch sites in northwestern USSR in 1957–1959 are sufficient to support an estimate that as of about 1 January 1960, the first operational Soviet ICBM unit was trained and equipped with a few missiles and launchers. This is referred to as IOC date. We believe that since that time, the USSR has had at least some capability to launch ICBMs with good accuracy and reliability against targets in the US.[15] [16]

130. Beyond this point, however, any estimate of Soviet operational ICBM strength is critically dependent upon interpretation of elements in the evidence which permit differing judgments. The question of the probable magnitude of current and future Soviet operational ICBM strength will be examined in the forthcoming NIE 11–8–61, "Soviet Capabilities for Long Range Attack."

Follow-on ICBM Development

131. As we have indicated, the current ICBM is already reasonably accurate and reliable, rugged, and capable of delivering high-yield warheads against targets anywhere in the US. It will probably continue to be modified and its performance characteristics improved over the next few years. Decoys and nosecones with reduced radar reflectivity may be developed for it. Somewhat greater flexibility will probably be achieved in the deployment concept, and much effort will be directed towards perfecting the logistic support, maintenance, and communications facilities necessary to the most effective employment of an ICBM force. But the present ICBM is extremely bulky and must be fairly difficult to handle, it has the relatively slow reaction time of a very large nonstorable liquid-fueled system with the attendant problem of holding the missile for periods of time, and it does not readily lend itself to deployment in hardened sites.

132. It is probable, therefore, that the Soviets would find it desirable to develop a new ICBM system which would incorporate some of the improvements mentioned above and would overcome disadvantages inherent in the present system. For example, while we do not exclude the possibility that the present system could be adapted to use missiles with storable liquid propellants, the better course for the USSR would almost certainly be to develop a new system using either storable liquid or solid fuels, and to build into it other elements compatible with such fuels. Greater flexibility and less vulnerability in deployment would be desirable characteristics for a follow-on ICBM system, even though rail service will probably continue to be an essential element in the preferred Soviet deployment concept.

133. A follow-on ICBM system may already be under development without our knowledge. We would expect detectable flight tests to begin some 18 months to two years prior to first operational availability. Such tests could begin at any time, and we therefore believe that a follow-on ICBM system could become operational in about 1963 or after.

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[15] The Assistant Chief of Staff for Intelligence, Department of the Army, believes that by early 1960, the Soviets had developed a 5,000 n.m. missile satisfactory for emergency deployment to interim ICBM launch facilities and that a few missiles possibly were deployed to such facilities. He believes that an IOC with fully developed, deployed, operational missile launch facilities did not occur in 1960.

[16] The Assistant Chief of Naval Operations (Intelligence), Department of the Navy, believes the Soviets probably had an emergency capability to launch a few missiles from test facilities (as opposed to operational launch sites) starting early in 1960. Factors which bear against a deployed operational ICBM capability and which are mentioned in the estimate weigh heavily in his judgment. These include [redacted] the lack of ICBM troop training activity, and the lack of firm evidence on operational ICBM sites. In addition, the first appearance of what appears to be an operational type site at Area C at Tyuratam which was estimated to be completed in late 1960 or early 1961 leads him to judge that operational launch sites were not available before that time.

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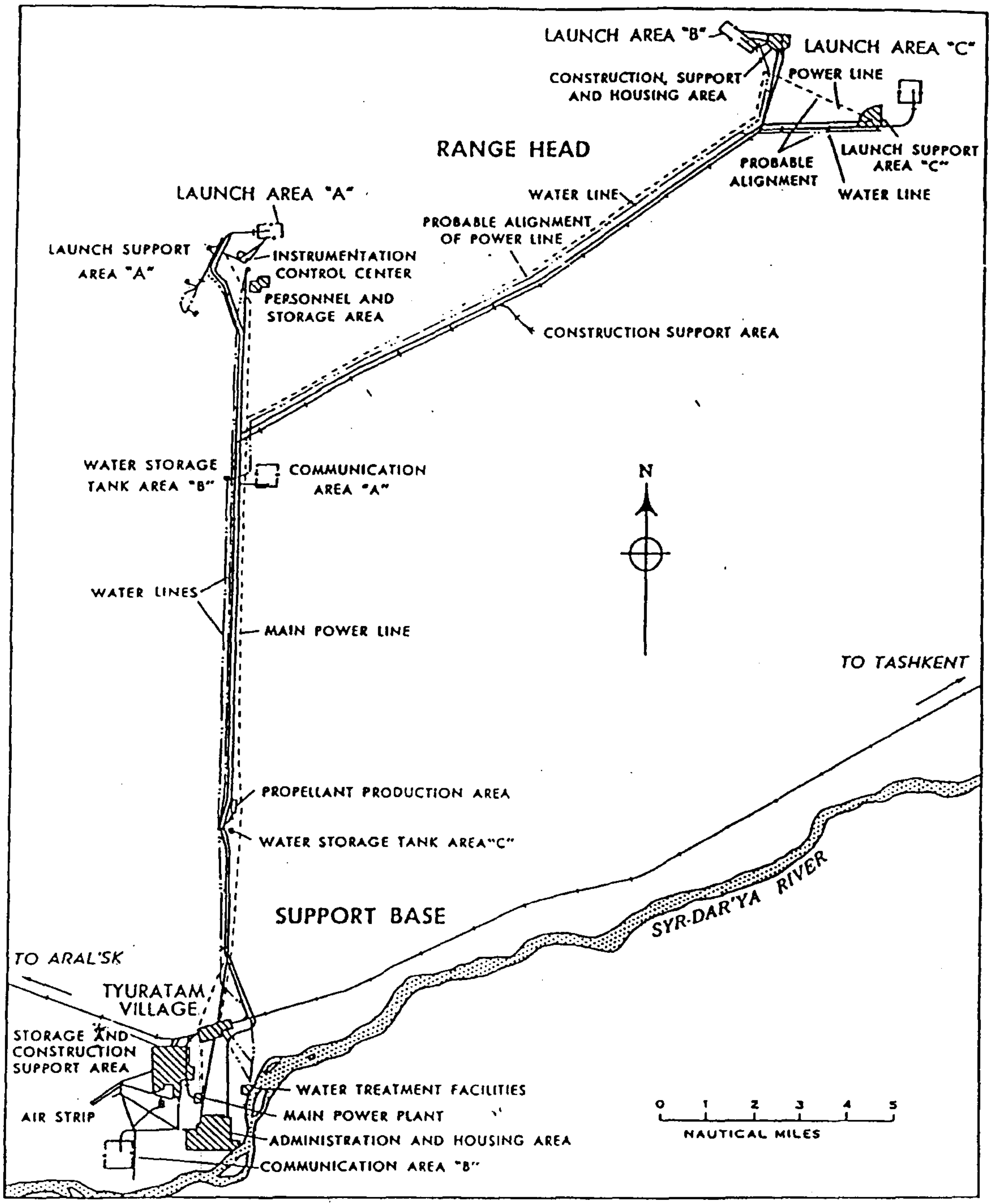
TYURATAM MISSILE LAUNCHING COMPLEX

Figure 27



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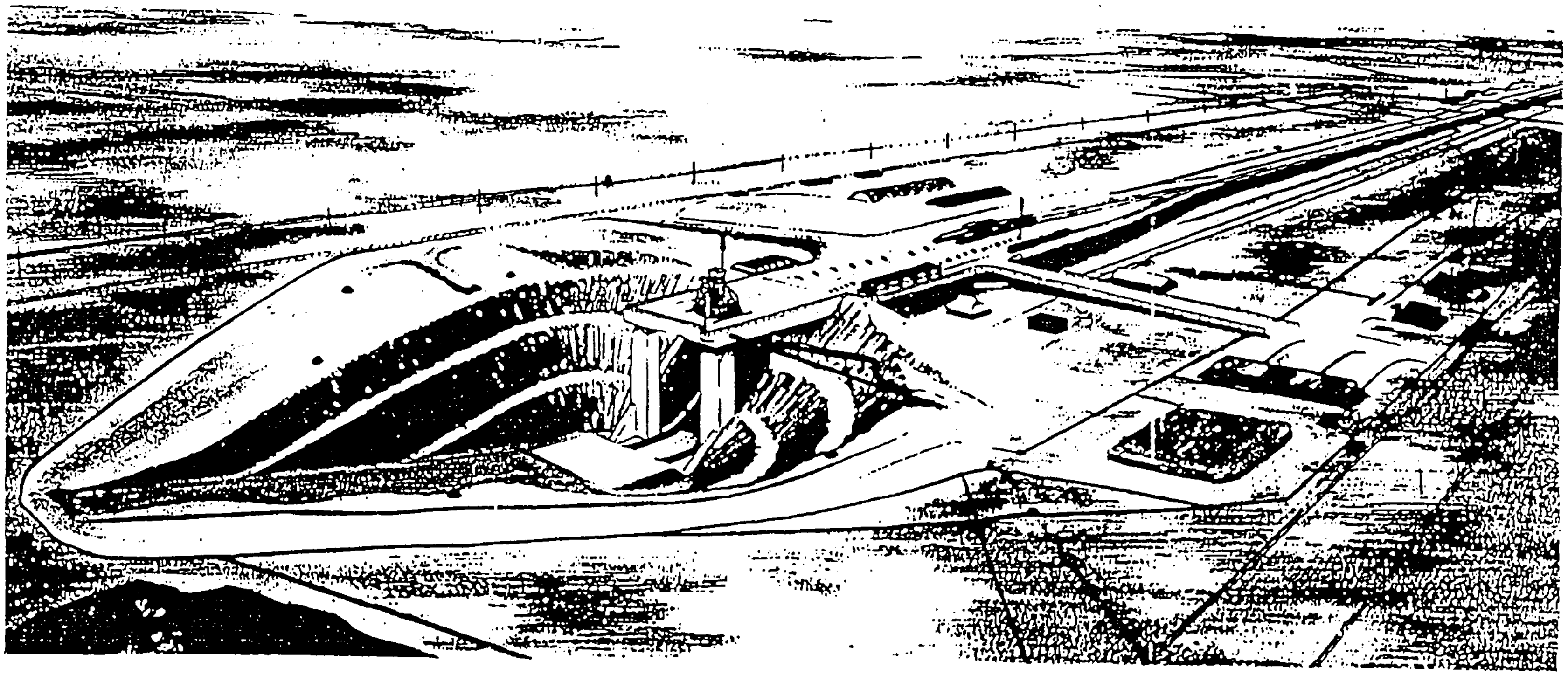
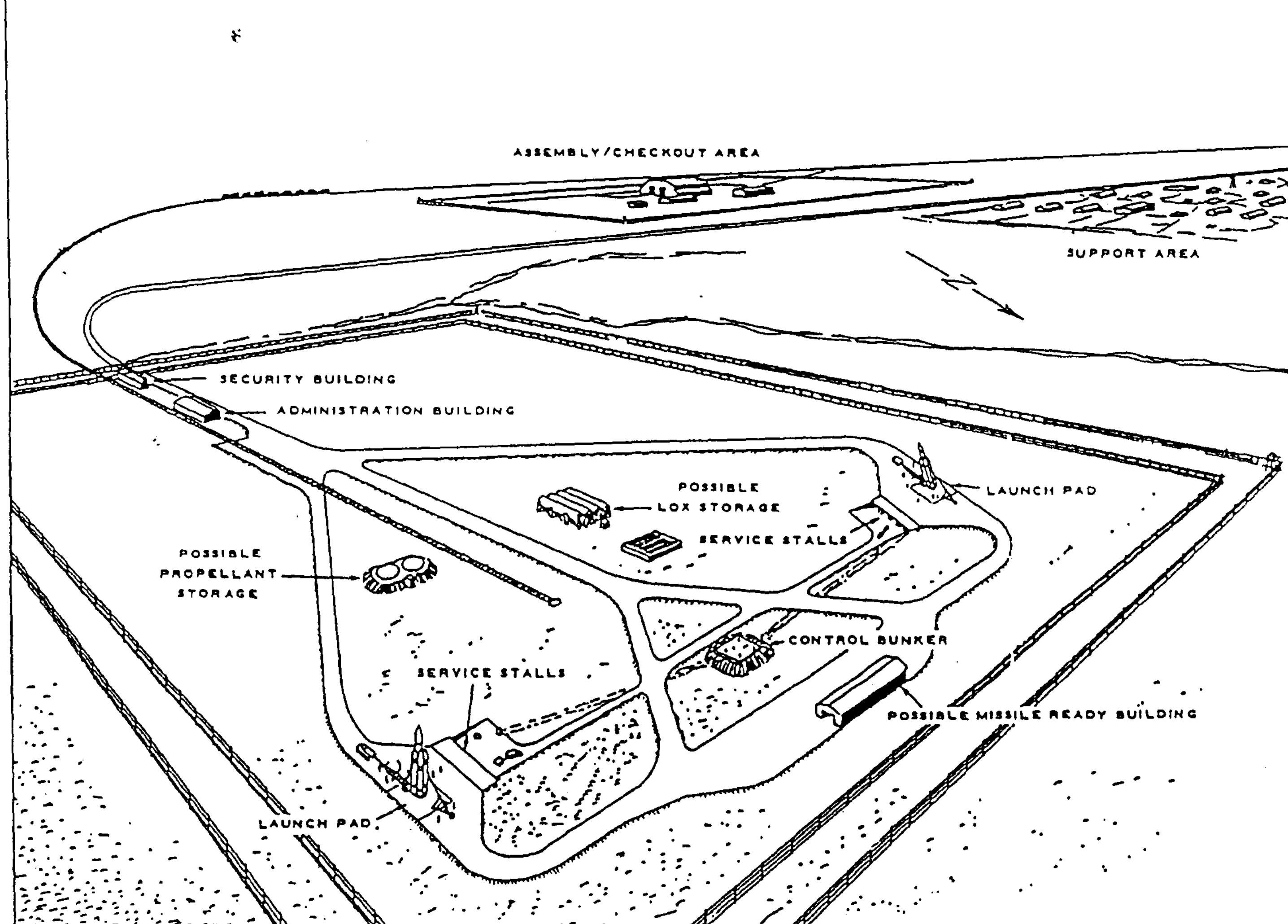
[redacted]

Figure 28



LAUNCH AREA A, TYURATAM

POSSIBLE CONFIGURATION OF COMPLETED LAUNCH AREA "C", TYURA TAM



VII. NAVAL LAUNCHED MISSILE SYSTEMS

134. There is little evidence of Soviet research and development on specific missile systems for naval application. However, over the past few years we have received considerable information, some of it provided by defectors, on the operational deployment of naval-launched missiles in both the surface and the submarine fleets.

135. There is good evidence that the USSR is building destroyers equipped to launch surface-to-surface cruise type missiles. The Soviets could adapt land-based surface-to-air systems for use on destroyers, but there is no evidence that they have done so. The first of the missile-launching destroyers, designated the Kildin class, is a modification of the Kotlin class destroyer. It is capable of launching missiles against either ship or land targets from its single, stern-mounted launcher. This class (see Figure 30) made its first appearance in 1958, but there is some evidence that it was under development as early as 1955. The Kildin served as the prototype for the missile system which now appears in the new Krupnyy class (see Figure 30), a larger missile-launching destroyer. This destroyer class was first identified in 1958, but may have been under development as early as 1956. The Krupnyy mounts two launchers, which are essentially the same as those on the Kildin, one forward and one aft. Each launcher is serviced by a deck house which contains the missile handling and checkout equipment. Good evidence indicates that nine missiles are stowed below decks for each launcher on the Krupnyy, and eight on the Kildin. The launching cycle time is on the order of 10 minutes. The Krupnyy has a platform on the stern apparently for the use of a helicopter which can serve as a forward observer when missiles are fired to full range. At least four Kildins and six Krupnyys were probably operational at the beginning of 1961. By 1958, the Soviets had available two types of surface-to-surface cruise missiles, SS-N-1 and SS-N-2, for use by destroyers.

136. One of these, SS-N-1, can be used against both land and ship targets. The guidance system probably permits the missile to be programmed, possibly with radar track radio command override feature, with terminal homing against ships. It probably flies at high subsonic speeds and at altitudes of 1,000 to 10,000 feet. When employed against a mobile target, the effective range of the missile is limited by the detection capabilities of the overall system. Therefore, when the firing ship is employed singly, the effective range of the missile is limited to 20 to 30 n.m. by the target acquisition range of the ship's radar. The use of another ship as a forward observer to detect and acquire targets for the launch ship may extend the effective range of the missile to 40–60 n.m. or to 100 n.m. by use of a helicopter or aircraft. Against a shore target, the missile would have a range of at least 100 n.m. without forward observation. The SS-N-1 carries a 1,000 pound HE or nuclear warhead [17] and has a CEP of about 150 feet against surface ships and 1–2 n.m. against shore targets.

137. The SS-N-2 is a supersonic cruise-type missile designed for use only against ships. Its range, estimated at 20–30 n.m. when used with a single ship, can be extended to 60–80 n.m. with assistance from a forward observer in a ship or aircraft. Its guidance system is similar to that of the SS-N-1. However, this missile probably approaches at a low altitude (about 200 feet) and then dives into the water short of the target so that the warhead will explode under the ship. Payload and accuracy are believed to be the same as estimated for SS-N-1 against ship targets.

138. We have photographs of a new class of patrol craft (designated "Osa" class) with four structures which appear to be launchers (see Figure 31). Conversion of smaller, existing motor torpedo boats (designated

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[17] Annex E, "Estimated Present Nuclear Warhead Capabilities." (Limited Distribution)

"Komar" class) to carry two similar structures is known to be underway. A defector has reported that patrol craft are being equipped with "rockets" to be used to attack ships. We cannot determine whether these launchers are designed for guided missiles or free rockets. Effective range would not exceed the radar horizon.

139. There have been reports of the installation of both surface-to-surface and surface-to-air missiles on one or two cruisers. Although the reports indicate that tests have occurred, the operational status of the system is not clear. The surface-to-surface systems may be essentially the same as those on the Krupnyy class destroyer, and the surface-to-air systems may be adaptations of the SA-2 or SA-3 land-based types. There is no evidence of new construction of cruisers designed to carry guided missiles, nor do we believe that there is an extensive program for the conversion of existing cruisers.

Antisubmarine Warfare Missile Systems

140. There is some evidence indicating that a program for developing advanced ASW weapons systems exists. The USSR has the basic scientific and technical capabilities to develop ASW missile systems and the required detection and tracking equipment. Based on requirements and our appreciation of the state of the art, we estimate that the USSR may be developing a missile for use in ASW. Assuming that an active development progam has been underway, we estimate that a ballistic-launched depth bomb could be available for use by surface ships with adequate detection and tracking equipment in 1962–1964. Similarly, a ballistic-launched homing torpedo to be fired from a submarine could be operational in 1963–1965. Such a missile could possibly also be used against surface ship targets.

Submarine Launched Missile Systems

141. The first indication that the Soviets were equipping their submarines with missiles was provided by reports in 1955–1956 of "W" class submarines equipped with hangar and launcher structures. It is probable that a few of these submarines were converted to carry subsonic cruise-type missiles for use against land targets at ranges of 150 n.m. Sightings of such submarines still occasionally occur, but we doubt that this system is currently operational.

142. We believe that the Soviets are developing a supersonic cruise missile with a range of about 300 n.m. which is designed to be launched from surfaced submarines. This system could be operational this year. The submarine for which this missile system was designed has not yet been identified.

143. Since 1956 there have been several sightings and photographs of modified "Z" class submarines with enlarged sails. On the top aft part of the sail are located two hatches, which are seven feet in diameter (see Figure 32). There is no firm evidence that these hatches cover missile tubes, but we believe that these submarines have probably been modified to carry and launch two ballistic missiles (SS-N-4) each against land targets. Six such "Z" class conversions have been identified in the Soviet fleets to date.

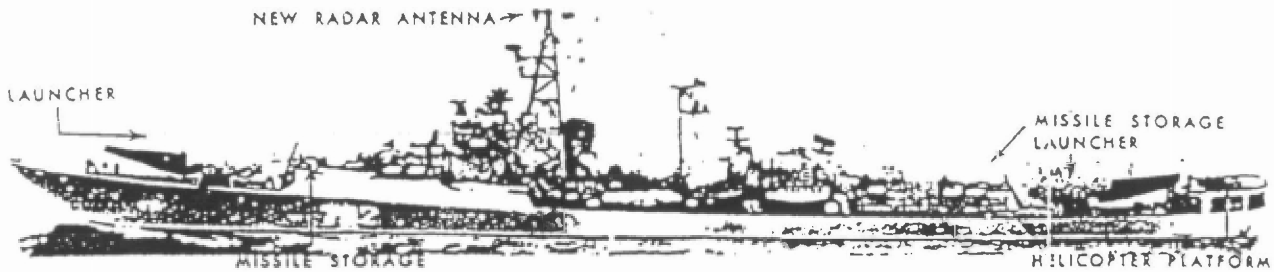
144. There is some uncertainty as to the range of the missile employed by the modified "Z" class submarine, although the evidence points to the probability that these missiles are of either 150 or 350 n.m. maximum range. The 150 n.m. SCUD (SS-1) is the only known surface-to-surface missile which uses storable liquid propellants, and thus could be adapted for use in a submarine. However, Khrushchev has said the USSR possessed submarines carrying a 600 km rocket (about 325 n.m.). Ballistic missiles have been test fired to 350 n.m. range at Kapustin Yar for some years, and we believe that a missile of this range could be adapted for installation in a submarine.

145. Since mid-1958, 14 new construction long range submarines, designated the "G" class, have been identified (see Figure 33). This submarine also has a large sail, much longer than that of the converted "Z" class. There are three pairs of fairing doors in the top of the sail, which could cover a total of three or four hatches of the type seen on the converted "Z" class. We estimate that the "G" class submarine probably is armed with

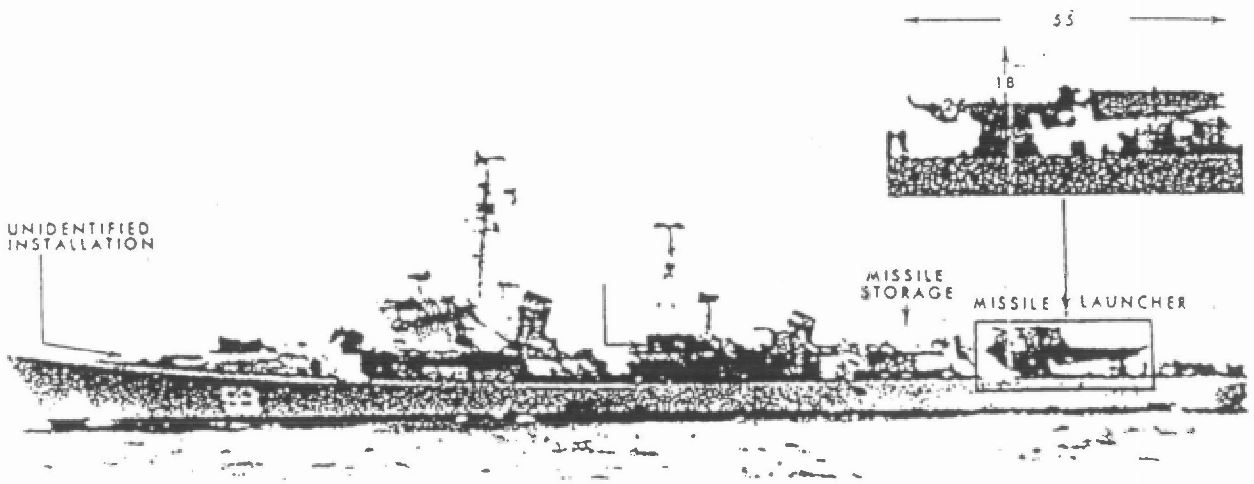
ballistic missiles of the type carried by the "Z" class conversion. For missile launching, both the converted "Z" and the "G" class submarines would need to be surfaced, or more likely with the sail awash. Since it has not been established that the fairing doors conceal ballistic missile tubes, the possibility cannot be excluded that the "G" class is equipped with cruise-type missiles.

146. We believe that Soviet planners would consider it operationally desirable to have nuclear-powered submarines capable of launching ballistic missiles, preferably while submerged. There is some evidence which suggests an active development program, and we believe that such a program probably is underway. We estimate that Soviet nuclear-powered submarines, each capable of carrying and launching while submerged 6–12 ballistic missiles of 500–1,000 n.m. range could become operational in 1962–1963. This system would require a new missile using either solid propellant or storable liquid fuel. We estimate that it would carry a 1,000 pound warhead and have a CEP of one to three n.m. We would expect that this missile (SS–N–5) would be tested at Kapustin Yar, that [ ] we would be able to identify it as a new missile, and that approximately 18 months of testing would be required before it could become operational. It is possible that the Soviets have elected to equip nuclear submarines with surface-launched ballistic missiles of the type attributed to the converted "Z" and "G" classes. If this is the case, a few Soviet nuclear-powered missile submarines could be operational this year.

Figure 30



KRUPNYY CLASS DDG



KILDIN CLASS DDG

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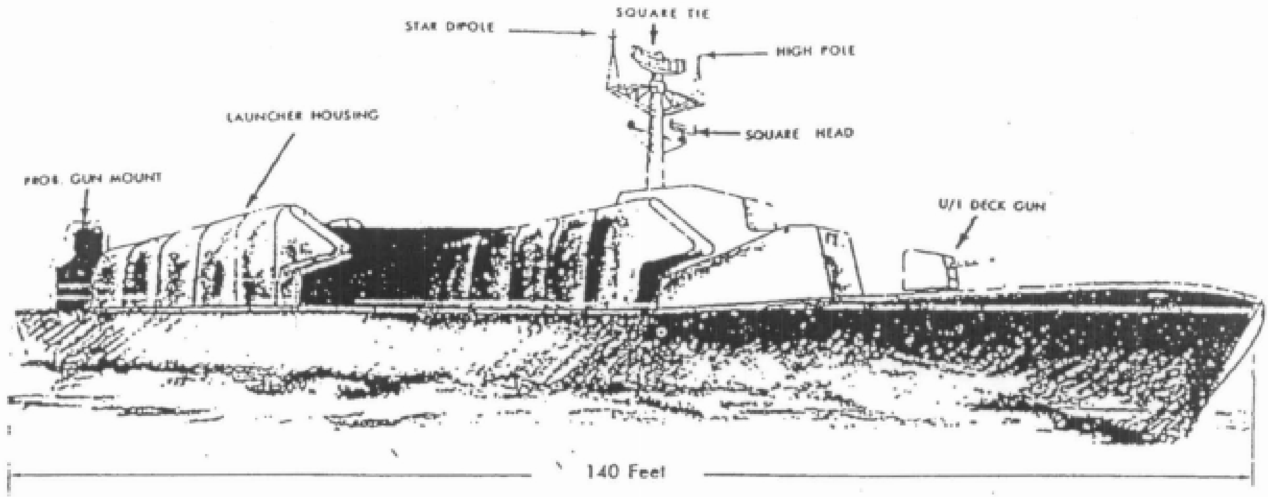
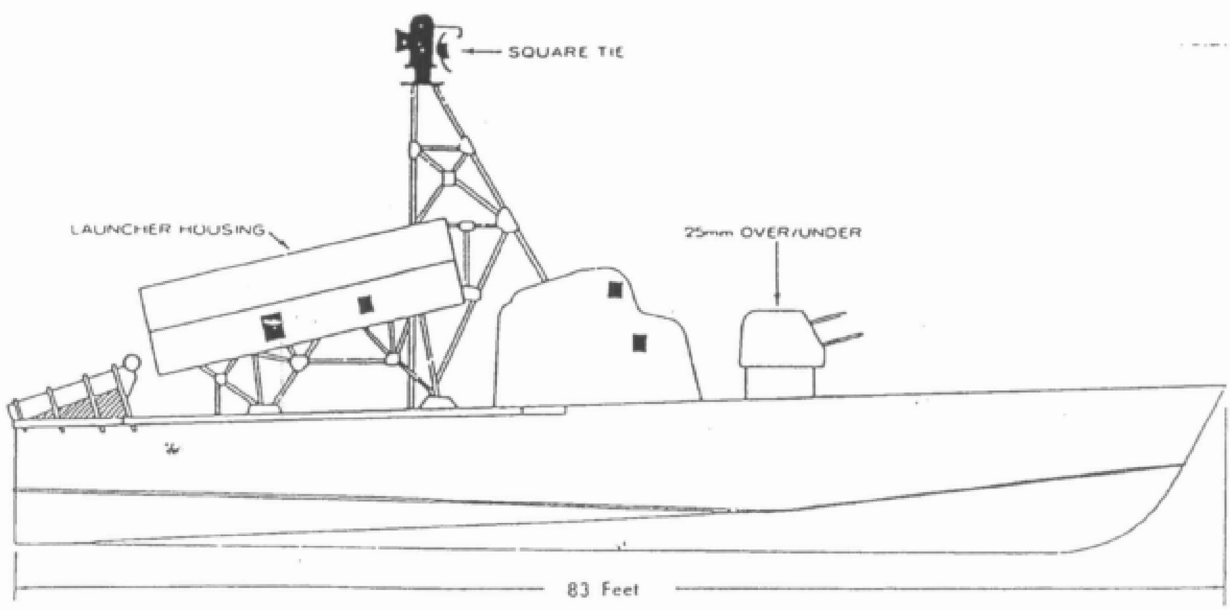
Figure 31



USSR 'OSA' CLASS PG



USSR 'KOMAR' CLASS PG

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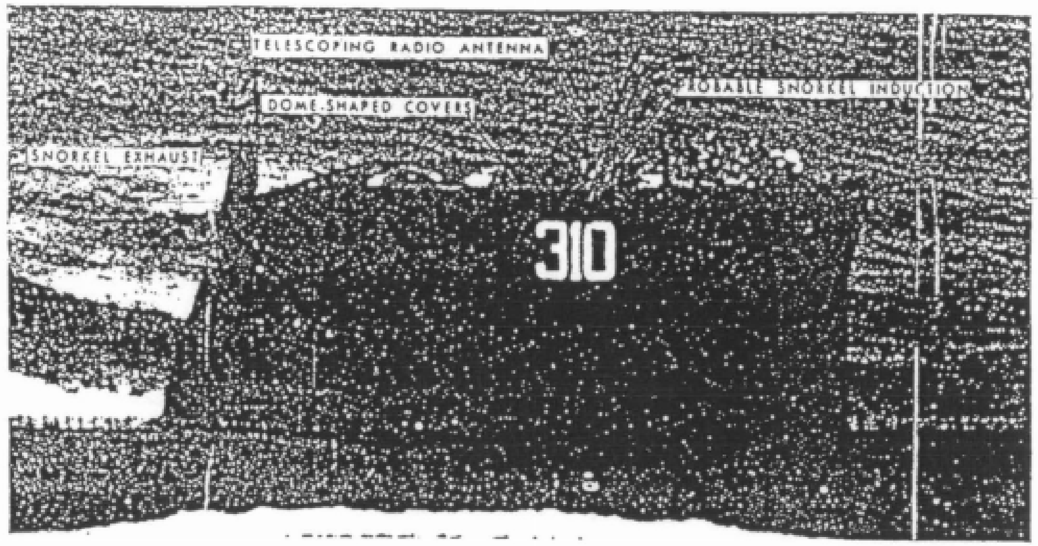

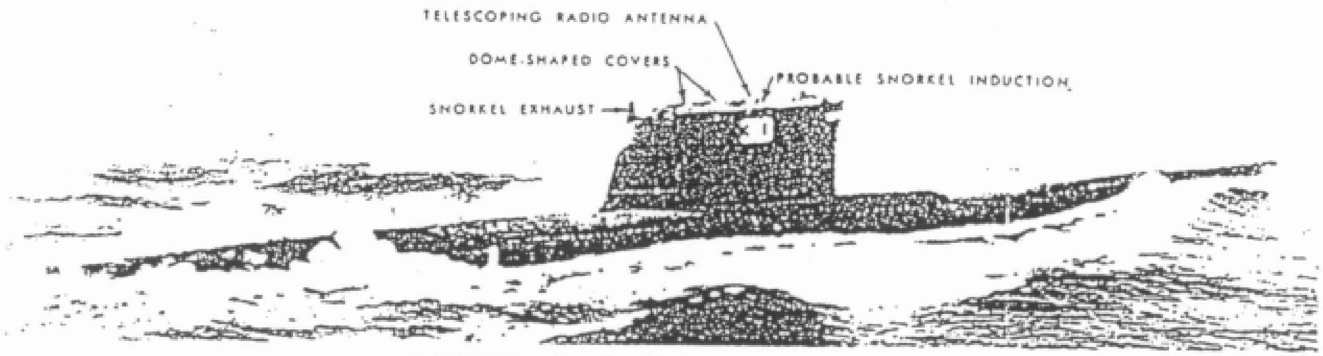

MODIFIED "Z" CLASS SUBMARINE

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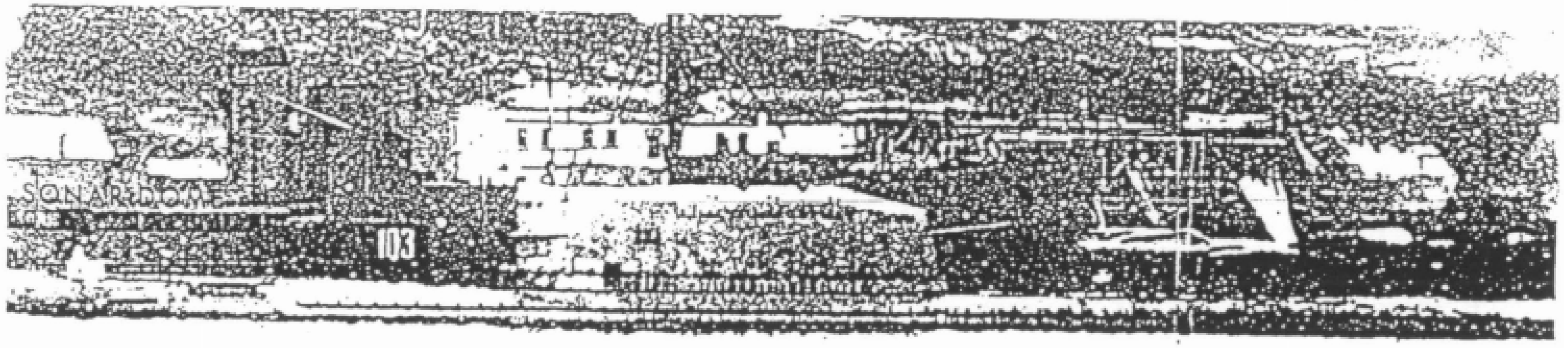
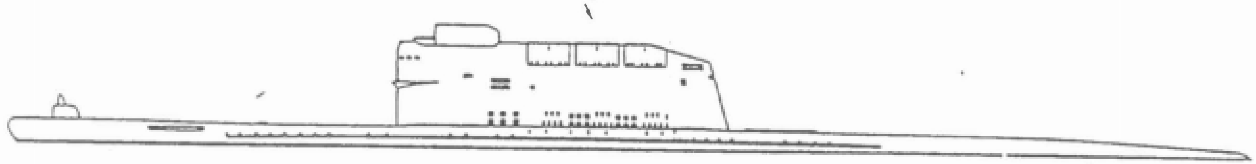
Figure 33





SOVIET 'G' CLASS SUBMARINE

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VIII. SPACE PROGRAM

147. The Soviet leaders clearly believe that achievements in space enable them to persuade the world that in the realms of science, technology, and military strength, the USSR stands in the very front rank of world powers. In seizing an early lead and following it with a series of dramatic successes, they have sought to bolster, both at home and abroad, their claims of the superiority of the Soviet system. The USSR has sought to maximize the impact of its achievement with spectacular "firsts," on occasion timed to coincide with international political moves. Intervening shots appear to have been designed largely to provide data for these "firsts."

148. Since 1955, the announced goal of the Soviet space program has been manned interplanetary travel. Many of the Soviet space activities to date, culminating in the recent manned satellite, have in one way or another contributed to progress toward this eventual goal. While the Soviet space shots have collected scientific data, the scientific aspects of the program seem to have been fairly selective, and to a large degree applicable to the support of future Soviet space missions.

149. We have no direct evidence on the priority of the Soviet space program relative to that of the military missile program. The two programs have used the same basic launching vehicles and shared the same launching facilities; to an extent, they have been mutually supporting. To date the USSR has apparently not launched any space vehicles specifically for military purposes, and we have no present evidence pointing to such a Soviet intention. However, many of their space experiments have produced information which would be useful in the development of future military space systems. It would be technically feasible at present for the Soviets to equip earth satellites for such military support roles as communications, reconnaissance, navigation, or collection of weather data. Their present satellites possess the attributes of payload, stabilization, and recoverability sufficient for such missions. We estimate that they could appear at any time.

Soviet Achievements in Space

150. The importance which the Soviets attach to the space program is demonstrated by the assignment of leading scientists to its direction, by the wealth of theoretical and applied research being conducted in its support, and by the allocation of resources and facilities to its implementation. Space vehicles have constituted more than one-third of the total number of launchings from Tyuratam in the past 3½ years. The impressive Soviet record now includes: orbiting of the world's first earth satellite and by far the largest satellites; launching of the first vehicles to impact the moon and to photograph the reverse side of the moon; launching of the first vehicle to transfer from earth orbit to a trajectory towards a planet; orbiting and recovery of the only earth satellites suitable for supporting manned orbital flight; and, most recently, the successful orbiting and recovery of a man.

151. Four distinct phases can be discerned in the Soviet space program to date:

a. Sputniks I, II, and III, launched in 1957 and 1958, were instrumented satellites designed to collect data on space near the earth and, in the case of Sputnik II which contained a dog, to provide some biological data (see Figure 34).

b. Luniks I, II, and III, launched during 1959, were all instrumented to collect data on space between the earth and the moon and with respect to the moon itself (see Figure 35).

c. The Soviet effort to put a man in space led in 1960 and 1961 to the orbiting of six heavy satellites. Five of these, Sputniks IV, V, VI, IX, and X, each probably contained a life support system suitable for man and equipment designed for his recovery. Sputnik V (see Figure 36) was successfully recovered in August 1960; Sputniks IX and X in March 1961. This effort culminated in April 1961 with the successful orbiting and recovery of a man in Sputnik XI.

d. The Soviet effort to launch an interplanetary probe probably began in October 1960 with what appear to have been two unsuccessful attempts to launch a probe toward

Table 2

SOVIET EARTH SATELLITES [a]

	SPUTNIK I (1957 ALPHA-2)	SPUTNIK II (1957 BETA)	SPUTNIK III (1958 DELTA-2)	SPUTNIK IV (1960 EPSILON)	SPUTNIK V (1960 LAMBDA)	SPUTNIK VI (1960 RHO)
Weight (lbs.)	184 (includes the structural weight).	1,120 (including batteries).	2,130 (plus about 800 lbs. of structural weight, i.e., 2,925 lbs.)	a. Weight of pressurized cabin .... 5,513 b. Weight of de-orbiting retro-rockets, fuel tanks, pumps and associated structure 1,241 c. Weight of instrumentation [c] .... 3,257 Total 10,011	10,143	10,037.
Configuration	Spherical	Conical [b]	Conical [b]	Unknown but probably very similar to Sputnik V.	Space ship configuration unknown. Emergency escape capsule is a circular cylinder with a hemispherical nose. Two dogs were placed in a pressurized container which was similar in size and shape to that used in Sputnik II.	Unknown but probably very similar to Sputnik V.
Diameter (ft) of Satellites.	1.9	3.3 [b]	5.7 [b]	Estimated at about 8 ft.	Estimated at about 8 ft.	Estimated at about 8 ft.
Length (ft) of Satellite.		6.5 [b]	11.7 [b]	Unknown	Unknown	Unknown.
Date Launched	4 Oct. 1957	3 Nov. 1957	15 May 1958	15 May 1960	19 Aug. 1960	1 Dec. 1960.
Orbit Period	96.17 minutes	103.7 minutes	106 minutes	91.1 min. prior to deorbiting attempt [d].	90.68	88.58.
Perigee (st mi)	142	140	130	189	193	116.
Apogee (st mi)	588	1,038	1,167	219	193	165.
Inclination to Equator (degrees).	64.3	65.4	65	64.89	64.9	65.
Remarks	Successful orbital flight.	Successful orbital flight.	Successful orbital flight.	Unsuccessful recovery attempt.	Successfully recovered.	Unsuccessful recovery attempt.

Table 2 (*Continued*)

	SPUTNIK VII (1961 BETA)	SPUTNIK VIII (1961 GAMMA) Venus Probe Success	SPUTNIK IX (1961 THETA)	SPUTNIK X (1961 IOTA)	SPUTNIK XI (1961 MU)
Weight (lbs.)	14,292	Approx. 14,000	10,360	10,352	10,428.
Configuration	Unknown	Unknown	Unknown	Unknown	Unknown.
Diameter (ft) of Satellites.	Unknown	Unknown	Unknown	Unknown	Unknown.
Length (ft) of Satellite.	Unknown	Unknown	Unknown	Unknown	Unknown.
Date Launched	4 Feb. 1961	12 Feb. 1961	9 Mar. 1961	25 Mar. 1961	12 Apr. 1961.
Orbit Period	89.8 up to Orbit 17 [e].	89.42	88.20 (Rev.)	88.42 (Rev.)	89.09 (Rev.).
Perigee (s. m.)	135	125.2	114	111	110.
Apogee (s. m.)	194	198.6	154	154	188.
Inclination to Equator (degrees).	65.10	65.01	64.87	64.54	65.00.
Remarks	Venus probe failure.	Venus probe success	Successfully recovered	Successfully recovered	Successfully recovered (manned).

[a] Most of these data are based on Soviet announcements or displays. In a few cases telemetry or other information confirms experiments or data.

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

[c] The meaning of the word "instrumentation" is not known. A weight of 3,257 lbs. seems high for instrumentation only.

[d] At 2352Z, 18 May, deorbiting was initiated, but due to malfunction in the orientation system the vehicle entered a new orbit having a period of 94.25 minutes, a perigee of 190 s.m., and an apogee of 428 s.m.

[e] A transfer to a higher energy orbit is believed to have occurred during the 18th orbit.

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Table 2 (*Continued*)

	SPUTNIK I (1957 ALPHA-2)	SPUTNIK II (1957 BETA)	SPUTNIK III (1958 DELTA-2)	SPUTNIK IV (1960 EPSILON)	SPUTNIK V (1960 LAMBDA)	SPUTNIK VI (1960 RHO)
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.	Based on Soviet statements, this vehicle contained systems and instrumentation required to check the operation of a life support system for man, an attitude stabilization and control system, and a deorbiting retro-rocket system. It was implied that vehicle did not include apparatus for protection from reentry heating or for braking to safe recovery speeds.	A life support system for man, an attitude stabilization and control system, a deorbiting retro-rocket system, a heat-protection and braking system for re-entry and recovery, a large variety of animal and plant life to determine the effect of launching and recovery and the effect of the space environment on living matter. Instrumentation required to determine these effects and transmit data to earth or store for recovery.	Two dogs, other unidentified animals, insects, and plants. Also instrumentation for investigation of outer space physics.
Radio Frequencies used, MCS.	20 40	20 40 66 70	20 66 70	19.996 (heard until 19 July 1960). 66 71 76 182 S-band	19.995 66 71 76 83 183 S-Band	19.995. 66. 71. 76. 83. 183. S-Band.
Date of last Signal Intercept.	25 Oct. 1957	10 Nov. 1957	6 Apr. 1960	19 July 1960 on 19.995 mcs.	20 Aug. 1960	2 December 1960.
Date of Satellite Demise.	4 June 1958	14 Apr. 1958	6 Apr. 1960	Indefinite	Recovered 20 August 1960.	2 December 1960.

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Table 2 (*Continued*)

	SPUTNIK VII (1961 BETA)	SPUTNIK VIII (1961 GAMMA) Venus Probe Success	SPUTNIK IX (1961 THETA)	SPUTNIK X (1961 IOTA)	SPUTNIK XI (1961 MU)
Contents	Probable Venus probe failure.	Used as a launching platform for Venus probe No. 1. Contents not known, but scientific instrumentation unlikely.	Identified by Soviets as "Space Ship No. 4." Probably basically similar to SPUTNIK V carried a dog and other biological specimens as precursors to manned flight. Recovery after one earth-revolution.	Identified by Soviets as "Space Ship No. 5." Probably basically similar to SPUTNIK IX. Carried a dog and other biological specimens. Recovered after one earth-revolution.	Carried the first man into near-space. Recovered after one earth-revolution. TV, telemetry, radiotelephone and radiotelegraph monitored the man's behavior and reactions during flight. Undoubtedly carried solar and cosmic ray radiation measuring equipment.
Radio Frequencies used, MCS.	20 66 71 76 2,825	20 66 71 76 922.8 2,825	20 10.005 19.995 66 71 76 83 182 2,740 2,790	 10.005 19.9 66 71 76 83 183 2,800	... 9.019. 20.005. 66. 71. 76. 83. 134. 183. 2,820.
Date of Last Signal Intercept.	4 Feb. 1961	12 Feb. 1961	9 Mar. 1961	25 Mar. 1961	12 Apr. 1961.
Date of Satellite Demise.	Unknown	25 Feb. 1961	Recovered 9 Mar. 1961	Recovered 25 Mar. 1961	Recovered 12 Apr. 1961.

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Table 3

SOVIET SPACE PROBES [a]

	LUNIK I [b]	LUNIK II [b]	LUNIK III [b] (1959 THETA) [c]	VENUS PROBE [d]
Weight (lbs.)	797	858	959	1418.
Configuration Diameter (ft.) and Length (ft.) of Satellite.	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. The last stage of all three Luniks was probably essentially the same as that displayed at New York and other expositions. Shape: A cone and cylinder, 17½ feet long, 8½ feet in diameter. Weight of empty last stage including instrumentation: varying slightly, about 3,250–3,400 pounds.			Cylinder with hemispherical end, length 6.67 feet, diameter 3.44 feet.
Date Launched	2 January 1959	12 September 1959	4 October 1959	12 February 1961.
Orbit Period	450 Days (around the sun)	Impacted on moon	Approx. 16 days (around the earth).	Not yet determinable.
Perigee (st. mi.)			Approx. 30,000	Not yet determinable.
Apogee (st. mi.)			Approx. 290,000	Not yet determinable.
Inclination to Equator (degrees).			Approx. 75	0.55 to the ecliptic.
Contents	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 photography experiments.	Equipment for measuring micrometeoroid impacts, nature of space matter, cosmic radiation, magnetic fields. [e]
Radio Frequencies Used, MCS.	183.6 19.993 19.995 19.997	183.6 19.993 19.997 20.003 39.986 71 76	183.6 39.986 71 76	922.8.
Date of Last Signal Intercept.	Soviets reported 62 hours reception.	38.4 hours of reception	Soviet: Unknown. US: Possibly 18 October 1959.	22 February 1961.
Date of Satellite Demise	Indefinite around sun	2102:24Z–13 September 1959.	Unknown	Indefinite around the sun.

[a] Most of these data are based on Soviet Announcements or displays. In a few cases telemetry or other information confirms experiments or data.

[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.

[d] Launched from a 14,300 lb. earth satellite vehicle.

[e] A primary purpose of this event was vehicle R & D, i.e., to check injection systems, propulsion and guidance, and radio communications over long distances.

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Table 4

SUMMARY OF SOVIET-ANNOUNCED SCIENTIFIC INSTRUMENTATION *

For Soviet Earth Satellites and Space Probes

Instrumentation (Soviet Terminology)	SPUTNIK I	SPUTNIK II	SPUTNIK III	LUNIK I	LUNIK II	LUNIK III	SPUTNIK V	VENUS PROBE	VERTICAL ROCKETS
Internal Temperature	X	X	X	X	..	..	..	..	X
Internal Pressure	X	X	X	X	..	..	..	..	X
Magnetometer	..	..	X	X	X	..	..	X	X
Solar Radiation:									
Corpuscular (sic)	..	X	X	X	..	..	..	..	X
Ultraviolet	..	..	..	..	..	..	X	..	..
X-Radiation	..	..	..	..	X	..	X	..	..
Cosmic Rays:									
Heavy nuclei	..	..	X	X	..	..	X	..	X
Light nuclei	..	..	..	..	..	..	X	..	..
Multicharged Particles	..	..	..	..	..	..	X	..	..
Photon Showers	..	..	X	X	..	..	X	..	X
Primary (composition)	..	X	X	X	X	..	X	X	X
Magnetic Manometer	..	..	X	..	..	..	..	..	X
Ionization Manometer	..	..	X	..	..	..	..	..	X
Ion Traps	..	..	X	..	..	..	..	..	X
Electrostatic Fluxmeter	..	..	X	..	..	..	..	..	X
Mass Spectrometer	..	..	X	..	..	..	..	..	X
Micrometeor Detector	..	..	X	X	X	..	..	X	X
Automatic Monitoring of condition or state of Micro-organisms.	..	..	..	..	..	..	X	..	..
Spacematter Density	..	..	..	..	X	..	..	X	..
Radiation Around Earth	..	..	..	..	X	..	..	..	..
Radiation Around Moon	..	..	..	..	X	..	..	..	..
Temperatures (Space)	..	..	..	..	..	X	..	..	..
Radiation (sic)	..	..	..	..	..	X	..	..	..
Lunar Photography	..	..	..	..	..	X	..	..	..
Sodium Cloud Experimentation	..	..	..	X	X	..	..	..	..
Lunar-Magnetic Field	..	..	..	..	X	..	..	..	..

* No specific information as to instrumentation was released by the USSR on Sputniks IV, VI, VII, VIII, IX, X, or XI. In addition to instrumentation, Sputnik II carried a dog, Sputniks V and VI each carried two dogs plus other biological specimens, Sputnik IX carried a dog and other biological specimens, and Sputnik XI carried a man.

Mars. In February 1961, the Soviets attempted with Sputnik VII to launch a probe toward Venus from an orbiting satellite, and succeeded later in the month with Sputnik VIII.

152. The reliability achieved in Soviet space shots has been much lower than that of the Soviet ICBM. Most space failures were apparently caused by factors unique to the space program, such as the addition of upper stages to the basic booster and in some cases the requirement to launch at stipulated times. The Soviets have achieved 14 successful launchings of space vehicles, but we believe that there have been nearly as many launchings which resulted in failures. Moreover, several of the vehicles which were successfully launched apparently did not function as planned. Lunik I, which was probably intended to hit the moon, missed by a wide margin and went into orbit around the sun. The recovery system contained in Sputniks IV and VI failed to function successfully. The first attempt to launch a Venus probe succeeded in orbiting the earth satellite, Sputnik VII from which the probe was to be launched, but failed during injection into the trajectory towards Venus.

153. The Soviets desire to accomplish dramatic "firsts" is probably another factor in the relatively low reliability of their space shots. They have undertaken some very challenging operations, and in their lunar and planetary shots have shown a tendency to move on to the next challenge once a given type of operation is successfully demonstrated. This approach has contributed to the impressive Soviet record in pioneering space achievements. There is evidence from public and private statements, however, that some Soviet scientists have been concerned lest political goals interfere with sound scientific progress.

Launching Facilities

154. Both of the major Soviet ballistic missile test ranges have been involved in the space program. Since 1954, about 25 vertical firings have been detected at the Kapustin Yar range. According to the Soviets, the purposes of such firings have included upper atmosphere research, sodium vapor ejection, photographing the earth's cloud cover, and space biology including the recovery of live animals. All launchings of earth satellites and space probes have taken place at Tyuratam. Although the majority of the launchings here have involved ICBM tests, there are indications that Tyuratam was designed with the space program clearly in mind. The facilities at launch areas "A" and "B" are of a size and design which could probably handle vehicles with thrusts on the order of several million pounds. Tyuratam should thus be able to satisfy the ground handling and launching facility requirements for much of the Soviet space program over the next 10 years.

155. *Propulsion.* All earth satellites and lunar vehicles, with the possible exception of Sputniks I and II, are believed to have used the same basic launching vehicle as the ICBM. One additional upper stage was added for the launching of the Luniks and Sputniks IV, V, VI, IX, X, and XI. Two upper stages were apparently added to the basic booster in the successful Venus shot—one of them to place Sputnik VIII into orbit around the earth and the other to power that portion of the satellite which entered a trajectory towards the planet.

156. The data available on the Venus shot indicates that with one additional stage the Soviet ICBM booster placed about 14,000 pounds into orbit around the earth. This is the largest payload the Soviets have succeeded in orbiting. We expect additional increases in launching vehicle capability through further improvements in staging and the use of improved fuels, which could increase the orbital payload to about 25,000 pounds in about 1962.

157. A new rocket engine, which may deliver 1 to 2½ million pounds of thrust, could be available for first flight in about 1963. Intelligence on a new rocket engine test facility near Kuybyshev indicates that the Soviets are actively developing such an engine. Clustering of two to five of these engines, which could probably be achieved in 1965–1970, would result in a booster capable of orbiting payloads of 50 to 100 tons. On several occasions, Khru-

shchev has alluded to plans for orbiting payloads of this magnitude.

158. *Structures.* The design and construction of the Luniks and the Sputniks, as displayed or otherwise publicized by the Soviets, indicate that relatively heavy structural design and fabrication techniques are used in the design of their space vehicles. The availability of high thrust launching vehicles has permitted the use of these heavy structures and of equipment which is probably not miniaturized. This in turn provides some benefit with respect to the potential reliability of a space system and its instrumentation.

159. *Re-entry.* In the area of re-entry, the Soviets appear to have made major strides during 1960 and 1961 in both ICBM nosecones and space vehicles. The Soviets have demonstrated that they now have adequate materials and techniques to protect space vehicles during re-entry into the atmosphere and to accomplish successful landings.

160. *Payload Instruments.* The Soviets have developed and successfully demonstrated extensive and complex instrumentation for their earth satellite and lunar space vehicles. Because of the USSR's large payload capability, we do not believe miniaturization has been a prime requirement for Soviet space instrumentation design to date. This has been supported by analysis of the space equipment which has been publicly displayed by the Soviets. However, as mission requirements increase, the Soviets will be required to attend more to the question of component miniaturization. Improvement of the photographic system used in Lunik III is expected to continue and similar techniques could be utilized in weather and possibly photographic reconnaissance satellites and in photography of other planets.

161. *Tracking and Surveillance Systems.* The extensive system used by the Soviets to track space vehicles, including optical observatories, radio telescopes, photographic stations, radars, radio direction-finders, and interferometers, appears to give them the capability for space tracking and surveillance from within their own borders. This capability is supplemented and extended mainly by ships at sea with some assistance from other Soviet Bloc and Western countries and from Soviet stations in the Antarctic. However, the Soviets lack the worldwide facilities available to the West. The recent effort to initiate negotiations for a tracking facility in Australia indicates a Soviet desire to extend their present system. We cannot estimate how many missions could be handled simultaneously; to date the Soviets have not demonstrated a capability for detailed tracking and readout on more than two objects at a time.

Major Basic and Applied Research Areas

162. We have estimated that payloads on the order of 50–100 tons will become possible in the latter half of the decade. The missions which can then be accommodated would potentially be capable of prolonged flight and changes in flight path long after initial injection into space. However, such mission capabilities would require further extensive research and technological advances in several key areas.

163. The Soviets are aware of the advantages offered by nuclear rocket engines for space use, and very limited evidence indicates that they are engaged in nuclear rocket engine development. We estimate that the first static test firing of a prototype system for upper stage use or space maneuvering could be made as early as 1965, and that test flights could begin before 1970.

164. At present the small internal power requirements for space payloads are being met by the use of chemical batteries and solar cells. However, increased demands for electrical power are expected to arise in the 1965 to 1970 time period. Ecological life support systems will require greatly increased power, and extremely heavy demands would be imposed by electric or plasma propulsion systems. These demands could be met by nuclear power sources, and there is evidence of work being done in this field. The Soviets also recognize the propellant weight advantage afforded by electric and plasma space pro-

pulsion systems.[18] Although none of the estimated missions require the use of this type of propulsion, we believe that basic research is under way in this area. However, we believe that the first test flights of prototype electrical or plasma propulsion systems in space are not likely to occur until late in the decade.

165. The Soviets are carrying out a broad program of research applicable to the development of extremely long range space telecommunications and navigation systems. This research includes the fields of information theory, radio wave propagation, maser and other low noise signal amplifying devices, antenna theory and engineering, radio astronomy, high power transmitting tubes, and solid state physics. The caliber of the Soviet work to date indicates that the USSR is among world leaders in such specialities as radio astronomy and solid state physics. We believe that the USSR will be able to satisfy its requirements for communications and navigation of space vehicles, despite its apparent recent difficulty in maintaining continuous communications with the Venus probe.

166. Since 1955, the USSR has intensified its physiological research on the control of environmental stress factors. This work concerns the functional characteristics of the human operator in space vehicles and includes research on the effects of acceleration, weightlessness, oxygen saturation, vibration and noise, and confinement over prolonged periods. Research directed toward the development of a completely closed life-support system probably is also underway. The USSR is also conducting active research on methods for protecting man against the radiation hazards of prolonged flight within and beyond the Van Allen belts.

Soviet Capabilities for Specific Future Missions

167. *Exploration of Cis-Lunar Space.* The Soviets probably have obtained sufficient data from their own and US experiments about the near earth (0–1,000 miles) space environment to allow them to begin bio-astronautic tests with organisms and animals in the cis-lunar region in the near future. The Soviets have already conducted some experimentation to lunar and interplanetary distances, and we expect a more thorough exploration of these regions.

168. *Unmanned Earth Satellites.* Earth satellite vehicles offer significant advances over conventional techniques for acquiring information on force deployment and mapping, for weather surveillance, and for communications. The USSR probably could have developed and used such devices, but has not done so.

169. As the US program for reconnaissance and early warning satellites develops, we believe that the Soviet Union will try to find ways to destroy them, possibly with counter-satellites. In view of the cost and technological difficulties to be overcome, we estimate that the first Soviet capability using unmanned orbiting vehicles to disable US satellites could occur sometime after the middle of the decade. (Other Soviet capabilities against satellites are discussed in paragraph 63.)

170. *Unmanned Lunar Flight.* We believe the USSR will place an instrumented satellite into orbit around the moon in the near future. An instrumented lunar soft landing probably can be made during 1961, although such a feat would require not only a retrorocket, but also more accurate guidance and more refined attitude orientation than that tested on Lunik III (October 1959). In order to collect data after a landing, the Soviets might use instrumentation packages similar to their automatic radio weather stations which are released from aircraft.

171. As landing techniques are improved, larger payloads including rocket systems with terminal control for a soft landing on the moon as well as lunar restart and launch capabilities will probably be developed. Soviet statements indicate that the USSR is also designing an unmanned mobile vehicle for

[18] Such systems are characterized by very low thrust but high specific impulse. They are useless for planetary take-off and landing maneuvers but show great promise for interorbital maneuvering and space travel.

the exploration of the lunar surface. The size and weight of this vehicle, which the Soviets call a Tankette, would require a launching booster much larger than now available. Its soft landing, using an advanced launching vehicle of about five million pounds thrust probably could not be accomplished before about 1965 (see paragraph 157, page 41).

172. *Manned Earth Orbiting Flight.* The Soviets have now successfully demonstrated their capability to orbit and recover a manned earth satellite. Additional missions of this type probably will be undertaken during the next year or so. We believe that future manned re-entry vehicles will be made more maneuverable in order to exploit the advantages which glide-type vehicles offer over the capsule-type vehicles currently being used. A manned glide-type recovery vehicle could be demonstrated, at the earliest, during 1963. We believe that by 1963 the Soviets could with conventional propellants have the capability to make limited angular or altitude changes in the path of manned earth satellite vehicles outside the atmosphere. As the payload-in-orbit capability increases, the capability to make repeated path changes can be expected. In about 1965, increased maneuverability of the vehicle should permit the Soviets to effect rendezvous with an earth orbiting vehicle.

173. Advanced earth orbiting space stations suitable for sustaining life and for performing scientific or military functions for extended periods of time (several months or more) are believed to be a part of the Soviet program. These stations would have to be able to keep their positions as well as make minor adjustments in position as desired. We estimate that a large, long-lived space platform weighing on the order of 50–100 tons could be established about 1968–1970, barring the existence of unforeseen space hazards which preclude it.

174. *Manned Lunar Flights.* Contingent upon successes with manned earth satellites and the development of large booster vehicles, the Soviets are believed capable of a manned circumlunar flight with reasonable chance of success in 1966; of recoverable manned lunar satellites in 1967; and of lunar landings and return to earth by about 1970. These are all estimated to be the earliest possible dates.

Offensive Space Weapons

175. There is no evidence that the Soviets are developing offensive space weapons. However, some of the Soviet achievements in space would be necessary initial steps in the development of space weapons, and the Soviets have undoubtedly undertaken studies and research in this area. Soviet success in space as exemplified by the Venus probe, the most recent successful orbiting and recovery of a man, and the capability to orbit still heavier payloads over the next few years, leads to the conclusion that the Soviets are technically capable of achieving an orbital bombardment vehicle toward the end of the period of this estimate. Moreover, the Soviet leaders might seek to derive some psychological or political advantage by hinting or even boasting that the USSR had a significant capability in space weapons. The launching of vehicles for which the Soviets claimed a military capability or other Soviet achievements in space could lend credence to such claims.

Table 5

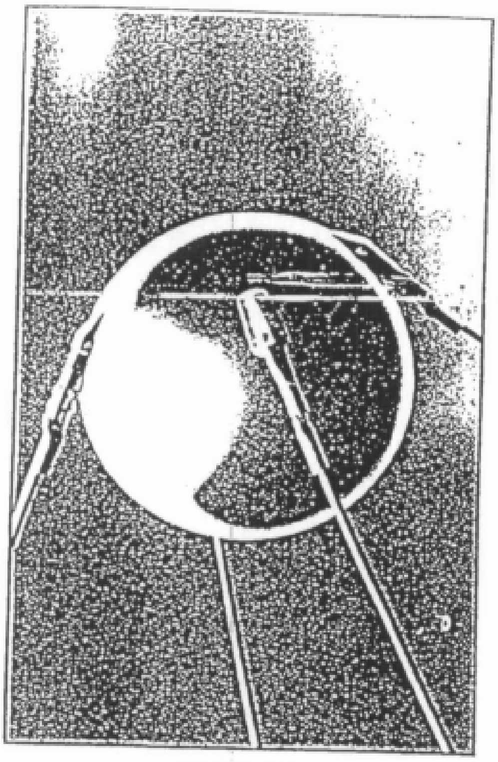
POSSIBLE SOVIET SPACE ACTIVITIES

Space Program Objectives	Earliest Capability Date
These dates represent our estimate of the earliest possible future time period in which each specific event could be successfully accomplished. We believe that several could have been accomplished in 1959 or earlier, if the Soviets had chosen to do so. Based on our uncertainty as to specific Soviet space objectives as well as competition between Soviet programs, we do not estimate accomplishment of every one of these objectives within the specified time periods.	
Unmanned Earth Orbiting Flight:	
15,000–20,000 pounds, low orbit	1961
Military satellites	
Communications	1961
Weather surveillance	1961
Force deployment and mapping	1961
Unmanned Lunar Flight:	
Satellite	1961
Soft landings	1961
Landing and exploration (Tankette)	1965
Manned Earth Orbiting Flight: [a]	
Glide-type vehicle recovery	1963
Maneuverable (minimum; exo-atmospheric; conventional propulsion)	1963
Orbital rendezvous (conventional propulsion)	1965
Maneuverable outside atmosphere (nuclear propulsion)	1968
Space platform (50–100 tons)	1968–1970
Manned Lunar Flight:	
Circumnavigate	1966
Satellite	1967
Landing	1970

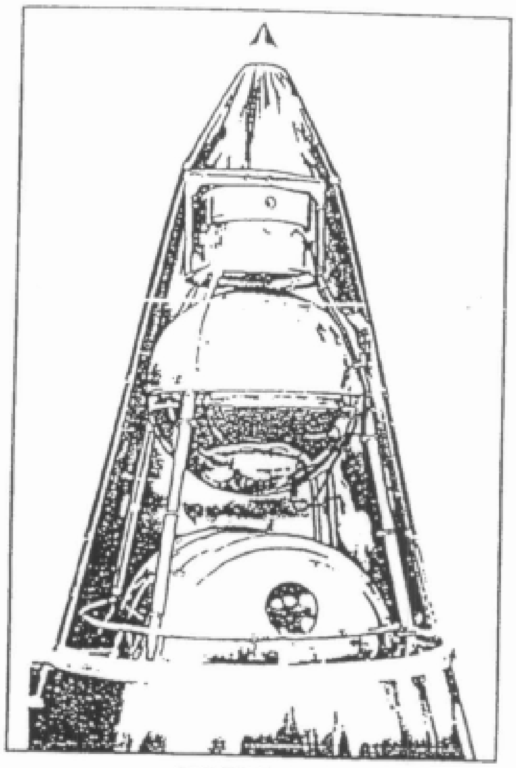
[a] The specified time periods for manned accomplishments are predicated on the Soviets having previously successfully accomplished a number of similar unmanned ventures.

Figure 34

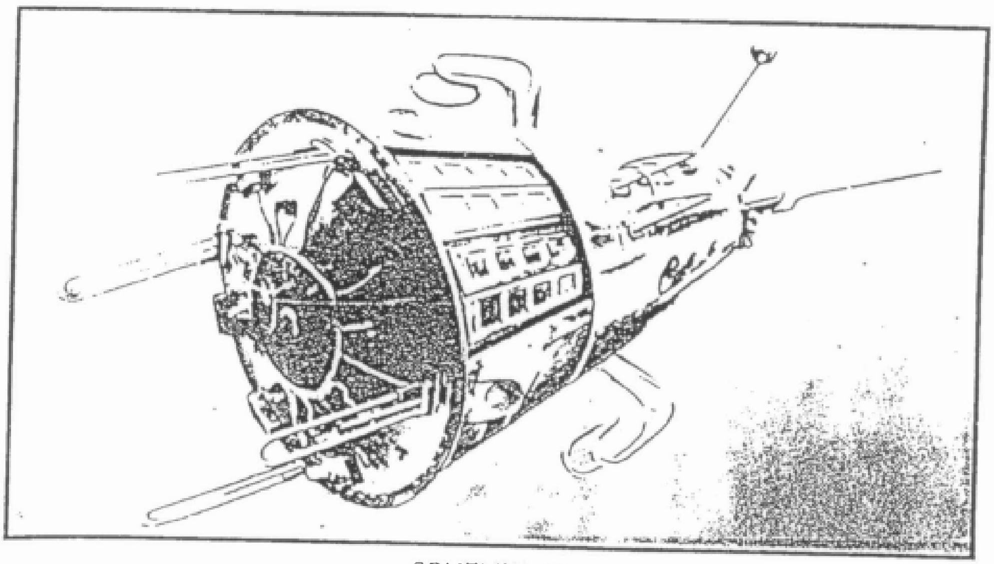
EARLY SOVIET EARTH SATELLITES



SPUTNIK I

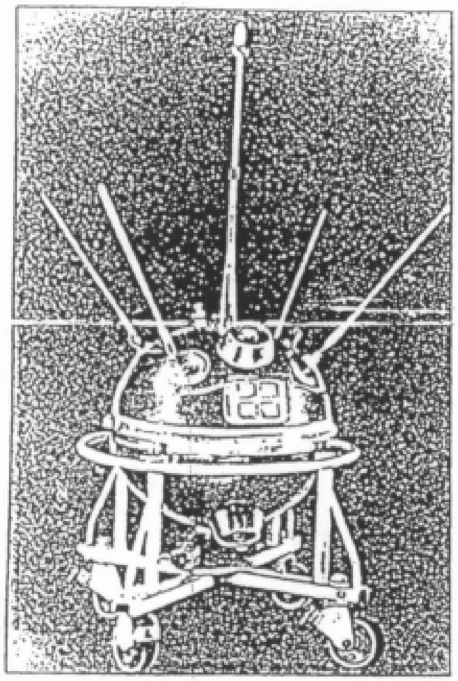


SPUTNIK II

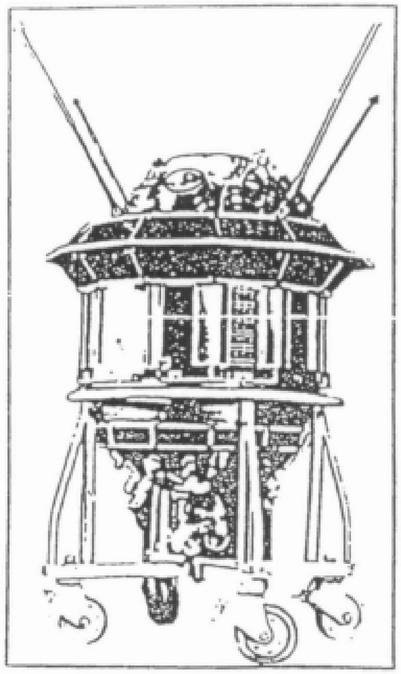


SPUTNIK III

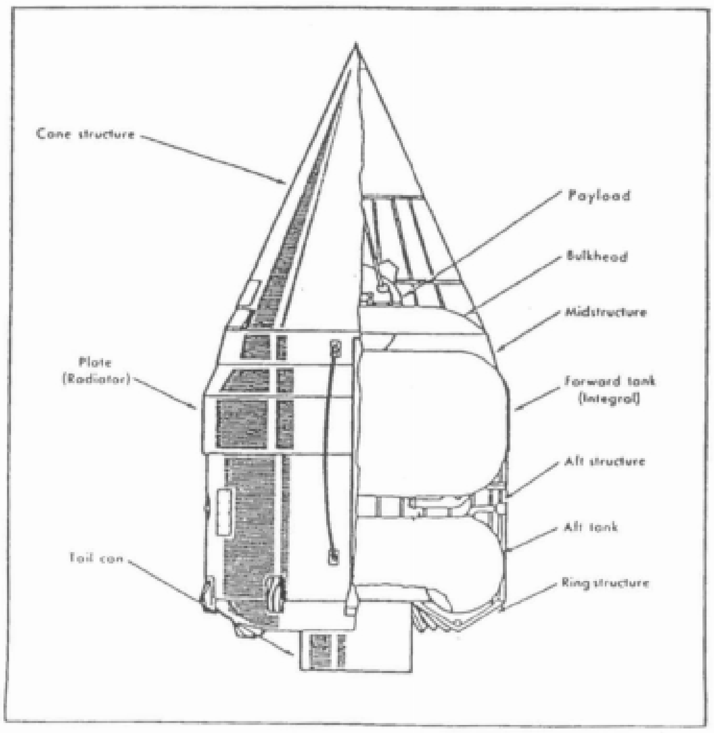
SOVIET LUNAR PROBES



LUNIK I PAYLOAD



LUNIK III PAYLOAD



LUNIK UPPER STAGE

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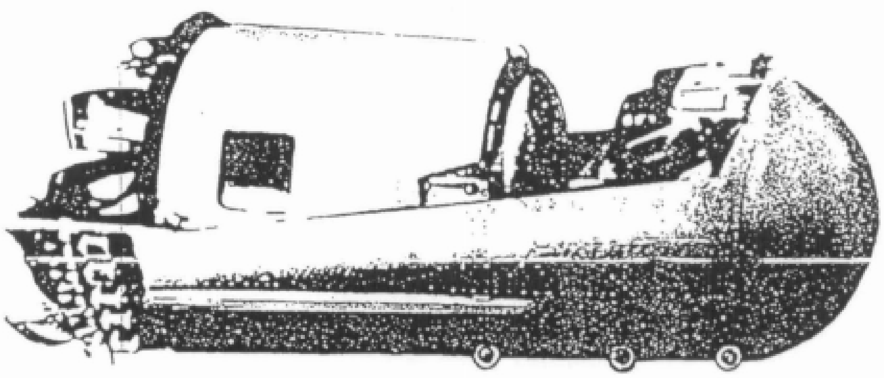
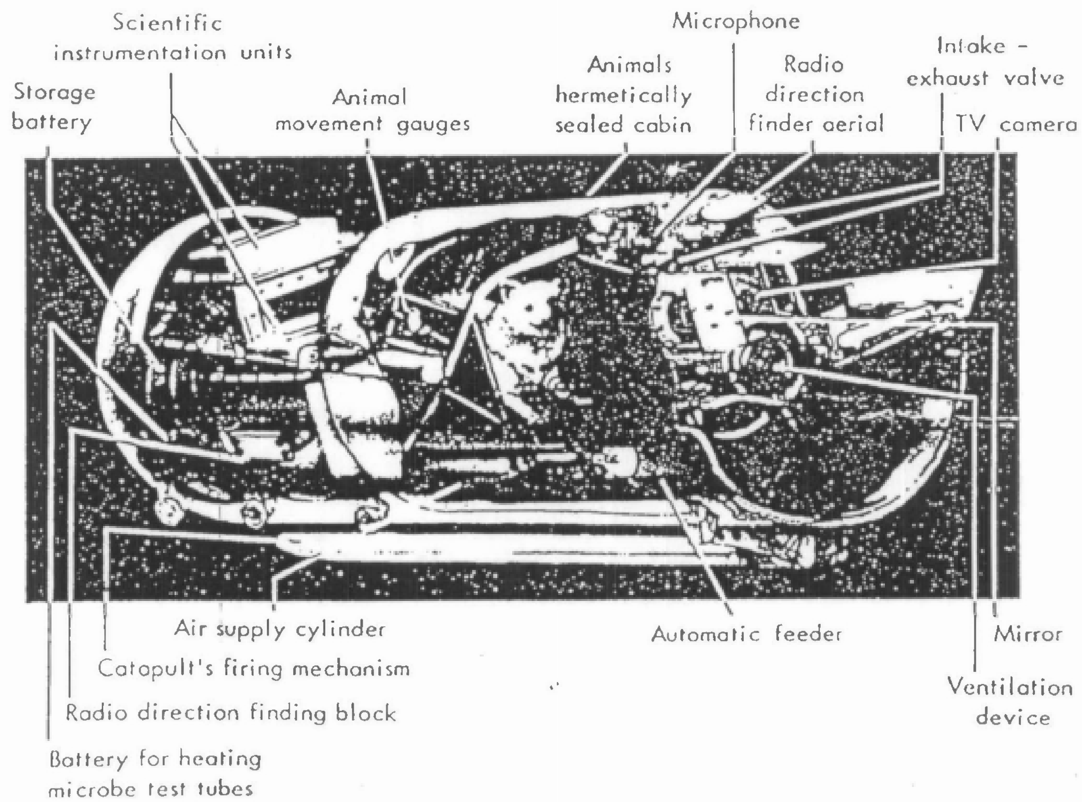
Figure 36

SPUTNIK V ESCAPE CAPSULE



THE CAPSULE WITH THE TEST ANIMALS WHICH WAS CATAPULTED FROM THE SHIP-SATELLITE AND WAS SAFELY RETURNED TO THE EARTH



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ANNEX A: ESTIMATED RELIABILITY OF MISSILE SYSTEMS

ANNEX A

ESTIMATED RELIABILITY OF MISSILE SYSTEMS

ESTIMATED RELIABILITIES

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 *current period*, and reflect improvements from the IOC date. In those cases where the IOC has been recent, or is in the future, improvements are generally specified.

US Designation	INITIAL OPERATIONAL CAPABILITY	Ready Missile Rate [a]	Reliability		REMARKS
			On Launcher [b]	In Flight [c]	
Air-to-Surface Systems: [d e]					
AS-1	1956-1957	*na*	90	80	55 n.m.
AS-2	Late 1960	*na*	80	70	100 n.m.
			(90)	(80)	(1963).
AS-3	Late 1960	*na*	80	70	350 n.m.
			(85)	(80)	(1963).
Surface-to-Surface (Ground Launched):					
SS-1	1957	*na*	90	80	150 n.m.
SS-2	1954	*na*	90	80	350 n.m.
SS-3	1956	85	90	80	700 n.m.
SS-4	Late 1958 or early 1959.	85	95	80	1,100 n.m.
SS-5	Late 1961 or early 1962.	75	80	75	2,000 n.m.
		(85)	(95)	(80)	(Late 1964-1st half 1965.)
SS-6	1 Jan. 1960 [e]	70-85	85-90	70-85	As of mid-1961.
		(85-90)	(90)	(80-90)	(1963).
Surface-to-Surface (Naval Launched): [d f]					
SS-N-1	1958	*na*	85	80	20-30 n.m. Subsonic, destroyer-launched.
SS-N-2	1958	*na*	85	80	20-30 n.m. Supersonic, destroyer-launched.
SS-N-4	1958/1959	*na*	95	80	"Z" and "G," 150 n.m./350 n.m.
SS-N-5	1962/1963	*na*	85	80 with subsequent improvement	500-1,000 n.m. Launched from nuclear sub.

See footnotes at end of table.

ESTIMATED RELIABILITIES (*Continued*)

US Designation	INITIAL OPERATIONAL CAPABILITY	Ready Missile Rate [a]	RELIABILITY On Launcher [b]	RELIABILITY In Flight [c]	REMARKS
Surface to-Air: [d]					
SA-1	1956 September	na	90	90	Moscow defense system.
SA-2	1957	na	90	90	Mobile SAM system.
SA-3	1961	na	90	90	Low altitude system.
SA-4	1965	na	80	75 with subsequent improvement	Antimissile missile.
Air to Air: [d e]					
AA-1	1956	na	85	80	"ShM" beam rider.
AA-2	1956	na	85	80	1-4 n.m. infrared homing.
AA-3	1958	na	90	85	3-6 n.m. radar homing.

[a] That percentage of missiles on launcher which are "ready missiles." A ready missile is an in-commission missile with warhead mated, mounted on an in-commission launcher in a trained unit which is considered ready to be committed to launch.

[b] The percentage of ready missiles which will successfully complete the countdown and leave the launcher within the required time limits.

[c] The percentage of missiles launched, the warheads of which actually detonate as planned in the target area (i.e., within three CEPs of the aiming point).

[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 factors not related to missiles.

[f] Reliability figures are not available for the SS-N-3, a 300 n.m. cruise-type missile.

[g] For the views of the Assistant Chief of Staff for Intelligence, Department of the Army, and the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, see their footnotes, page 30.

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ANNEX B: ESTIMATED REACTION AND RELOAD TIMES

ANNEX B

ESTIMATED REACTION AND RELOAD TIMES

Surface-to-Surface Missiles

We have no good evidence on the reaction times of Soviet surface-to-surface missile units. However, based on our analysis of the characteristics of these systems and general Soviet capabilities, we estimate the following reaction times as of mid-1961:

a. SS–1: This 150 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–2 through SS–4: Although these systems are capable of varying degrees of mobility we estimate that they would be deployed to simple presurveyed sites when hostilities become imminent. The reaction times for units already deployed will vary with the degree of alert and will be approximately the same as discussed under SS–5 and SS–6 (ICBM) below. For units in transit at the time of alert, 2–4 hours will be required to launch the first missile after the unit has arrived at the presurveyed or prepared site.

c. SS–5 and SS–6 (ICBM): We estimate the SS–6, and probably the SS–5, will probably utilize fixed sites. The Soviet design philosophy, particularly in the respect to the fueling techniques employed at operational launch sites, will critically affect ICBM reaction times. Assuming that rapid reaction time has been a Soviet objective, we estimate the following minimum reaction times for ready missiles under the three alert conditions indicated:

Condition I: Crews on routine standby, electrical equipment cold, missiles not fueled. Reaction time 1–3 hours.

Condition II: Crews on alert, electrical equipment warmed up, missiles not fueled. Reaction time 15–30 minutes.

Condition III: Crews on alert, electrical equipment warmed up, missiles fueled and occasionally topped. This condition probably could not be maintained for more than an hour or so. Reaction time 5–10 minutes.

Air-to-Air and Air-to-Surface Missiles

The AAMs and ASMs have a short enough reaction and reload time that they are not the delaying factor in the takeoff of the aircraft.

Surface-to-Air Missiles

All SAMs, including those mounted on ships, will have a reaction time of no more than a minute when alerted. The reload time will vary with the type of missile system.

Naval Missile Systems [10]

The reaction times in minutes for naval systems are estimated as follows:

	Alert	Routine	Reload Time	Remarks
SS–N–1	1	5–10	5	DD Subsonic cruise 30–40 n.m.
SS–N–2	1	5–10	5	DD Supersonic cruise 30–40 n.m.
SS–N–4	10	15	No reload	"Z" Class Sub
SS–N–5	5	15	No reload	Advanced Sub

[10] No estimates of reaction and reload times are available for SS–N–3, a 300 n.m. supersonic cruise missile designed to be fired from a surfaced submarine.

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ANNEX C: ORGANIZATION AND CONTROL

ANNEX C

ORGANIZATION AND CONTROL

1. There is inconclusive evidence concerning the Soviet organizations responsible for developing and producing hardware, constructing operational facilities, and training personnel to operate guided missile weapons systems. Our view of these is based largely upon our general knowledge of Soviet organization, practices, and relationships in dealing with military and civilian programs. Other than Soviet statements, there is even less specific information, although there are useful analogies in the Soviet military concerning the command structure which controls the employment of guided missile forces.

2. Decisions concerning major programs upon which the strategic goals of the regime depend are highly centralized at the level of the interlocking directorate formed by the Presidium of the Central Committee of the Communist Party and the Presidium of the USSR Council of Ministers. The Party Presidium makes the policy decisions on the missile weapons systems with which the Soviet armed forces are to be equipped and on the overall resource requirements to be devoted to the guided missile program. The Presidium exercises close supervision over the organizations responsible for translating its decisions into military capabilities and approves such major adjustments in the program as may seem necessary in the light of technological developments and changes in the Presidium's strategic goals. Ultimate responsibility for control of forces using guided missiles also is centered in the Party Presidium. The mechanism for operational control of military forces is distinct from but closely coordinated with that required to develop, produce, and deliver all the elements of the missile weapons system. Throughout the operational organization and command channels, there are also significant variations of control depending upon the type and mission of the weapons system considered.

3. The staff work of several organizations provides the basis for the Presidium's decisions on the composition of the guided missiles program which will serve its strategic goals and on the relative priorities to be assigned the individual missile systems. The Ministry of Defense is the principal source of proposals for weapons systems. The Academy of Sciences provides supplementary proposals and research programs designed to advance the state-of-the-art. The USSR State Planning Committee, the USSR State Scientific Economic Council, and the Ministry of Finance work out estimates of the resource and funding requirements of alternative programs and their implications for other major economic and political goals of the Presidium. When the Presidium reaches its decision, these central planning and financial organs incorporate the missile program into the overall economic and financial plans. Detailed implementation of development, production, and construction schedules is carried out by the economic bureaucracy of the Soviet Government.

4. Translating the policy decisions on a guided missile program into complete weapons systems in the hands of troops requires a well-coordinated effort to develop and produce the missiles, guidance, ground support equipment, fuels, and warheads, to construct the launch and support facilities, and to train the troops. Given the current administrative structure of the Soviet economy, the complexity of the problem, and the competing nature of the priorities among various weapons systems, it is likely that a special executive authority within the Council of Ministers is responsible for implementing the guided missile weapons program approved by the Presidium. Such

an executive authority would be headed by a Council of Ministers' Presidium member—probably D. F. Ustinov, a Deputy Chairman of the Council of Ministers and a full member of the Party Central Committee, who has an extensive background in weapons production. It would probably include the Chairman of most of the State Committees, the Minister of Defense or the Commander-in-Chief of Rocket Troops, and the heads of the planning and financial staff organs. The functions of this executive authority would be to coordinate the work of the participating organizations, to make the necessary day-to-day decisions using the USSR State Planning Committee as its administrative arm, and to submit key problems promptly to the Presidium for review and decision.

5. The Ministry of Defense is responsible for the military aspects of the guided missile program: formulating strategic and tactical doctrine, specifying military requirements, funding within the framework of military expenditures, participating in design and testing, military acceptance of finished hardware, troop training and construction, and maintenance of operational facilities. Coordination of this activity with development and production organizations is probably effected through an executive authority with the Council of Ministers. Within the Ministry of Defense, the Chief Artillery Directorate is the principal organization designated to carry out responsibilities that apply to the procurement, quality control, and maintenance of equipment for all the force components. The force components (ground, air, rocket, naval, PVO) of the Ministry of Defense, organize the forces for the employment of guided missile systems.

6. The research and development phase of the program is centered in research institutes and design bureaus subordinate to and managed by the State Committees, the Ministry of Medium Machine Building, and the Defense Ministry. The production of hardware for missile systems probably is carried out in plants under the guidance of the State Committees and, for nuclear matters, under the Ministry of Medium Machine Building. Many plants under the jurisdiction of the Councils of the National Economy, however, perform an essential subcontracting role.

7. In addition to operation of the test ranges, the Ministry of Defense is responsible for the training of the troops for the guided missile systems. Part of the troop training program is carried out at the test ranges. Responsibility for the administration of test ranges, and probably for troop training as well is divided between the force components of the Ministry of Defense and higher technical organization. This division of responsibility seems to be based upon the mission of the particular missile system and the component to which it is primarily assigned for operational use. Responsibility for the construction of operational facilities for surface-to-surface and surface-to-air systems probably is centered in the Ministry of Defense.

8. In May 1960 the USSR announced the formation of a new missile command, the "Rocket Troops of the Soviet Army," which has been designated one of the main components of the Soviet armed forces. Like the other major components (ground, naval, air, and air defense), the new command is concerned with the organization, doctrine, training, administration, and logistic requirements of its forces. In addition, according to Soviet statements, the Commander-in-Chief of Rocket Troops is in the direct chain of operational command, at least with respect to long range ballistic missiles.

Organization and Control of the Space Program

9. The Interagency Commission for Interplanetary Communications under the Astronomical Council of the Academy of Sciences probably has the prime responsibility for planning, programing, and coordinating space research. Administrative responsibility for the program appears to be divided between civilian authorities who direct scientific research and military authorities who conduct the present launching vehicle program.

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ANNEX D: TABLES

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Summary Table I

PROBABLE SOVIET DEVELOPMENT PROGRAM FOR SURFACE-TO-AIR MISSILE SYSTEMS [a] (Ground Launched)

Arbitrary Reference Designation	Initial Operational Capability Date [b]	Maximum Effective Altitude [c] (in feet)	Maximum horizontal Range (nm) [c] / Speed Class	Operational [d] Accuracy (CEP in ft.)	Guidance	Maximum Warhead [e] (lbs. and type)	REMARKS
SA-1	1954	60,000 (minimum about 3,000).	20–30 / 3.5	65–120	Track-while scan/ radio command.	500 HE or Nuclear.	Deployed around the Moscow area only. Uses V-301 guided missile. GUIDELINE (part of SA-2 system) may be used in some SA-1 sites replacing V-301.
SA-2	1957	60,000 (minimum altitude about 2,500). We estimate that in the next few years the system could be improved in range, altitude, and ECCM capabilities.	25–30 / 3	100	Track-while scan	500 HE or Nuclear.	Mobile SAM system using GUIDELINE missile. Extensively deployed in USSR; chief advantage is its flexibility in deployment.
SA-3	1961	40,000–60,000. Nominal minimum 50	12–15 / 2	20	Semiactive CW radar homing.	200 HE or Nuclear.	Mobile system: for use with field forces and defense of industrial and communications centers.
SA-4 (AMM)	1963–1966	Soviets will probably deploy an antimissile missile system during 1963–1966 even if the system provides only an interim limited capability. See paragraphs 60–61, page 15 for discussion of the capabilities.					

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

[b] The date when the first operational unit is trained and equipped with a few missiles and launchers.

[c] Maximum altitude is not necessarily achieved at maximum range. Range will vary with the size, direction of approach, and altitude of the attacking aircraft. A limited capability will exist above the estimated altitude.

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

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

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Summary Table II

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

Arbitrary Reference Designation	Initial Operational Capability Date [b]	Guidance	Operational Accuracy (CEP in ft.)	Maximum Warhead [c] (lb. and type)	Approximate Gross Weight (lbs.)	AIRCRAFT			REMARKS [e]
						Compatible Aircraft	Attack Capability	Range n.m. [d]	
AA-1	1955–1956	Radar beam rider.	20	30 HE	130	FARMER E	Rear quarter	2½ (tail) 5 (head-on).	All-weather. Soviet designation "ShM 122".
						FRESCO D and E	do		
						FITTER B	do		
						FISHPOT	do		
						FLASHLIGHT	360°		
AA-2	1955–1956	Infrared homing	10	25 HE	175	FAGOT	Tail pursuit	1½ n.m. to 4 n.m.	Limited to clear air mass [f] conditions. Range varies with altitude and with the target determination capability of fighter.
						FRESCO	do		
						FARMER	do		
						FITTER	do		
						FISHBED	do		
						FLASHLIGHT	do		
						FISHPOT	do		
AA-3	1958	Semiactive radar homing.	15	25 HE	200	FRESCO D and E	Rear quarter	3 (tail) 6 (beam).	All-weather.
						FARMER E	do		
						FITTER B	do		
						FLASHLIGHT	Rear and beam		
						FISHPOT	do		

OTHER: Soviet development of improved air-to-air missiles over the next few years is contingent upon trends in Soviet fighter and Western bomber forces and in Soviet surface-to-air missile defenses (see paragraph 68, page 17).

[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 when the first operational unit is trained and equipped with a few missiles and launchers.

[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.

[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 III

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

Arbitrary Reference Designation	Initial Operational Capability Date [b]	Maximum Range (n.m.)	Operational Accuracy (CEP)	Maximum Warhead [c] (lbs. and type)	Cruise Speed (Mach No.)	Guidance	REMARKS
AS-1 [d]	1956–1957	55	150 feet against ships	3,000 HE or Nuclear	0.8	Beam riding with semi-active homing.	Targets are primarily ships at sea with limited application with degraded accuracy against coastal targets. Carried by BADGER.
AS-2 [e]	Late 1960. Early 1961.	100	150 feet against ships; 1 n.m. against coastal targets.	3,000 HE or Nuclear	Low supersonic.	See paragraph 74. Radar terminal homing against ships.	Same targets as above. Imposes little if any restriction on launch aircraft (BADGER).
AS-3 [f]	Late 1960. Early 1961.	350	1–2 n.m. against land targets; 150 ft. against ships.	3,000 HE or Nuclear	1.5 to 2.0	All inertial against land. Terminal homing required against ships.	See paragraph 77. Probably carried by heavy bombers (BEAR and BISON).

OTHER: It is possible that the Soviets may develop ASM of 500–1,000 n.m. range and higher survival potential than the AS-3.

[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 when the first operational unit is trained and equipped with a few missiles and launchers.

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

[d] System restricts the aircraft during launch to about 15,000 feet altitude with greatly reduced speed. The BADGER's radius is 1,250 n.m. when carrying one missile, 1,000 n.m. with two. This radius can be increased by about 35 percent by a single aerial refueling.

[e] The BADGER's radius would be about the same as with AS-1.

[f] The AS-3 probably weighs 9,000 to 10,000 pounds; two could be carried by the BEAR or the BISON. A range degradation of 8–10 percent for these aircraft when carrying one missile, and 15–20 percent when carrying two is estimated.

Summary Table IV

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

Arbitrary Reference Designation	Initial Operational Capability Date [b]	Maximum Operational Range (n.m.)[c, e]	Guidance	Operational Accuracy (CEP)[d]	Maximum Warhead [e] (lbs. and type)	REMARKS
SS-1 (SCUD).........	1957..........	150	Probably Radio inertial but possibly all-inertial.	½ n.m.......	1,500 HE, Nuclear, CW.	Storable liquid fuel. Mobile in fueled condition.
SS-2................	1954..........	350	Radar track-radio command.	¾ n.m.......	2,000 HE, Nuclear, CW.	Believed to be outgrowth of V-2, improved in range and accuracy. Road mobile.
SS-3 (SHYSTER).....	1956..........	700	Radio/inertial..........	1 n.m........	3,000 Nuclear...	Road mobile.
SS-4................	Late 1958...... Early 1959.	1,100	Radio/inertial..........	1½ n.m......	3,000 Nuclear...	Road mobile.
SS-5................	Late 1961 or 1st half 1962.	2,000	Radio/inertial..........	1½ n.m. or better.	4,000 Nuclear...	Probably fixed sites.
SS-6................	1 Jan. 1960[h].... Mid-1960[h]......	5,000 7,000	Radio/inertial..........	1961–2 n.m.[f].	6,000–10,000.... 6,000 Nuclear...	Heavy nosecone version. Lighter nosecone version.

Footnotes for Summary Table IV.

OTHER: 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 shaped HE charge against tanks or other hard targets; (b) missiles with improved simplified inertial guidance components capable of delivering a 500 pound payload to ranges on the order of 5 to 15 n.m. We estimate that the first of these missiles probably has been developed and is now operational.

We believe that the Soviets are developing and could have available for operational use by 1962–1963, a ground-launched ram-jet propelled vehicle with a speed of about Mach 3, a flight altitude of about 70,000 feet, and a range in excess of 4,000 n.m.

In the time period 1961–1970 the Soviets will probably have under development follow-on ballistic missile systems. Desirable characteristics for such systems might include fast reaction times, storable liquid or solid propellants, improved guidance systems and greater flexibility. We would expect the Soviets to follow established development patterns by depending on proven components, simplicity, and high reliability.

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[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 when the first operational unit is trained and equipped with a few missiles and launchers.

[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. The accuracies specified are approximate figures which we apply to all ranges to which the missiles are likely to be fired.

[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 n.m. 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 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 the ballistic missiles unlikely, although possible for certain special purposes.

[f] Should the Soviets so desire, ICBM accuracy could be improved to 1 n.m. as early as 1963, but we regard 1965 as a more likely date for such an achievement.

[g] It is pointed out that the rotation of the earth, the latitudes of the launch point and target affect the maximum range of a ballistic missile, with the influence becoming significant at the longer ranges. For the SS-5 and SS-6 maximum range indicated is nominal, for a nonrotating earth and in some cases, should be adjusted.

[h] For the views of the Assistant Chief of Staff for Intelligence, Department of the Army, and the Assistant Chief of Naval Operations (Intelligence), Department of the Navy, see their footnotes, page 30.

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Summary Table V

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

Arbitrary Reference Designation	Initial Operational Capability Date [b]	Maximum Operational Range (n.m.)	Guidance	Operational Accuracy (CEP) [c]	Maximum Warhead [d] (lbs. and type)	Configuration	REMARKS
SS-N-1	1958	100 assisted by helicopter. 60-80 assisted by forward ship. 30-40 unassisted.	Programed possibly with radar track/radio command over-ride with terminal homing against ships.	150 ft. against ship. 1-2 n.m. against land targets.	1,000 HE or Nuclear.	Cruise	Destroyer and possibly cruiser launched. High subsonic used against land or ship targets. 1000'-10,000' altitude.
SS-N-2	1958	30-40 unassisted. 60-80 when assisted.	See paragraph 137, page 31.	150 ft	1,000 HE or Nuclear.	Cruise	Destroyer and possibly cruiser launched. Low supersonic for use against ships only 200' altitude.
SS-N-3	1961	300	A supersonic cruise missile designed for launching from surfaced submarines.				
SS-N-4	1958-Z class sub. 1959-G class sub.	150 or 350	Radio/inertial	1-2 n.m.	1,500-2,000 Nuclear.	Ballistic	Not launched submerged. Modified "Z" class carries 2. "G" class can carry 3-4.
SS-N-5	1962-1963	500-1,000	Inertial	1-3 n.m.	1,000 Nuclear	Ballistic	6-12 missiles per sub. Launched submerged or surfaced.

OTHER: The Soviets now have operational a short range missile, guided or unguided, for use in patrol craft.

Based on requirements and our appreciation of Soviet state of the art, we estimate that the USSR may be developing a missile for use in ASW. Assuming that an active development program is underway, we estimate that a ballistic-launched depth bomb could be available for use by surface ships in 1962-1964 and that a ballistic-launched homing torpedo to be fired from a submarine could be available in 1963-1965.

[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 when the first operational unit is trained and equipped with a few missiles and launchers.

[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, and for naval systems include the error in the location of the launching ship.

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

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