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SPECIAL

NATIONAL INTELLIGENCE ESTIMATE

NUMBER 11-10-57

THE SOVIET ICBM PROGRAM

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. The Conclusions of this estimate were approved by the Intelligence Advisory Committee on 10 December; the Discussion was approved on 17 December 1957.

Concurred in by the

INTELLIGENCE ADVISORY COMMITTEE

Concurring were The Director of Intelligence and Research, Department of State; the Assistant Chief of Staff, Intelligence, Department of the Army; the Director of Naval Intelligence; the Assistant Chief of Staff, Intelligence, USAF; the Deputy Director for Intelligence, The Joint Staff; and the Atomic Energy Commission Representative to the IAC. The Assistant Director, Federal Bureau of Investigation, abstained, the subject being outside of his jurisdiction.

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THE SOVIET ICBM PROGRAM

THE PROBLEM

To estimate the probable development timetable and characteristics of the Soviet intercontinental ballistic missile (ICBM), including the probable date of first operational capability, and to examine the factors likely to affect Soviet acquisition of a substantial nuclear delivery capability with the ICBM weapon system.*

CONCLUSIONS

1. ICBM development has an extremely high priority in the USSR, if indeed it is not presently on a "crash" basis. We believe that the USSR will seek to acquire a substantial ICBM capability as rapidly as possible.

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* For purposes of this estimate, a "first operational capability" is arbitrarily defined as a total of 10 prototype ICBMs in the hands of trained units at completed launching sites; a "substantial operational capability" is arbitrarily defined as a total of 500 ICBMs in the hands of trained units at completed launching sites.

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2. We believe the USSR is concentrating on the development of an ICBM which, when operational, will probably be capable of carrying a high-yield nuclear warhead to a maximum range of about 5,500 nautical miles, with a CEP of 5 nautical miles or less at maximum range, and a system reliability of about 50 percent. The Assistant Chief of Staff, Intelligence, Department of the Army, believes that the USSR will adopt initially an operational ICBM of at least 3,800-4,500 nautical miles maximum range, and that it will further develop this weapon to the longer-range system indicated above.

3. The date at which the USSR will have a first operational capability with the ICBM will depend on many factors, apart from the over-all urgency of the program. These factors include the extent of technical success in missile testing and the availability of launching facilities, supporting equipment, and trained personnel to operate the system. We estimate that some time during the period mid-1958 to mid-1959, the USSR will probably have a first operational capability with up to 10 prototype ICBMs, with characteristics approximating those estimated in the first sentence of Conclusion 2.*

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* In the belief of the Assistant Chief of Staff, Intelligence, Department of the Army, this initial operational capability will be with an ICBM of at least 3,800-4,500 nautical miles maximum range.

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4. ICBMs could probably be produced, launching facilities completed, and operational units trained at a rate sufficient to give the USSR an operational capability with 100 ICBMs about one year after its first operational capability date, and with 500 ICBMs about two or at most three years after first operational capability date.

DISCUSSION

5. We estimate that ICBM development has an extremely high priority in the USSR, if indeed it is not presently on a "crash" basis, and that the USSR will seek to acquire a substantial ICBM capability as rapidly as possible. On the basis of all the available evidence, we believe the USSR is capable of accomplishing very ambitious goals in this field.

6. Soviet planners have probably long estimated that important military, political, and psychological advantages would accrue to the first nation to achieve an ICBM capability. They probably believe that certain disadvantages they now face in the application of intercontinental striking power can be overcome if, at an early date, they can acquire a substantial capability to deliver nuclear attacks on continental US targets with a weapon system imposing maximum surprise

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and difficulty of interception. They have recently demonstrated their acute awareness of the benefits of rapid Soviet progress in ICBM and earth satellite programs, as enhancing their deterrent posture against the US, supporting an aggressive foreign policy, and building confidence within the Bloc.

SOVIET EXPERIENCE IN BALLISTIC MISSILES

7. The thorough and systematic exploitation of German guided missile personnel and experience initiated by the USSR at the end of World War II provided a firm foundation for Soviet ballistic missile work, including guidance, aerodynamics, propulsion, and structural design. Operational and prototype German missiles were tested and improved upon; for example, some reports indicate that as many as 100 to 300 V-2 motors of 25 metric tons[1/] thrust were completed during the period 1947-1950. German missile specialists were, however, kept relatively isolated from the native Soviet missile program, and by 1948 the native program had apparently reached the point where it could largely dispense with German assistance.[2/]

1/ Metric tons are used throughout this estimate.

2/ For further details, see NIE 11-5-57, "Soviet Capabilities and Probable Programs in the Guided Missile Field," 12 March 1957, Chapters II and III and Annex B (TOP SECRET).

8. Liquid Rocket Motors. For a number of years the USSR has had available the type of motors necessary for propulsion of long range missiles. A German-developed, improved V-2 engine with a thrust of 35 tons was placed in production in late 1948; some 100 to 250 had reportedly been produced by 1950. More important, by 1952 a nominal 100-ton thrust motor, representing an outstanding achievement in advanced technology, had probably been developed to the point of static test. US studies have indicated that, with minor improvements, these motors could probably achieve thrusts up to about 40 and 120 tons, respectively, at sea level. We believe that rocket motors of 35 and 100 tons thrust have been thoroughly tested and probably improved in the course of extensive flight testing of 350 and 700 nautical mile (n.m.) missiles at Kapustin Yar.

9. Ballistic Missile Firings at Kapustin Yar. Prior to 1957, the only definitely identified Soviet ballistic missile test range was that located east of Kapustin Yar, a small town near Stalingrad.* This range has existed since early in the postwar period; it is still undergoing expansion and improvement. Good evidence on range activities

* A detailed discussion of this range and its activities to early 1957 may be found in NIE 11-5-57, Annex C (TOP SECRET).

dates from about 1953. Since the middle of that year, at least 300 ballistic missiles of short and medium ranges have been fired, of which about 100 have been 700 n.m. missiles. Since June 1957, there have been seven test firings of a 1,000 n.m. missile. The Kapustin Yar program has been characterized by minimum delays and rapid rates of test firing. The range has launched 4 missiles in a single day, 5 missiles within a 24 hour period, and 22 missiles to various ranges in a single month (August 1957). Such high activity indicates that handling and check-out procedures are good and test crews are well-trained.

10. Under test range conditions, good accuracies are evidently being achieved up to ranges of about 700 n.m. High reliability is evident from the very few apparent in-flight failures. [

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* "Probable Error" is defined as that error which is as likely to be exceeded as not.

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EVIDENCE ON THE SOVIET ICBM FLIGHT TEST PROGRAM

11. Tyura Tam-Klyuchi Test Range. In about mid-1955, the construction of new instrumentation facilities began in the vicinity of Tyura Tam, near the extreme down-range end of the Kapustin Yar test range. Accumulating evidence has made it clear that the activity which began in 1955 was in fact the start of a new Soviet missile test range, extending approximately 3,500 n.m. from Tyura Tam northeastward to a down range instrumentation area near Klyuchi, on the Kamchatka Peninsula. [

] the new range facilities do not yet appear to be fully completed, [

]

12. Firings from Tyura Tam, August-November 1957. We believe that by mid-August 1957 the new test range was capable of supporting limited ballistic missile flight testing. [

] Although the evidence was fragmentary, it supported Soviet statements that ICBM flight tests

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had been made. (While the TASS announcement may have been timed for maximum propaganda effect, past Soviet statements of this type have generally been based on actual performance or assured capability.) We concluded that the USSR had probably flight-tested two ICBM vehicles, although the only information as to the range, accuracy, or character of the vehicles fired was that contained in the Soviet statements and that which could be inferred from the length of the test range.*

13. On 4 October and again on 3 November, the USSR successfully orbited earth satellites; we have determined [ ] that they were launched from the Tyura Tam range-head. [ ] information regarding the two satellite launchings and the launchings on 21 August and 7 September from Tyura Tam does indicate some differences [ ] These differences may be attributed to [ ] as well as to differences in launching purposes. It is not logical, nor is it compatible with our knowledge of previous Soviet testing practices, to assume that the first satellite

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* See SNIE 11-8-57, "Evaluation of Evidence Concerning Soviet ICBM Flight Tests," 18 September 1957 (TOP SECRET).

was launched on 4 October without preliminary flight tests. Thus [ ] on the first two firings from Tyura Tam, there remains a question whether they were actually test vehicles for an ICBM or for an earth satellite, or were part of a combined program.

14. [ ] It does not appear that a launching has been attempted at Tyura Tam since the orbiting of the 3 November satellite, but we cannot entirely exclude this possibility. In any case, [ ] the next launching could occur at any time.

15. Probable Relationship between ICBM and Earth Satellite Programs. On the basis of all the evidence, we estimate that the Soviet earth satellite program was developed concurrently with and superimposed upon the ICBM program, as Soviet statements have implied. Because so few vehicles of this magnitude have been noted, we believe

that all four vehicles launched from Tyura Tam probably utilized the same first and second stage propulsion systems. The reported weight of the first satellite (185 lbs.) would require a propulsion system comparable to that of an ICBM. The minimum propulsion required for such a satellite would be a two-stage system utilizing a nominal 100-ton first stage and 35-ton second stage -- such a system in an ICBM would probably be capable of carrying a 2,000 lb. warhead some 3,800-4,500 n.m. On the other hand, the second and reportedly much heavier satellite (1,120 lbs.) would have required either this minimum propulsion system plus an added third stage, or a large two-stage system utilizing paired 100-ton thrust motors or an equivalent single motor in the first stage. In an ICBM, either of the large two-stage systems referred to would probably be capable of carrying a 2,000 lb. warhead 5,000-6,000 n.m. Although unofficial Soviet statements have indicated that the second satellite was a three-stage vehicle, we are at present unable to make a positive determination. However, we believe that for efficiency of design and reliability, the Soviets would not utilize three propulsion stages in their ICBM.

16. With regard to guidance, we do not know how close the actual orbits of the satellites were to those intended, [

J Guidance errors permissible in the orbiting of an earth satellite would not be acceptable for an ICBM with a CEP of 5 n.m. or less. Consequently, the capability to place a satellite into an eliptical orbit does not of itself indicate that ICBM guidance problems have been solved for such a CEP. We believe, however, that the guidance system used in Soviet 700 nautical mile ballistic missiles already achieves accuracies better than those required to orbit earth satellites.

17. In spite of these unresolved questions, the four Tyura Tam firings attest to the high capabilities of the USSR in long range ballistic missile development, especially in the field of propulsion. We believe it likely that the first few firings in an ICBM program would serve primarily to test propulsion, stage separation, and rough guidance; for such purposes, it would matter little whether the first tests were of earth satellite vehicles or of true ICBM test vehicles. Therefore, we believe that, for practical purposes, the Soviet ICBM flight test program began on 21 August 1957.1/2/

1/ The Assistant Chief of Staff, Intelligence, Department of the Army, agrees with the 21 August date only if it applies to an ICBM system as described in his footnote at the end of paragraph 21.

2/ See footnote of the Deputy Director for Intelligence, The Joint Staff on next page.

2/ The Deputy Director for Intelligence, The Joint Staff, believes that the first two probable firings on the Tyura Tam range, 21 August and 7 September 1957, were primarily for the purpose of testing earth satellite vehicles of the type or types launched on 4 October and 3 November 1957. He agrees that information useful to the ICBM program was obtained from these tests, particularly if the last stages on the missiles fired were allowed to impact. However, the subsequent firings of two satellites and the apparent lack of any other firings on the Tyura Tam test range to date indicate that the first two firings cannot be considered as part of a flight test program for a specific ICBM any more than numerous previous firings on the Kapustin Yar range or the satellite firings themselves. The Deputy Director for Intelligence, therefore, believes that the specific flight test program discussed in paragraph 27 of this Discussion has not yet begun.

PROBABLE SOVIET ICBM CHARACTERISTICS*

18. We estimate that the USSR probably has a military requirement for an ICBM with a range of about 5,500 n.m. We further estimate that this requirement would include, for initial operational capability, a missile CEP of 5 n.m. or less at maximum range, a high-yield nuclear warhead, and a system reliability approximating 50 percent. Continued improvement of ICBM system efficiency and reliability would be a Soviet objective. However, the USSR will also desire to achieve an effective ICBM capability at the earliest practicable date. Pending the development of a missile meeting the foregoing criteria, it may seek to establish an initial operational capability with a missile having a range of at least 3,800 n.m. A missile of 3,800 n.m. range could reach the most distant target of importance in the US only from the Chukotsk Peninsula and could reach less distant targets from somewhat less exposed positions. However, a range of about 5,500 n.m. would be necessary to reach all important US targets from launching sites located with greater regard for their security and logistic support.

19. On the basis of the evidence, we believe that the ICBM currently under development in the USSR is a two-stage vehicle designed

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* The Assistant Chief of Staff, Intelligence, Department of the Army, calls attention to his general footnote at the end of paragraph 21.

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to carry a warhead of about 2,000 lb. With the evidence at hand, we cannot determine whether it will employ a single 100-ton motor in its first stage, a pair of such motors, or a large single motor roughly equivalent to the paired motors. In the first case, it could achieve a maximum range of 3,800-4,500 n.m.; in the second and third cases, 5,000-6,000 n.m.

20. Whichever line of development the USSR is now pursuing, after the initial two-stage flight test the achievement of an initial operational capability would require about the same amount of time, roughly within a six month span. In the case of the single 100-ton first stage engine, however, the missile's range would fall short of the optimum. The USSR, if it is developing this system, may expect that its range can later be extended to 5,500 n.m. by a second generation weapon with some combination of developments such as higher thrust, more efficient motors, a reduction in nose-cone weight or the use of high-energy fuels. However, the transition by this means from a 3,800 n.m. to a 5,500 n.m. ICBM, including an additional number of missiles to be test fired, would probably impose an unacceptable delay.

21. On balance we consider it likely that the USSR is proceeding directly to the development of a 5,500 n.m. ICBM powered by paired 100-ton motors or a roughly equivalent single motor in the

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first stage, and that, at the earliest practicable date, it will establish a first operational capability with a few prototype missiles.*

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* The Assistant Chief of Staff, Intelligence, Department of the Army, does not concur in the probable characteristics of the Soviet ICBM presented in paragraph 21 and in certain specific points in paragraphs 18, 19, and 20. He believes that:

1. Soviet objectives for an ICBM system cannot be firmly established. A missile system with a range of 3,500-6,000 n.m. would enable the Soviets to attack the US within the limitations expressed in paragraph 18.

2. The Soviets could employ any of the systems described in paragraph 19 to attain the ranges given, and could extend the range of the system using a single 120-ton thrust engine (paragraph 8) by some combination of increasing engine efficiency, use of fuel additives, or reducing nose cone weights.

3. To arrive at an ICBM capability with any system in mid-1958 to mid-1959 requires the assumption that one of these propulsion systems was used in the satellite launchings. Moreover, calculation of these systems was based on Soviet announcements of the weight of their satellites (paragraph 15). Since these weights are accepted, it is also valid to accept the statements that the second satellite utilized three stages and both used tested missile components. Since there is no evidence of the development of paired engines or a nominal 200-ton thrust engine (paragraph 22), he believes that this last reference was to the nominal 100-ton and 35-ton engines believed developed for shorter range missiles. This factor, evident Soviet practice of improving or scaling-up tested components to develop progressively longer range missiles, and probable Soviet desire to keep their ICBM system as small and movable as possible, all support a system based on improvements to the single 120-ton thrust first stage system.

4. Improvements to this smaller system would not necessarily involve changes of such nature as to make it a "second generation" system. Attaining the 5,000-6,000 n.m. range by this means, rather than causing "unacceptable delay," could provide the Soviets their earliest ICBM capability by a substantial margin if they have not already developed the larger paired engines or 200-ton thrust engine.

The Assistant Chief of Staff, Intelligence, Department of the Army, therefore believes this estimate should state that the USSR will adopt initially an operational ICBM system of at least 3,800-4,500 n.m. range and that it will further develop this system to the 5,000-6,000 n.m. range.

PROBABLE DEVELOPMENT TIMETABLE

22. A major development effort would of course precede any flight test program. While evidence is limited, it is sufficient to establish or infer certain key elements in the probable Soviet pre-flight program. As indicated above, we believe the basic 100-ton rocket motors were probably ready for static test in 1952 and have been tested extensively in shorter range missiles since that time. If the USSR has elected to couple 100-ton thrust engines for first stage propulsion, coupling designs could probably have been made as early as 1954. If a single engine of greater thrust were chosen, there has been sufficient time for its design, development, and static testing prior to the fall of 1957. There is no evidence of either the coupling of two engines or of the equivalent single engine..

23. At least by mid-1955, when construction of the Tyura Tam-Klyuchi range was begun, the USSR was preparing for missile tests beyond the capabilities of the existing Kapustin Yar range. While the new range was under construction, Kapustin Yar was continuing to provide much basic experience in ballistic missile work. Tests there could have provided experience and design data on many ICBM problems, including mock warheads, fuzing devices, and possibly re-entry bodies and stage separation techniques.

24. Guidance. We believe the USSR is capable of solving the critical guidance problem. The USSR now has a guidance system which, if improved somewhat and placed in an ICBM, could achieve CEP's of 5 n.m. or less at ranges of 3,500 to 5,500 n.m. in 1958. This system probably is a radar track-radio command/inertial guidance system of the type previously estimated for the Soviet 350 and 700 n.m. missiles. The USSR need not rely on this type of system, however, inasmuch as a Doppler/inertial guidance system, employing principles almost certainly known to the USSR, could probably achieve CEP's of 5 n.m. or less by late 1958, and possibly down to about 2 n.m. by 1960.

25. Warhead. We estimate that high-yield nuclear warheads, suitable for employment in an ICBM, could probably be available in 1958.*

26. On the basis of the above, we believe that major design characteristics of the Soviet ICBM had probably been formulated by late 1955 or early 1956, and that at the present time, most major component problems have been largely solved. While there is no intelligence to indicate whether the USSR is developing heat sink or sublimation type nose cones, US experience indicates that the reentry problem is not likely to delay the program.

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* See ANNEX, Soviet ICBM Warhead Capabilities

27. Flight Test Schedule. On the basis of our estimate that the USSR is proceeding directly toward the development of an ICBM having a range of 5,500 n.m., a CEP of 5 n.m. or less at maximum range, and a 2,000 lb. warhead, and considering Soviet operations at Kapustin Yar and the progress which the USSR has already made in ICBM development, we estimate that a program of some 20-50 flight tests would be required to achieve the specified accuracy and a system reliability of 50 percent.* We believe that the USSR will compress its ICBM flight test schedule as much as possible, and it is probably that a buildup to 3-4 test firings per month could be achieved in this program, barring some major accident. The span of time required for completing the test firing program and the number of missiles needed for testing are factors of uncertainty in our estimate. Early and continued success could permit a schedule with as few as 20 flight tests. On the other hand, if success in flight tests is not continuous, as many as 50 tests might be necessary. We do not believe that the Soviets will encounter difficulties leading to very extended delays, and we therefore estimate that this test program, leading to the attainment of

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* We estimate that the USSR would require a minimum system reliability of about 50 percent under operational conditions. "System reliability" in this context means the percentage of missiles which function according to specifications from missile takeoff to detonation in the target area. Malfunctions prior to launch are not considered.

a first operational capability with up to 10 prototype missiles, could probably be completed some time during the period mid-1958 to mid-1959.[1] The research and development test and improvement program will continue thereafter.

FIRST OPERATIONAL CAPABILITY DATE

28. We have previously estimated that the Soviets will probably equip their first operational ICBM unit with prototype missiles, and will not wait for series produced missiles.[2] The date at which the first unit would be equipped in this way will depend on many factors, apart from the over-all priority of the program. These factors include the extent of technical success in missile testing, the degree of international tension, and the availability of a launching site, supporting equipment and trained personnel to operate the system. An additional factor to which the Soviets have undoubtedly given considerable weight is the psychological and political, as well as the possible blackmail, advantages of achieving a nominal ICBM capability before the US. Provided the Soviets made a decision sometime ago to prepare a site and train the necessary personnel, we believe that some

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1/ The Assistant Chief of Staff, Intelligence, Department of the Army, refers to his general footnote at the end of paragraph 21.

2/ See NIE 11-5-57, paragraph 84.

time in the period mid-1958 to mid-1959 they will probably have a first operational capability with up to 10 prototype ICBMs with characteristics approximating 5,500 n.m. range, 5 n.m. CEP, and 50 percent reliability.[1/2/]

FACTORS AFFECTING OPERATIONAL CAPABILITIES

29. We do not know what production facilities are now devoted to the Soviet ICBM program, nor have we any direct evidence regarding Soviet preparations to produce ICBMs and systems equipment in quantity. We do know, however, that the USSR possesses a highly developed industrial base which includes all the skills and facilities necessary for quantity production of successfully developed missile systems. Based on our estimate that the development of an ICBM capability is a major Soviet objective, we believe that the USSR will allocate the necessary resources.

30. ICBM Production. The centralized planning of the Soviet economy will permit the USSR very rapidly to marshal economic resources

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1/ The Assistant Chief of Staff, Intelligence, Department of the Army, refers to his general footnote at the end of paragraph 21.

2/ The Deputy Director for Intelligence, The Joint Staff, believes that the Soviets could, if they so desired, establish an extremely limited operational capability in the latter half of 1958 with up to 10 ICBM's with a range of approximately 5,500 nautical miles and a CEP of approximately 5 nautical miles, but whose reliability would be uncertain and probably less than 50 percent. He therefore estimates that the USSR will establish a limited operational capability with up to 10 ICBMs with characteristics approximating 5,500 nautical miles range, 5 nautical miles CEP, and 50 percent reliability in about mid-1959.

for the quantity production of ICBM systems and equipment. Soviet industrial resources can be focused on the production of the major components of the ICBM; i.e., engine, guidance system, control systems, warhead, and airframe. Each of these components can be produced in separate, specialized facilities on a coordinated basis. During the course of the ICBM flight test program the designs of various components or subsystems will prove their adequacy to meet required specifications. As each component is proven, its design will be "frozen" and production drawing and specification, as well as detailed production plans, will be prepared. Many of these steps will have been taken prior to completion of the full flight test program. When the final element of the ICBM system design has demonstrated its acceptability, the design of the system as a whole will be "frozen," immediate steps will be taken to initiate series production, and a build up to a pre-selected peak rate of production will begin. The more rapidly the production program is pushed, the more likely difficulties are to develop which require costly changes. The USSR must weigh the cost of delays due to modifications against the advantages of getting operable missiles early. In light of extensive Soviet experience with shorter range ballistic missiles, we believe that the likelihood of prohibitive costs in resources due to a crash production is not very great.

31. A 500 ICBM Program. Our estimate of the scheduling and resource allocations required for an assumed high priority ICBM production, construction, and training program involving 500 ICBMs deployed on 50 launching facilities follows. These figures were selected arbitrarily and we have not attempted to define them as optimum or minimal quantities. Although we have no evidence that the USSR is actually planning to carry out this specific program, this examination permits the assessment of the economic feasibility and implications of such a program.

32. The USSR will determine the peak production rate for ICBMs on the basis of Soviet planners' judgments, primarily with respect to their requirements for various numbers of missiles at selected points in time, together with their capabilities to achieve these requirements. These capabilities will include not only those for the production of ICBMs but also those for the construction of sites, production and installation of equipment, training of troops, and establishing logistic lines. We believe that a peak production rate of about 40 ICBMs per month is compatible with the 500 ICBM program examined here. A period of 10-14 months from the beginning of series production would be required to build up from an R & D production rate of 6-7 ICBMs a month to a monthly rate of 40 series-produced ICBMs. The length of time required to build

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up to a peak production rate governs the number of ICBMs which could be available in the early period after series production is initiated, regardless of the peak production rate. In addition to the ICBMs delivered to site, many missiles will have to be produced for training, testing, and logistic backup; the total number of ICBMs produced might exceed 700 by the time 500 were delivered to sites.

33. Warhead. We estimate that a sufficiently high priority will be assigned to nuclear warheads so that they will be produced for stockpiling on at least a one-to-one basis for ICBMs intended for operational use. Prior to January 1959 these warheads would be fabricated by essentially hand-produced methods. In the period January 1959 to January 1960 serial production could begin, the rate thereafter being dependent upon the scale of the production effort.

34. Launching Facilities. We believe that detailed planning of ICBM operational bases was being carried out concurrently with the preliminary and detailed design of the ICBM system, and further, that by early 1956 hardware design could have been sufficiently firm to permit the USSR to make basic decisions regarding projected ICBM deployment. Such decisions include the location of operational sites,

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general operational concepts, and logistics. At that time the detailed layout of many elements of the operational bases could have been determined, and a program of site construction and equipment for either mobile or fixed launching facilities could have been initiated. Although we have no direct evidence of Soviet ICBM launching facilities, we conclude that the USSR has had ample time to complete the preparation of some launching facilities already, and could now be engaged in a large scale effort to provide the additional launching facilities needed to deploy the ICBMs it plans to produce.

35. Considerations affecting Soviet planning for ICBM launching facilities might have included the following:

a. a very high initial salvo capability;

b. minimum practicable detectability of launching facilities;

c. operational sites capable of surviving nuclear attack;

d. rail transport as the basic means of logistic support.

Based on these considerations, we have postulated several Soviet programs for mobile and fixed site construction and ICBM deployment which are consistent with our estimate of the times at which various quantities of ICBMs could be available.

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36. Postulated Operational Systems. The magnitude of the resources the USSR would have to invest in providing an operational system for 500 ICBMs can be appreciated by examining several possible operational site systems, both mobile and fixed. We have postulated that 50 launching facilities, consisting of 5 launchers each, would be provided for 500 ICBMs.

37. The first postulated ICBM system considers a mobile rail concept. This system consists of 50 trains, each carrying 10 missiles with associated guidance, handling and support equipment, and complete supplies for independent operation over a specified period (1-2 months). Each train consists of 110-120 railroad cars, probably divided into sections, and includes facilities for housing and maintaining five launch crews and associated support personnel. The entire system requires construction of about 500 miles of sidings and the preparation of 500 or more launch pads. From an operational standpoint such a system could be established under conditions which would allow for 90 percent of the units in the system to be in a specified readiness state on launching sites at any given time.

38. We estimate the equivalent cost to the USSR of manufacturing and fully equipping each missile train, and providing the associated

fixed installations, to be roughly 50 million dollars.[1] The total initial costs for the entire deployment system, including rail and pad construction, would be on the order of 2.5 billion dollars.[2] The economic resources required for a rail system of this type would come principally from the heavy industrial sector of the Soviet economy. We believe that this sector of the economy is capable of sustaining a program of this magnitude and character with only minor delays in the over-all investment program.

39. The second postulated ICBM system consists of 50 fixed launch sites hardened to withstand overpressures of 100 psi. Each launching site requires 18-24 months to construct and consists of five underground launching positions and adjacent storage, maintenance and checkout areas, and an underground guidance station. Each of the launch positions contains one missile erected and another in a storage area prepared for firing. Separate underground launch control centers, crew quarters and fuel storage tanks are located near each launch position. An unhardened

1/ This figure includes 7 million dollars for 10 ICBMs, excluding the cost of warheads.

2/ The dollar figures are used to indicate only the general magnitude of the resources required.

support area contains those functions related to housekeeping, maintenance, and administration. The entire system is serviced by rail.

40. We estimate that the cost to the USSR for constructing and fully equipping each launch site would be the equivalent of about 70 million dollars,[1] or a total cost of about 3.5 billion dollars for the 50 sites in the system.[2] If the USSR were to implement this program, it would have to devote large quantities of construction resources sorely needed in other branches of the Soviet economy.

41. If a less refined, fixed, aboveground system with the ability to withstand overpressures of only 6 psi were chosen, the construction time would be reduced to 9-15 months and the total initial cost would be about 2.2 billion dollars, or 1.3 billion dollars less than the 100 psi system. The savings would be almost entirely in the cost of construction. The initial costs of sites harder than the 6 psi system but softer than the 100 psi would range between 2.2 and 3.5 billion

1/ This figure includes 7 million dollars for 10 ICBMs, excluding the cost of warheads.

2/ The dollar figures are used to indicate only the general magnitude of the resources required.

dollars; for example, a 500 missile/50 site system, hardened to 50 psi, would cost about 3.0 billion dollars.

42. The following table compares some economic aspects of each of the four systems considered above:

Type Facilities	Cost (billion dollars)	Special Economic Impact
Rail Mobile	2.5	Heavy Equipment Industries
Fixed 100 psi	3.5	Construction
Fixed 50 psi	3.0	Construction
Fixed 6 psi	2.2	

43. Manpower and Training. We estimate that for a total system of 50 launch facilities, the manning requirement would be 500 launch position crews totalling about 25,000 men, and 100 guidance and control site crews totalling about 3,000 men, plus generalized support and administrative personnel. Crews already trained in shorter range missiles could be re-trained in the ICBM in a period of about two months. Such procedure could sharply reduce the training time required to provide at least initial operational capability. Within a short time after occupying a launching facility, newly trained units would be able to

launch missiles operationally, with varying degrees of proficiency. We estimate that six months to a year of further training on sites would be required to attain a high degree of operational proficiency. The amount of training on a launching facility will affect, to an unknown degree, the reliability of the missile system and the ability of the USSR to launch missiles simultaneously from each launching position.

44. General Economic Assessment. A Soviet ICBM production and deployment program of the scope postulated herein would require a high order of planning and accomplishment. Our assessment of Soviet capabilities leads us to conclude that from the economic point of view, the production of ICBMs and systems equipment in quantity, and the acquiring and training of troops, would be less burdensome to the USSR than the construction of hardened launching sites with maximum operational effectiveness, low vulnerability, and a high degree of concealment. The USSR may decide on a launch system involving a somewhat smaller commitment of resources. However, any of the postulated operational systems would be well within Soviet economic capabilities.

45. Considering the various factors discussed above, we estimate that ICBMs could probably be produced, launching facilities completed,

and operational units trained at a rate sufficient to give the USSR an operational capability with 100 ICBMs about one year after its first operational capability date, and with 500 ICBMs about two or at most three years after first operational capability date.