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Impact of a Threshold Test Ban Treaty on Soviet Military Programs

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THE IMPACT OF A THRESHOLD TEST BAN TREATY ON SOVIET MILITARY PROGRAMS

THE PROBLEM

To estimate the impact of a Threshold Test Ban Treaty on Soviet military programs, with particular emphasis on its impact on Soviet ABM activities; to discuss the capabilities of US intelligence to monitor such a test ban; and to evaluate Soviet capabilities for covertly violating it.

FOREWORD

The Threshold Test Ban Treaty considered in this estimate is generally in line with proposals under discussion in the US and abroad, but it does not reflect a specific proposed treaty. We assume continuation of the terms of the Partial Test Ban Treaty now in effect, which prohibits testing of nuclear devices in the atmosphere; beyond its limits, including outer space; underwater (including both territorial waters and the high seas); or in any other environment if such explosion causes radioactive debris to be present outside the territorial limits of the state under whose jurisdiction or control such explosion is conducted. The Threshold Treaty considered in this estimate would add to the restrictions of the current treaty a prohibition of any underground nuclear test producing a seismic disturbance above 4.75 on the Gutenberg-Richter scale. It is assumed that treaty language will specify a method by which a mean magnitude for any particular event will be established, thus avoiding international disputes about the magnitude of reported events. It imposes no limitations on the underground medium in which the tests take place, or on the degree of decoupling employed. It provides no on-site inspection and no sanctions. Each participating nation will have to decide for itself whether

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any given seismic event of magnitude greater than 4.75 was caused by a nuclear detonation and constituted a treaty violation.

CONCLUSIONS

A. We believe that for most of the Soviet military development programs which we can foresee over the next few years a Threshold Test Ban Treaty would impose no greater restrictions than those already imposed by the Partial Test Ban. However, the relationship between the yield of underground explosions and the resulting seismic readings is uncertain at best, and can be greatly altered by decoupling. The Soviets might therefore still test over a wide range of yields, depending on how far they were willing to risk violating the treaty and to support the cost and effort of decoupling. Practically speaking, we believe that they could develop weapons yielding [redacted] by scaling up from lower yield tests which would have a fair chance of not producing seismic readings above 4.75. They might conceivably develop TN weapons with yields [redacted] by expensive decoupling methods. (*Paras. 13 through 19*)

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B. With respect to ABM weapons, we think there is about an even chance that the Soviets have already [redacted] exoatmospheric ABM warhead yielding [redacted] If they have not already done so, a Threshold Treaty would not, in our view, make such a development impossible, as we believe existing Soviet weapon technology would support it either without further testing, or with tests that would have a reasonable chance of not exceeding the threshold. (*Paras. 10 through 12, 20 through 21*)

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C. We believe that a Threshold Treaty would impose prohibitive restrictions, beyond those of the Partial Test Ban, only for developing weapons which might need new warheads yielding [redacted] If the development of such weapons had a sufficiently high priority the Soviets might conduct tests virtually certain to violate the treaty, in the belief that the violation could not be proved against them. As few as one or two such tests a year could be of significant aid to their military programs. (*Paras. 18 through 19, 30 through 33*)

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D. The US Atomic Energy Detection System (AEDS) would almost certainly detect all seismic events in the USSR with a magnitude of 4.75 or greater. Perhaps with help from [redacted] sources, it could probably discriminate between explosions and earthquakes occurring in most parts of the USSR, but there would still be a few events a year over 4.75, especially in the Kamchatka-Kuriles area, which could not be so identified. Such events would represent possible treaty violations, but it would be extremely unlikely that intelligence could with certainty either confirm or deny that a nuclear event had in fact occurred. (*Paras. 23 through 28*) 1.5(c) 3.4(b)(1)

E. If a seismic event over 4.75 was identified as an explosion, it would almost certainly be nuclear in origin. Thus this evidence, combined with what might be available from intelligence sources, would probably be sufficient, except in a few cases, to determine to the satisfaction of the US government whether or not the explosion was nuclear in origin. Evidence sufficient to convince a world forum that an explosion was nuclear could almost certainly be derived only from on-site inspection, which is not permitted by the Threshold Treaty under consideration. (*Paras. 25, 29*)

DISCUSSION

I. CURRENT SOVIET NUCLEAR WEAPONS TECHNOLOGY

1. The past decade of increasingly sophisticated Soviet testing of nuclear devices and weapons has included the 1958 series, two series of intensive tests in 1961 and 1962, and two years of testing underground since the Partial Test Ban Treaty was signed in August, 1963. An evaluation of the effects of a Threshold Test Ban Treaty on Soviet military programs must start with a review of present Soviet nuclear technology developed through these tests and its relation to Soviet military programs.

A. Technology Applicable to Programs Other Than ABM

2. *Weapons Development.* The Soviets have a family of thermonuclear (TN) weapons responsive to the present needs of their strategic attack and general purpose forces. Soviet Long Range Aviation and the Rocket Forces have a large number of older TN weapons in the low megaton range based on the results of the tests conducted in 1958 and earlier. Weapons based on the 1961 and 1962 test series probably began to enter stockpile in 1964, and are now being produced in significant quantities, and will continue to be produced in order to replace older weapons still in the strategic attack forces stockpile. These new weapons generally represent significant improvements over the entire weapons spectrum, and probably include some high yield (over ten MT) TN weapons for delivery by both aircraft and missiles. A warhead [redacted] suitable for the SS-11 is estimated to be now available as a result of the 1961-1962 tests. 1.5(c) 3.4(b)(1)

3. The Soviets had by 1958 developed a variety of relatively large implosion fission weapons in the [redacted] range, which are probably still in stockpile in large numbers for tactical missile and rocket forces, for tactical aviation, for general purpose uses by the Soviet navy, and for SAM forces. As a result of the 1961-1962 tests the Soviets were able to develop fission weapons in the [redacted] range, [redacted] Most of the newer fission weapons entering the Soviet stockpile in the last few years are probably these improved low-yield weapons. 1.5(c) 3.4(b)(1)

4. Prior to the Partial Test Ban Treaty the Soviets had largely fulfilled their basic requirements for multimegaton TN weapons and for fission weapons. They may still have a requirement for TN warheads in the submegaton and low megaton range, e.g., for the SS-11. This requirement can be fulfilled under the Partial Test Ban, and probably would be fulfilled before the Soviets acceded to a Threshold Treaty. Under the Partial Test Ban, the Soviets have conducted tests yielding up to 450 KT. Some of the tests yielding around 50 KT and higher

were probably directed toward development of TN weapons. Several tests yielding 30 KT or less have been detected, especially during the past year; these could have been oriented toward development of either fission or TN weapons. Some weapons based on the underground tests of the last two years will probably start entering stockpile next year, and will be available for systems being deployed over the next several years.

5. *Effects Testing.* Our analysis of Soviet tests provides very little information on Soviet programs to enhance the kill potential of nuclear weapons, or on the state of Soviet knowledge of the various kill effects of nuclear explosions. Most of the thermonuclear tests were held at Novaya Zemlya, where the Soviets were probably able to instrument only for the basic diagnostic information required for development of TN weapons. Most of the Soviet fission devices were tested at Semipalatinsk; we know little about the methods of testing there or the kinds of effects instrumentation employed.

6. The evidence does indicate, however, that the Soviets have conducted extensive tests of the effects of nuclear bursts on military equipment and structures. We have also detected one HE explosion which may, among other things, have been part of a program designed to test hardness of missile silos. Although we cannot say how much the Soviets may have learned about kill effects from their tests, they have clearly had ample opportunity to discover the same important nuclear effects which we have discovered.

7. Analysis of Soviet publications and classified manuals shows that the Soviets have acquired effects data of sufficient scope and quality on air, surface, underwater, and underground bursts to be adequate for planning and executing most military operations. Unclassified articles show that they are aware of the transient radiation effects on electronic equipment (TREE). Although we have no knowledge of the extent to which they may have explored these effects, we do have evidence that they are aware of the vulnerability of US missile guidance systems to them. The Soviets have also shown that they understand the electromagnetic pulse (EMP) phenomena produced by nuclear explosions, and they may have instrumented a number of low-yield surface tests to measure the EMP effect on military systems and communications equipment. Although the Soviets are probably aware of the EMP vulnerability of ICBMs and silos, it is doubtful that they have conducted tests of the surface EMP effects of high yield weapons.

8. Considering the foregoing, we think the primary effect of the present Partial Test Ban on Soviet weapons programs has been to prevent complete systems testing and effects testing in the atmosphere or space. Nevertheless, the Soviets can obtain some significant data on these effects by simulating atmospheric and space environments in underground tests.

B. Technology Applicable to ABM Programs

9. *High-Altitude Tests.* During the 1961-1962 series, the Soviets conducted a number of high altitude nuclear tests, primarily at Sary Shagan. (See Table I.)

TABLE 1

SOVIET HIGH ALTITUDE TESTS

JOE NO. OF TEST	DATE	APPROXIMATE YIELD (KT)	APPROXIMATE ALTITUDE (KM)	REMARKS
79	6 Sept. 1961	25	15	KY Vertical Shot
98	6 Oct. 1961	200	30	"
105	21 Oct. 1961	1	300	KY-SS Shot (Multiple Missile)
109	27 Oct. 1961	1	150	"
157	22 Oct. 1962	.55	280	"
160	28 Oct. 1962	180	145	"
168	1 Nov. 1962	1,600	75	"

These tests indicated a Soviet interest in assessing the capability of an ABM system to discriminate and track two or more targets approaching successively on nearly identical trajectories, both in a radar blackout environment and in a normal atmosphere. The 1962 events appear to have been conducted for the primary purpose of studying the effects on radar systems of blackouts created by high yield precursor bursts or by detonation of the interceptor's own ABM warheads. Data relating to certain long range effects, such as EMP and TREE, may also have been collected. It is unlikely, however, that the tests involved devices which had enhanced radiation output (i.e., hot X-rays), or that the Soviets were testing for the vulnerability of re-entry vehicles (RVs) to shock produced by surface absorption of low energy X-rays.[1]

10. *Characteristics of Certain Nuclear Weapons.* Another portion of the 1961-1962 test series involved the detonation of a group of TN weapons in the 3-25 MT range. These weapons showed certain characteristics suggesting that they represented a new Soviet weapons design. One recent attempt to construct a theoretical model exhibiting these characteristics led to a design that could produce an enhanced X-ray output. We think it likely that the Soviets would realize the importance of these X-ray effects for exoatmospheric ABM weapons and could adapt such a design accordingly. If such is the case, the Soviets then could have a weapon that would emit X-rays [redacted] 1.5(c) 3.4(b)(1)

11. *ABM Deployment.* For several years the Soviets have been constructing what we believe are ABM defenses.[2] The missile most likely to be used in an

[1] A low energy X-ray output is one of about 1-2 kilo-electron volts (Kev). This X-ray energy can be enhanced, at the expense of other effects, by appropriate design of the weapon. An X-ray energy of 5 Kev is considered medium energy, and 8-9 Kev is high energy. An X-ray energy above 1-2 Kev is often called "hot" X-ray.

[2] See NIE 11-3-65, "Soviet Strategic Air and Missile Defenses," 18 November 1965, paragraphs 24 to 37 and footnotes thereto.

exoatmospheric role in such defenses is the Galosh or a Galosh-type. Given the formidable difficulties of identifying lethal warheads amid a cloud of incoming objects outside the atmosphere, it is desirable that an exoatmospheric ABM system employ weapons with as large a kill radius as feasible. This in turn would require a nuclear warhead with improved kill capabilities, one way of achieving which might be through hot X-rays. One of the group of weapons described in the preceding paragraph appears highly suitable for use with the Galosh missile. We have no evidence whatsoever that this or any other of the group of unusual Soviet nuclear weapons is the Galosh warhead, nor indeed can we be sure that the group of new nuclear weapons [redacted] Nevertheless, the apparent deployment of an expensive ABM system employing exoatmospheric interceptors argues that the Soviets have a warhead with a large kill radius, whatever mechanism may be used to achieve it. 1.5(c) 3.4(b)(1)

12. The considerations in the preceding paragraphs lead us to believe that the chances are about even that the Soviets have developed an exoatmospheric ABM system [redacted] even though we think that they did not test a complete system in 1961-1962. It is of course desirable to test ABM warheads in their actual environment, but it is possible by extrapolating from laboratory and underground test data to calculate the effects of specific warheads on various objects at various altitudes. 1.5(c) 3.4(b)(1)

II. IMPACT OF A THRESHOLD TEST BAN TREATY ON SOVIET MILITARY PROGRAMS

A. Limitations on Nuclear Testing

13. *Degree of Risk Accepted.* Because of variations in geological structure and in the propagation paths of seismic signals, nuclear explosions of the same yield may produce quite different seismic readings. Experimental evidence based on US tests and measurements indicates that the seismic magnitude of a nuclear test of known yield and in a given medium may vary by up to 0.5 units on the Gutenberg-Richter scale. As 50 percent of the cases fall above and 50 percent below the average magnitude, a shot intended to produce a reading of 4.75 on that scale would have a 50 percent chance of exceeding that reading. A country desiring 75 percent assurance of not exceeding the 4.75 limit would be limited to tests of about one-half the yield it might test with only 50 percent assurance.

14. *Testing Medium.* Most detected Soviet underground tests have taken place in granite. [redacted] 1.5(c) 3.4(b)(1)

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15. It would be possible, without violating the Threshold Treaty, to test in dry alluvium devices of larger yield than those which could be tested in granite. [redacted] We believe that the Soviets have had little experience in testing underground in dry alluvium at yields above the low kiloton range. The USSR probably has alluvial deposits of sufficient depth, but we do not know whether the deposits are dry to such a depth as would permit testing [redacted]

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16. *Decoupling.* It is possible that the Soviets would resort to decoupling—a technique in which the nuclear explosion takes place in a large cavern, thereby reducing the seismic disturbance. Decoupling at lower yields appears feasible, but to decouple larger yields so that they can be tested within magnitude 4.75 becomes increasingly expensive and difficult. It has been estimated that under a given seismic threshold one might test with decoupling a device with a yield up to as much as 10 to 100 times greater than could be tested without decoupling. But this is a highly theoretical and obviously very uncertain estimate. As a practical matter, it seems to us likely on the basis of present knowledge that seismic effects from an explosion on the order of [redacted] could, most of the time, be degraded through decoupling to produce a magnitude 4.75 reading, although a very large and costly cavity would be required.

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17. The Soviets could probably scale up from the devices they tested and build, with reasonable confidence, weapons having yields four or five times as great as the test devices. Thus, we think that, providing they accepted in some cases a 50-50 chance of exceeding the threshold, the Soviets could develop weapons yielding [redacted] Conceivably they might develop weapons with yields [redacted] by utilizing expensive decoupling methods.

B. Impact on Military Programs Other Than ABM

18. It follows from what has been said above that a Threshold Treaty would not seriously hamper Soviet development of small yield tactical weapons, low yield testing for special effects (enhanced or suppressed radiation for tactical devices), or acquisition of data on the vulnerability of components. Under such a treaty, though with some risk of violating it, the Soviets could also probably develop new or follow-on TN warheads with yields [redacted] for their small-silo missile systems, as well as for new naval missile systems. But we believe that for the tests needed to develop an entirely new warhead with a yield [redacted] the Soviets would be forced either to resort to expensive decoupling, or, more likely, to accept a greater than 50 percent chance that a test would exceed a 4.75 seismic reading. Full-scale tests of high yield warheads or of silo hardness against nuclear weapons cannot be conducted under either the Threshold Treaty or the Partial Test Ban.

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19. It is difficult even under the Partial Test Ban to conduct the tests necessary to develop new warheads yielding [redacted] The Threshold Treaty would add to these difficulties. [redacted] 1.5(c) 3.4(b)(1) It may be that the Soviets will wish to develop new warheads of such yields which are hardened against US ABM weapons, or which can be used in their own ABM programs, or both. Apart from fulfilling these possible requirements, we believe that the Soviets do not need to conduct such tests as would carry high risk of violating the Threshold Treaty. Their 1961-1962 tests enabled them to develop multimegaton weapons with acceptable yield-to-weight ratios for Long Range Air Forces and Strategic Rocket Forces, and to test effects of these weapons to a degree compatible with military requirements.

C. Impact on ABM Programs

20. As stated above, we believe there is about an even chance that the Soviets have already developed [redacted] ABM warhead. If they have not already done so, a Threshold Treaty would not, in our view, make such a development impossible, as we believe existing Soviet weapon technology would support it, either without further testing or with tests that would have a reasonable chance of not exceeding the threshold. The Soviets could obtain X-ray lethality data applying to such a warhead from underground testing without violating the Treaty. We believe also that in their 1961-1962 tests the Soviets acquired enough data on radar blackout effects to permit them to develop and deploy this weapon system. Although the Soviets would almost certainly have a requirement for a full-yield exoatmospheric test of the system and for tests to acquire additional blackout data, this is already prohibited under the Partial Test Ban. 1.5(c) 3.4(b)(1)

21. We believe the Soviets have not developed an ABM warhead with [redacted] They might see a need for such warheads [redacted] In this event, we believe that a Threshold Treaty would not be a limiting factor as long as the prospective warheads were in the submegaton range. For the development of a new ABM warhead of this type in the multimegaton range the Threshold Treaty would impose a significant limitation over the present treaty. 1.5(c) 3.4(b)(1)

III. US DETECTION CAPABILITIES

22. The ability of the US to monitor a Threshold Treaty and to detect violations involves establishment that a seismic event has taken place and is above 4.75 magnitude, identification of such an event as natural or explosive in origin, and identification of an underground explosion as nuclear or conventional high-explosive. A different, but related, problem is that of persuading a world forum

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of the validity of a US identification of a seismic event above 4.75 in magnitude as a nuclear explosion.

A. Monitoring Capabilities of the AEDS

[redacted]

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[redacted]

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[redacted]

1.5(c)
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[redacted]

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B. Capabilities of Intelligence Sources [redacted]

27. Intelligence resources of the USIB community could sometimes be useful in supplementing the AEDS analysis [redacted]

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[redacted]

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28. Sigint may also be a useful back-up tool, but it is not of itself sufficient to prove or to disprove the occurrence of a nuclear test. Since the Partial Test Ban has been in effect, one or more Sigint indicators, such as flight activity, weather reporting, or Soviet detection system activity, have been associated with a large percentage of the Soviet underground tests. There have been some cases when no Sigint indicators were acquired. There have been more cases in which indicators were acquired but no tests were detected; many of these indicators may have been related to tests which were postponed or cancelled or were below our threshold of detection. They may have been dry runs. [redacted] It should be noted, however, that the USSR has the capability to invoke stringent communications security procedures, and to use other methods which could degrade or eliminate Sigint indicators. [redacted]

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C. Proving a Violation

29. No criteria for proving a violation are specified in any of the proposals for a Threshold Treaty. [redacted] We believe that in general such proof could be demonstrated to a world forum only by on-site inspection, which is not permitted under any form of the contemplated Threshold Treaty. [redacted]

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IV. THE POSSIBILITY OF SOVIET COVERT VIOLATION

30. We have estimated above that the Soviets can meet most of their outstanding requirements for weapons development without violating a Threshold Treaty. If they foresaw testing requirements for military programs that would require consistent violation, they probably would not sign the treaty in the first

[3] We have assumed in the Foreword an agreed international procedure for establishing whether a seismic disturbance exceeds 4.75.

place. We also believe they would not accede to the treaty unless they thought it would be relatively advantageous to them, or at least not disadvantageous. Once they had entered into a treaty, the Soviets probably would feel that the advantage to be gained from frequent violation would not be worth the political damage to their international position, providing these violations were proved against them.

31. It is clear, however, that the Soviets could gain significant advantages in weapons development from one or two tests a year which exceeded the threshold.

[redacted] 1.5(c) 3.4(b)(1)

32. If the Soviets should desire to test above 4.75 with the least chance of being caught, they could move the tests away from a known test area to a heavily seismic area, such as the Kamchatka-Kuriles area.

[redacted] 1.5(c) 3.4(b)(1)

33. [redacted] 1.5(c) 3.4(b)(1)

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