

*BREAKOUT WARNING: A PROBLEM OF VERIFICATION*

R-2094-ACDA

Robert Perry  
The Rand Corporation  
November 1977

Prepared for: U.S. ARMS CONTROL AND DISARMAMENT AGENCY  
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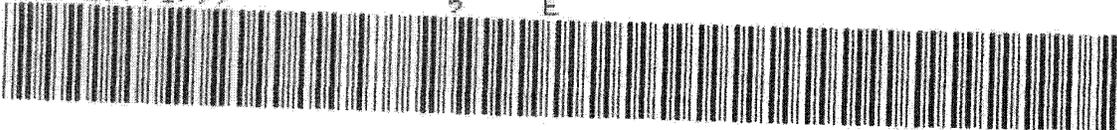
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PREFACE

This Report was prepared for the Arms Control and Disarmament Agency (ACDA) under the provisions of Contract AC6AC406. Any communications concerning Byeman aspects of the Report should be routed to Rand through the National Reconnaissance Office (NRO), Directorate of Special Projects (SAFSP), to the attention of the author.

By agreement with ACDA, various members of the NRO staff assisted the author during research for and preparation of the Report. SAFSP, in particular, furnished indispensable facility support, and several individuals assigned to the Office of the Secretary of the Air Force, Space Systems (SAFSS) generously aided in the research enterprise. ACDA people, notably Amrom Katz, also contributed information and advice. The author's colleagues, Abraham Becker and William R. Harris, aided in matters of both form and substance. Nonetheless, the views, findings, and recommendations expressed or implied here are the author's and should not be attributed to the NRO, to ACDA, to Rand colleagues, or to Rand or any of its clients.

Owing to the nature of the material used in this Report and a succession of administrative problems associated with handling that material, it has not been exposed to the customary editorial and peer review processes of Rand. Flaws of finish and errors of interpretation have probably survived the scant review that proved possible. Nonetheless, the author is wholly responsible for faults that escaped the scrutiny of the few readers of earlier drafts.

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SUMMARY

This Report, one of three in a related set prepared by Rand for the Arms Control and Disarmament Agency, deals with questions of the verifiability of present Soviet-American arms control agreements by "national technical means" (chiefly reconnaissance satellites of various kinds) and with the larger question of whether such "means" can provide adequate warning of concealed or clandestine Soviet effort to acquire a major advantage in strategic weapons. It incorporates by inference and reference findings of two companion Reports:\* in the Soviet view the advantages of a successful breakout effort may be large enough to generate political will given that a marked advantage in strategic force effectiveness could be used for negotiation, coercion, and warfighting; Soviet instincts and past practice would tend to encourage such a decision; the politico-diplomatic objections to breakout, and its unfavorable consequences, internally and external to the Soviet Union, are of uncertain dimensions; while conceivable shifts in present economic, technical, or diplomatic or military balances affecting the United States, Western Europe, China, and the Soviet Union could have a considerable influence on Soviet perceptions of advantage and disadvantage.

Soviet perceptions are here given considerable weight. The extent to which the Soviet Union credits American capability to detect a breakout effort may dominate Soviet appreciations of both opportunity and payoff.

Existent arms control agreements limit the numbers and sizes of present strategic weapons, chiefly missiles and launchers, and prohibit expansion of currently small anti-ballistic missile capabilities on both sides. The agreements also provide that neither party may interfere with the "national technical means" the other uses to verify compliance with the treaties. But the agreements are in various ways ambiguous, and unilateral interpretations have no weight. "Allowable" verification means have nowhere been defined; the Soviets have consistently rejected "espionage" as an internationally permissible "means." Other potential problems for the United States arise in the inability of American interpreters to diagnose the intent of many recent Soviet R&D activities and the prospect that novel or unrecognizable strategic weapons may enter the Soviet inventory without being so perceived by American authorities.

\* Becker, Abraham S., *Strategic Breakout as a Soviet Policy Option*, R-2097-ACDA, The Rand Corporation, March 1977; Harris, William, *Prospects for SALT Verification and Breakout Warning*, R-2093-ACDA, The Rand Corporation, November 1977.

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From the standpoint of the United States, "successful" verification depends critically on the adequacy of U.S. reconnaissance systems and on a Soviet perception that those systems can indeed provide the information sought by the United States. "Adequate" verification capability for the United States must extend to the interpretation and diagnosis of any Soviet attempt at breakout, whether or not the weapons or means involved are "conventional." Indicators of intent must be as perceptible as indicators of an actual breakout maneuver. Ambiguity is intolerable.

In agreeing to present arms limitations, the United States fundamentally assumed (1) that satellite reconnaissance and associated technical capabilities could provide conclusive evidence of Soviet non-compliance with treaty provisions, (2) that it would not be possible for the Soviet Union to conceal a breakout attempt long enough, or well enough, to acquire real strategic dominance, and (3) that while the Soviet Union credits those assumptions, neither major treaty violation nor a covert effort to break out of the arms control agreements is likely to be attempted.

The Soviets may have underestimated American reconnaissance satellite capabilities when the treaties were being negotiated and signed (1968-1972), but subsequent improved understanding is probable. Soviet concealment and deception activities increased after 1968 and became still more widespread after 1972, which at least suggests that the Soviets now have a good appreciation of the technical qualities of American reconnaissance devices.

Soviet options extend to degrading, interrupting, or entirely preventing American visibility into Soviet R&D and weapons deployment. At present, preventing American satellite operations would constitute open abandonment of detente; there appear to be no conceivable means for *precluding* American overflight of Soviet territory without being obvious about it--although in some circumstances the Soviets might exploit a third-party capability (presumably Chinese, given the state of space technology in the world) to their own advantage. But that is an unlikely threat, on balance. Degrading U.S. coverage by political means (by declaring high resolution systems to be espionage devices rather than verification instruments, for example), by technical means (camouflage and concealment), or by some combination of the two would not necessarily cause an immediate American abrogation of the arms agreement. Subtle interruption of American coverage by means not unambiguously attributable to Soviet initiatives could create a coverage lapse during which the Soviets could deploy strategic weapons without alerting American authorities. Such a threat is perhaps unlikely but is no less alarming for that. It seems reasonable to assume that no serious effort to either degrade or interrupt American surveillance of Soviet development and deployment activities would be attempted until or unless the Soviets had

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previously prepared some strategic system for rapid deployment and unless they perceived large advantages in successful deployment. The object of degrading or interrupting coverage might be merely to delay American reaction until a deployment had been largely completed, or to complete and conceal a deployment between intervals of American surveillance. The latter would represent the most grave threat to American security. It would also represent the most difficult of operations for the Soviet Union.

Potential American responses are limited. Other than for imagery, American "national technical means" are ultimately dependent on Soviet cooperation (communications and electronic operations open to American intercept). No backup imagery systems are available to the United States once the immediate reserve (which is quite small) has been used, and the potential for creating crisis or backup surveillance systems in the United States is diminishing. Further, newer American systems are longer lived, more costly, and in some respects more vulnerable than their predecessors; thus successful interruption of surveillance operations in the absence of a crisis or backup system could easily generate a gap in coverage.

Although successful American experience in satellite reconnaissance has extended over 15 years, in no instance have reconnaissance systems been designed explicitly for treaty verification purposes. Instead, the attractions of promising new technology, institutional preferences, and the instinct to pursue "technologically superior" capabilities on their own merits have generated "requirements." The resulting systems are indeed more capable in many respects than their predecessors, but they are also much more costly, more vulnerable to the consequences of successful interference, and consequently are more attractive targets for a determined Soviet breakout effort.

The essentials of adequate breakout warning extend to assurances that the breadth and detail of returns will satisfy basic needs, that the regularity of coverage can be guaranteed, and that evidence of any interference with satellite operations will be sufficiently unambiguous to warrant an appropriate American response. If those conditions prevail *and are perceived by the Soviet Union*, the likelihood of a breakout effort is lessened thereby. But insuring the persistence of such an environment means lessening obvious American vulnerabilities, countering improved Soviet capabilities, increasing the risks to the Soviets, and diminishing any Soviet perception of opportunity and benefit combined with slight risk.

In such circumstances, it seems essential for the United States to conduct a new, careful, institutionally objective review of requirements for breakout warning (which, if adequate, will readily comprehend the needs of arms control agreement verification). In that setting the

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priorities of strategic intelligence, technical intelligence, economic intelligence, and breakout warning could be assessed and ordered. Finally, the need for a backup (crisis) reconnaissance system or for otherwise reinforcing current capabilities could be dispassionately evaluated. The object would necessarily be to provide both political and technical options for the United States, to insure careful periodic review of the arms control (and breakout warning) environment, and to determine the need for dedicated breakout warning systems.

At the end it is entirely conceivable that evaluation of the requirements for adequate breakout warning would support the conclusion that "national technical means" are no longer entirely adequate. Should that occur, it would probably be necessary to reintroduce on-site inspection provisions into negotiations for renewal or expansion of the present arms control agreements.

Although the possibility that the Soviets would attempt a breakout of the sort here considered may seem slight, it is not obvious that Soviet perceptions of advantage, penalty, difficulty, or advisability are those of American analysts. If a breakout threat does exist, its early identification will be essential to U.S. security--but present means for detecting and identifying such a threat seem less than adequate.

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I. INTRODUCTION

In the interest of avoiding unnecessary confusion, it seems advisable to state at the onset that the "national technical means" so vaguely cited in Soviet-U.S. arms control agreements are the reconnaissance and intelligence-gathering satellites operated by each of the two nations, and a few large earthbound radar systems. The qualification "technical" (which was not a fixture of early discussions) inferentially excludes "non-technical" means: classical espionage. Both countries indulge in spying, of course.

Other assumptions of prior understanding appear hereafter. This Report does not attempt any extended discussion of the origins and early history of satellite reconnaissance, which has been an operational reality for the United States since August 1960. Since that time, capabilities have steadily improved and U.S. reliance on them has steadily increased. (So has cost: early systems cost roughly one-tenth as much to develop and one-twentieth as much to fabricate and operate as do 1976 reconnaissance systems.)

The world of strategic warfare--and strategic arms control--has changed several times over since 1960, when two successful missions by photo-reconnaissance satellites of limited capability\* sufficed to provide incontrovertible evidence that Soviet claims of strategic missile superiority were hollow to their core. Destruction is more effectively packaged in 1977; for all practical purposes, photo interpreters can no longer be confident that the objects pictured on the reconnaissance photographs (or similar images) are strategic weapons at all. Their functions may be entirely unknown. That is not true of all strategic weapons, of course. An intercontinental ballistic missile still is distinguishable and identifiable. But photographic evidence alone is no longer sufficient to provide assured identification of a strategic bomber, or to distinguish an intercontinental missile from one that nearly resembles it but presumably lacks an essential booster stage. Further, in the 16 years that have passed since the United States first succeeded in obtaining satellite photography of the Soviet Union, the Soviets have become much more skilled in concealing their military enterprise from overflying cameras--notwithstanding a marvelous improvement in virtually all aspects of satellite reconnaissance, from resolution to reliability.

\* The early CORONA satellites could, under ideal conditions, distinguish objects about eight meters across; if 1977 photo-reconnaissance satellites cannot quite reproduce the numbers on license plates, they can at least indicate which cars carry plates.

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This study is concerned with a few selected aspects of the verification problem, chiefly capabilities for both U.S. detection and Soviet concealment, and the necessary preconditions for successful verification. The likelihood and characteristics of breakout have been addressed by Abraham Becker in R-2097-ACDA, *Strategic Breakout as a Soviet Policy Option*, March 1977, and the elements of arms control agreements and verification policies that are most vulnerable have been identified by William Harris in R-2093-AEDA, *Prospects for SALT Verification and Breakout Warning*, November 1977. This study, a comparison piece to those noted above, addresses the probabilities and consequences of a breakdown in verification processes, whether by U.S. inattention or by Soviet machination. The question it considers, in the end, is the extent to which current and pending "national technical means" can adequately cope with the subtle, change-susceptible requirements of present and possible future arms control agreements.

Breakout is viewed here (and by Becker and Harris) as a process of weapons deployment designed to alter significantly the strategic balance. The term can also include a concept of concealment and deception capped by either the disclosure of a hitherto concealed capability or its operational use. Concealment could extend to types, numbers or attributes of weapons and explicitly includes all measures essential to their initial development and subsequent production.

Those aspects of breakout addressed here are mostly concerned with its detection. Of necessity, the United States must be concerned with detecting and unambiguously identifying indicators either of a breakout maneuver or of preliminary measures which at some later time could support a Soviet breakout. The key element is ambiguity. The discovery that a Soviet anti-ballistic missile had been widely deployed and was operational, or that considerable numbers of hitherto undetected intercontinental missiles were in the Soviet strategic inventory presumably would constitute an unambiguous signal that breakout had occurred. Indications that the Soviet Union was constructing numerous launch platforms for some unidentified missile could be construed as a warning of an impending breakout attempt, but such an indicator, standing alone, would not necessarily prompt a major U.S. counteraction.

Breakout can be subtle, extended in time, and disguised in various ways. Detection and interpretation of breakout indicators are equally important, but ambiguous indicators are likely to prompt ambiguous interpretations. Protracted, small-scale, low-profile indicators are likely to prove most difficult both to identify and to interpret. The sudden appearance of large-scale, prominent indicators is another matter. The first can readily be assumed to indicate the probability of the second. They may (and seem likely to) be successive phases.

This Report is concerned with the possibilities of detecting and promptly interpreting as such a Soviet breakout, whether protracted and subtle or abrupt and obvious. The long lead times required for the

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deployment of substantial numbers of contemporary "conventional" strategic weapons, both defensive and offensive, places a premium on deployment preparations: development and test, site preparation, the creation and exercise of a production capability, and inescapable training requirements. Many of those activities are immune to detection by observation satellites. Communications intercepts, defectors, or conventional espionage agents probably represent the only feasible means of detecting early indications of production or production preparation, development, or cadre training. Testing is somewhat less readily concealable, although still ambiguous to some extent. Even widespread weapons deployments may be cloaked or obscured if sufficient pains are taken. Finally, any breakdown in American verification machinery--the observation satellite complex--could provide an opportunity for carrying out all of those activities without providing an equivalent opportunity for U.S. detection of them. If such a breakdown could be precipitated by Soviet actions, and the duration of a coverage lapse accurately anticipated, the Soviets would have a marvelous opportunity to escalate, undetected, from subtle, protracted preparations to sudden widespread deployment. Here again, ambiguity is the key. Obvious and confirmable Soviet interference with American reconnaissance satellites would constitute an obvious and confirmable indicator that arms control had failed. But a failure of American verification mechanisms which could be attributed to "natural" causes would provide no such signal. It presumably would raise questions about the possibility of induced failures, of course. What, in that case, would be the U.S. options?

From four to eight years are needed to develop and deploy a new intercontinental ballistic missile. Many of the less conventional weapons postulated for the early 1980s (such as cruise missiles and mobile ICBMs) probably will be less protracted in development and easier to deploy. If deployment does not require rearranging large chunks of landscape, the customary preliminary indicators of pending deployment may never appear. With the possible exception of operational testing (and later operational training), few of the other essentials of developing and deploying a new strategic weapon are intractably unconcealable. And a substantial lead in producing and deploying a new weapon could be as destabilizing as the completion of that deployment. Thus the ability to detect and correctly interpret early indicators of a breakout capability (or plan) can be as vital as the ability to detect--promptly--the first indicators of actual deployment.

What are U.S. capabilities for breakout warning? What are the vulnerabilities of the American verification mechanism, which is so heavily dependent on satellite reconnaissance? What responses might the U.S. invoke if breakout indicators with varying degrees of ambiguity became apparent? What precautions can the U.S. take to

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improve its potential for detecting breakout indicators? For precluding a complete breakdown of verification capabilities? What are Soviet perceptions of opportunity? Of cost and benefit? How can the United States influence those perceptions?

It is to such questions that this Report is addressed.

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II. VERIFICATION: CONCEPTS AND APPLICATIONS

United States' confidence in Soviet compliance with the terms of existing and pending arms limitations agreements is universally conceded to be essential to the continuation of present agreements or the approval of future treaties. The existence of mechanical devices to perform verification is not sufficient, of itself, to ensure compliance. For the U.S., the validity of the agreement hinges on the extent of U.S. confidence in the adequacy of the various "national technical means" that presumably will detect any evidence of Soviet non-compliance with the agreements. Nor is the credibility of negative evidence a central issue; the absence of indications of major Soviet violations of strategic arms limitations agreements is but one aspect of credible verification. If the United States is to rely on reconnaissance satellites for verification of compliance with arms agreements, the United States must also have ultimate confidence that those reconnaissance satellites can detect, and U.S. interpreters can diagnose, any attempt by the Soviet Union to make extensive advance preparations for a breakout.\* That requires success in tracking and evaluating tests of advanced weaponry, in identifying and appreciating the significance of any unusual test, development, or construction activity that might signal the pending creation of a capability either to deploy unconventional weaponry or to deploy undetected quantities of more-or-less conventional strategic weapons that could significantly alter the strategic balance; and in accurately assessing indicators of intent to prepare clandestinely for breakout. That list does not include all of the attributes of "successful" verification, but the most critical are noted.

The adequacy of any verification system is ultimately determined by the extent to which it serves its intended function. Unhappily for such assessments, failures become evident only retrospectively; they cannot be detected in advance and can only imperfectly be anticipated. Further, acting on an anticipation is not easy for the United States. A complex of technological, budgetary, political, diplomatic, social, and institutional influences condition responses to vaguely perceived threats of uncertain substance.\*\*

The purpose of a verification system in any arms control setting is limited to providing credible indications that no violations of the

\* Becker, R-2097-ACDA, has a more extended discussion of the implications of breakout.

\*\* The reactions of the Allied powers to proclaimed German ambitions of 1934-1938, and to the military and diplomatic actions that accompanied them, sufficiently illustrate that point.

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underlying agreements have occurred. Existing strategic arms limitation agreements between the United States and the Soviet Union are monitored by what have with precise vagueness been described as national technical means of verification (NTMs). Several kinds of "national means" may be relevant, but the fundamental reliance of the United States is overhead photography provided by reconnaissance satellites.\* By implication, "national technical means" excludes espionage from the category of acceptable "national means"--although espionage is nowhere defined in the SALT I agreements and the later Vladivostok protocol.

Verification by international control (on-site inspection teams) was, until 1961, the "in principle" mechanism regarded by all major powers as the only acceptable means of enforcing arms control and disarmament agreements. The Soviets introduced the concept of "existing national technical means" in November 1961 as an alternative to on-site inspection. It was intended originally to apply solely to a ban on atmospheric tests of nuclear weapons, but the Soviets subsequently maintained that an agreement to ban underground nuclear tests could be similarly verified.

The limited nuclear test ban treaty of 1963 acknowledged that international inspection was unnecessary for verification of compliance with agreements covering nuclear tests in the atmosphere, the seas, and outer space. The inability of the nuclear powers to agree on a mutually acceptable inspection process or on the validity of "national technical means" for verification prevented extension of the ban to underground testing. The Soviet position at that time was that token inspections would be permissible, but that widespread inspections of the sort proposed by the United States and the United Kingdom would constitute espionage. The only substantial Soviet departure from that position was acceptance of the somewhat far-fetched proviso that installations on the moon and other celestial objects might be inspected by all comers to ensure compliance with the 1967 ban on the emplacement of nuclear weapons in outer space. (The treaty does not contemplate "inspection" of earth satellites, which are not considered to be "celestial bodies.")

\*\* It is interesting to speculate about the significance of the qualifier "existing." In November 1961 the U.S. possessed CORONA with a ground resolution capability of about eight meters, and SAMOS I, a relatively primitive readout satellite, with the ability to resolve details at the thirty meter level. Soviet capabilities probably were not greatly inferior. Did the Soviets propose somehow to freeze satellite reconnaissance technology at its 1961 levels? How did they view the problem of insuring compliance with such an agreement?

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For practical purposes, the technology of 1950 was adequate to police a test ban covering nuclear detonations in the atmosphere, in the oceans, or in outer space, but neither in the 1960s nor later would the United States agree that "national means" alone were sufficient to establish, with certainty, that all seismic events were or were not of natural origin. Actually, the general adequacy of seismic sensors probably was sufficient by 1975 to distinguish between earthquakes and single nuclear explosions, but could not routinely be counted on to distinguish carefully timed multi-shot underground nuclear explosions from large earthquakes.

Unproductive discussions of inspection mechanisms for verifying troop reductions in Europe have been intermittently in progress since the early 1960s. Although the general notion of inspection posts and liaison missions has been accepted "in principle" by the Soviet Union, disagreement about the permissible number of the first and the frequency and freedom of movement of the latter have again prevented any agreement. What constitutes "espionage" has been a persistent sticking point. In 1964 the Soviets refused to expose budget information which would have increased American confidence in the reality of an announced cut in Soviet military spending. (U.S. defense budgets were similarly cut back.) In 1964 the Soviet Union rejected an American initiative on freezing existent levels of strategic delivery systems for nuclear weapons; again, the United States proposed inspection on site as a precondition of agreement. (In that instance Soviet numerical insufficiency was so pronounced and so widely known that a "freeze" had no real chance of acceptance.)

By 1961, the United States had acquired a modest capability to determine the numbers, status, and position of contemporary Soviet strategic delivery systems. By 1964, that capability had so improved that the United States was fully cognizant of the significant inferiority, both in numbers and quality, of Soviet missile and bomber forces. Starting in August 1960, the United States had successfully orbited a number of increasingly proficient satellite reconnaissance systems and had recovered photographic imagery that clearly demonstrated the hollowness of Soviet claims to strategic parity, much less superiority. The quality of returns from such satellite missions improved appreciably during the first decade of operations. Early missions (1960 and 1961) were able to establish how many intercontinental ballistic missiles the Soviet inventory contained, their locations, and in a general way, their operational readiness. That much could be learned from the outputs of photographic instruments which could distinguish objects about six meters across in their narrowest dimensions; by 1970 objects measuring about 45 centimeters were routinely distinguishable from 90-mile orbits and many were identifiable.



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As early as 1965, the U.S. reconnaissance community appreciated that resolution at the [ ] level would be available in five or six years. In 1965, the Arms Control and Disarmament Agency first argued that limitations on numbers and kinds of missile launchers could be adequately verified by inspection from satellites. (SIGINT and ELINT were by that time contributing some useful confirmatory data.) By 1967, the President had accepted such a premise for the purposes of conducting informal discussions with his Soviet counterpart. The assumption of the time (in which the Central Intelligence Agency and the Joint Chiefs of Staff did not yet concur) was that numbers of ballistic missiles, of bombers, and of submarines could be adequately verified from satellite photography although distinguishing between intercontinental and lesser-range ballistic missiles would be difficult. Mobile missile launchers were then widely assumed to be impervious to positive identification and assured numbering.

The position of the Joint Chiefs in the spring of 1968 was that exclusive reliance on satellite inspection to verify strategic arms inventories would unduly burden the threat assessment process by diverting resources needed elsewhere, and that such reliance invoked unverifiable assumptions about U.S. capability to detect violations early enough to permit an effective response. The Joint Chiefs also maintained that using satellite reconnaissance as the sole source of evidence for a claim of violation would compromise the entire U.S. collection system. Then as later, U.S. authorities generally assumed that the Soviets did not comprehend the very remarkable capability of U.S. satellites to portray a broad range of military activities (including much research and development and testing) being conducted within the Soviet Union.

In August 1968, in preparation for the opening of discussions about a strategic arms limitations treaty, the National Security Council accepted the premise of unqualified reliance on "national means of verification" but insisted that American negotiators attempt to induce the Soviets to accept selective inspection of sites or of events where activities were ambiguous or weapons capabilities could not be adequately confirmed by inspection from space.\*

In the course of the protracted 1970 negotiations which finally put strategic arms limitations in the context of a prospective treaty, the

\* The Soviet Union was willing to require close inspection of suspect locations for both the non-proliferation treaty and the seabed negotiations; in neither instance, of course, would inspection of Soviet territory be necessary. The principal Soviet objection to "selective" inspection was that the would-be inspector could claim access to any site he was interested in--for any reason. Any such concession would represent a clean break with a 50-year tradition of Soviet secretiveness and 400 years of Russian paranoia concerning espionage.

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Soviets ultimately rejected all proposals for on-site inspection. Further, when discussing the definition and interpretation of "national technical means," the Soviets explained informally that in their view "national means" precluded reliance on espionage. Soviet spokesmen illustrated the point by contrasting space observation with U-2 operations (referring explicitly to the 1960 Gary Powers episode).<sup>\*</sup> The principle of non-interference with national means, proposed by the United States, proved mutually acceptable. The Soviets would discuss on-site inspection only in terms of a toothless clause which provided that either party could file a request to inspect but that the owner of the suspect site need not admit applicants. Similarly, the Soviets refused to accept the principle of selective on-site inspection as an element of the anti-ballistic-missile provisions of the agreement. Prohibition on certain ABM-related radar construction activities, which were assumed by the U.S. to be readily verifiable from space, represented the principal element of the "no-upgrading of SAMS" provision on which the United States insisted. The United States refused to include MIRVs in the limitations on the grounds that "national means" could not verify compliance. Concealment was expressly excluded (with the qualifier that "This obligation shall not require changes in current construction, assembly, conversion, or overhaul practices" on the part of either party). "National technical means" were defined only to the extent that they were to be used "... in a manner consistent with generally recognized principles of international law." The qualifier was of Soviet origin.

If, as often assumed, the "principles of international law" clause implied a distinction between verification and espionage, it becomes necessary to consider what inferences may be drawn from earlier references to the U-2 as an espionage device. As noted above, by 1970 the American GAMBIT system was returning imagery not greatly inferior to that generated by the 1960-vintage U-2, while Soviet 1970-era reconnaissance satellites apparently had less than half of that capability. It is entirely conceivable that the Soviets did not appreciate the extent to which American photographic emulsions, film transport mechanisms, motion compensation devices, and satellite stabilization capabilities contributed to superior satellite

<sup>\*</sup> Presumably acting in accordance with the sleeping dogs principle, U.S. negotiators did not inquire into the basis for that distinction. The obvious interpretation (but not automatically the correct interpretation) would be that the Soviets then assumed that satellite reconnaissance was less productive in resolution and detail than U-2 reconnaissance. The 1960 U-2 flown by Gary Powers carried cameras (not the most advanced models then available, happily) capable of about 70-centimeter resolution from 25000-meter altitudes. By 1970, GAMBIT cameras were returning photography of roughly that quality from altitudes of about 140 kilometers. Soviet satellites of that era apparently were capable of resolving ground details at the 1.75 to 2.0-meter level.

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photography. It is very likely that the Soviets appreciated and conceded American advances in optics, but did not credit American advances elsewhere. In fact, the substantial contributions to improved resolution represented by film improvements alone were sufficient to explain most of the American advantage, and those improvements arose in private-sector development (mostly by Eastman Kodak) not readily achievable in a Soviet economy. That the Soviets believed they appreciated American satellite reconnaissance capabilities and understood the practical limits of improvement seems apparent. That they erred in their assessment seems likely.

Those verification provisions implicitly expressed both the American assumption of adequacy and the Soviet understanding of what constituted acceptable means of verification.\* American assumptions concerning the adequacy of verification devices were predicated on notions which derived from the perceived capabilities of systems designed in the 1960s to perform tasks deemed vital to the collection of strategic and technical intelligence of that period. By 1970, when the SALT I treaty was being drafted, the United States was phasing out the last of its first-generation surveillance systems (CORONA), introducing a much more capable system (HEXAGON), and starting the development of a near-real-time system that promised to provide continuing coverage, at levels of resolution on the order [redacted] of the entire Soviet land mass.\*\* The chief instrument for technical intelligence of the sort required to establish the configuration details of missiles, bombers, and submarines was a much improved version of the GAMBIT system, originally conceived in 1960 and first successfully operated in 1964.

All the available evidence suggests that Soviet progress in reconnaissance by means of photographic satellites lagged behind that of the United States by at least five to seven years and that in the construction of devices requiring the conceptual and electronic complexity of KENNEN the lag may have been as much as 10 years. For practical purposes, by the late 1960s the United States had become capable of performing 1960-era equivalent U-2 reconnaissance operations using spacecraft. If Russian technical intelligence experts were aware of that circumstance before 1971, either they did not alert their SALT specialists or they thought the matter unimportant.

\* The importance of such implications will be addressed later in this section.

\*\* [redacted]

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But by 1976, the Soviets had become fully capable of distinguishing between "broad coverage" (HEXAGON) and "high resolution" (GAMBIT) missions, by all indications had a more realistic appreciation of the capabilities of each, and were acting on that information. The change could have occurred by reason of the gradual relaxation of the original tight controls over the dissemination of and access to satellite reconnaissance photography in the U.S. (and by its allies) during the 1970-1976 period, but it was just as likely to have derived from appreciations of continuing Soviet R&D program in satellite photography. Using their own satellites to view their own installations and tending to credit American satellites with superior performance, the Soviets would inevitably have come to appreciate potential American capabilities.\* Further, in the course of arms control negotiations American authorities disclosed details of Soviet activities that did indeed reveal capabilities approaching the limits of existent American satellite reconnaissance, and if the Soviets were capable of extrapolating from their own rates of progress to probable American rates of progress they would certainly have credited the Americans with resolution, contrast, and coverage potential greatly superior to Soviet systems. The expansion of concealment and deception efforts in the Soviet Union in the period 1973-1976 provides considerable support for the argument that both Soviet capabilities and Soviet appreciation of American capabilities rapidly improved at that time.

On such grounds it seems no more than reasonable to assume that by late 1976 the Soviet Union had acquired a rather good understanding of the abilities and limitations of the traditional photographic satellite

\*Some American authorities have speculated, however, that Soviet assessments were unlikely to credit the United States with the ability to develop satellite reconnaissance capabilities that did not become publicly known almost immediately. U.S. security has been notoriously poor for generations; the "black" U-2 and A-11/SR-71 programs were not successfully concealed; and much was written in the 1960s about the potential of the "Samos" reconnaissance satellites in development in the early 1960s. The basic NRO policy after 1961 (when it was conceived by the late Major General R. E. Greer, the first director of NRO's Special Projects organization) was to withhold information about the scope of the reconnaissance satellite program but to conceal entirely information concerning the *quality* of systems. The first objective was but indifferently achieved; the second would appear to have been mostly successful through the early 1970s, judged in terms of the meaningless Soviet distinction between U-2 and satellite photography.

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reconnaissance systems of the United States. Soviet specialists quite probably understood fully what the United States had considered to be "adequate" capabilities for arms limitations verifications as of 1970, and very likely appreciated later American improvements, though perhaps not their magnitude.\*

\* Which should not suggest that the Soviets could replicate American achievements in all respects. Satellite reconnaissance requires a particular and demanding compound of optical, electronic, and chemical technologies, properly ordered, and most of which have become unique to the United States. As in other instances, the Soviets have standardized their reconnaissance satellites, have limited the scope of technical changes, and have substituted bulk or quantity for technological elegance. The traditional style of Soviet R&D--incrementalism compounded by a preference for "brute force"--may have served to mislead Soviet evaluators. In satellite photography, elegance is precisely the essential element. Conventional and more mundane Air Force satellite programs, and NASA programs, lag three to five years behind reconnaissance programs in achieved levels of applied technology. And they generally have been more costly for comparable achievements.

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III. CAPABILITIES AND ADEQUACY

Three U.S. assumptions\* underlie past and proposed arms limitations agreements:

- (1) U.S. National Technical Means can provide conclusive evidence of compliance or non-compliance with agreements.
- (2) Expansion of Soviet strategic capabilities could not be concealed well enough, or long enough, to permit the development of a serious threat to the strategic balance.
- (3) So long as the Soviet Union credits those assumptions, no serious effort to "break out" of the arms limitations agreements will be attempted.

The third of those assumptions is self fulfilling if the first two are indeed valid. But it hinges on questions of the extent to which the first and second are reasonable and on prospects of their transience.

Assumptions of "conclusive evidence" hinge on several premises. The first is that sufficient information can be elicited from current and pending reconnaissance satellites to reconfirm, periodically, Soviet compliance with terms of the existing arms limitations agreements. That means only the treaty-constrained items and implies that the United States should be and need be concerned only about those items of strategic weaponry that are constrained by treaty.\*\*

But that does not imply that only relatively large sites or objects readily identifiable as missile launchers, intercontinental bombers, or anti-ballistic-missile hardware need be watched. If the United States is to receive adequate warning of incipient violations, development and test activities must be monitored. Means of circumventing Soviet concealment and deception measures must be devised. Finally, and most important, the United States must be concerned not only about some particular arms control mechanism but about the totality of national security. That responsibility extends to monitoring all activities that conceivably could generate or grow into a strategic threat. Thus, while verification is technically concerned only with the numbers and status of treaty-

\* Although not universally accepted, those assumptions were endorsed-- at least by implication--and acted upon by U.S. SALT negotiators.

\*\* See Harris, R-2093-ACDA, for a broader discussion.

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constrained strategic weapons, national security requires attention to less obvious, perhaps more readily concealable threats to the strategic balance. That is where breakout enters the scene.

If the premises noted above are to have continuing validity, there arises an implication that U.S. capabilities will improve at a rate consistent with the need to detect and identify unconventional ("exotic") weapons or to disclose that conventional weapons have been concealed.

If the Soviet Union honored both the letter and the spirit of the accepted arms limitations agreements, eschewing concealment and deception where operational strategic weapons were involved, existing U.S. "national technical means" presumably would continue to be adequate insurance against violation of the terms of those agreements. But to what extent do present and proposed "national technical means" provide assurance that a Soviet breakout attempt, subtle, extended, and skillfully camouflaged, could be detected? And to what extent are Soviet perceptions of U.S. capabilities, present and pending, likely either to deter or encourage a Soviet breakout effort?

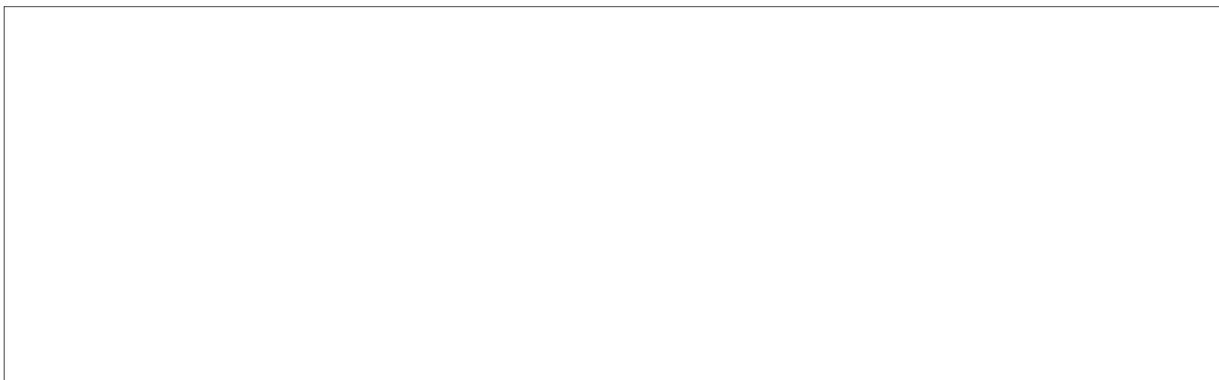
Addressing those questions requires, first, examining the contents of the present U.S. inventory of "national technical means." Present and near-term contemplated systems in that inventory (all subject in one way or another to degradation, interruption, or preclusion of operation) are listed in Table 1 (next page).

The chief instruments of verification are GAMBIT, HEXAGON, and KENNEN. To some extent, all other U.S. intelligence-generating satellite systems are dependent on the interception of Soviet emissions in some part of the electronic spectrum. Active radar systems, which may appear in the inventory in the late 1970s or early 1980s, have limited applications, while infrared detectors are chiefly relied on for warning of attack. Several predecessor U.S. systems have been phased out of the inventory; they have in all instances been replaced by systems with improved capabilities. Indeed, steady and frequently spectacular improvement has been the dominating attribute of the National Reconnaissance Program since its formal inception in 1961 and capabilities were continuing to change in the mid-1970s. But the assumption of continued potential for continued improvement is misleading and the nature of some recent "improvements" may be inconsistent with the needs of verification (as opposed, for instance, to strategic intelligence or technical intelligence requirements). KENNEN, for example, was originally viewed as a potential replacement for either GAMBIT or HEXAGON--or perhaps both--



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Code Name	Orbit	Application
989 (P-11)	Varies	ABM/SBM, identify some air defense radars



GAMBIT	75-225 nmi	Photo, with [redacted] 5-mi frame width; principal verification instrument
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HEXAGON	82-144 nmi	Photo, 2.5-foot resolution, 300-mi swath; major verification device
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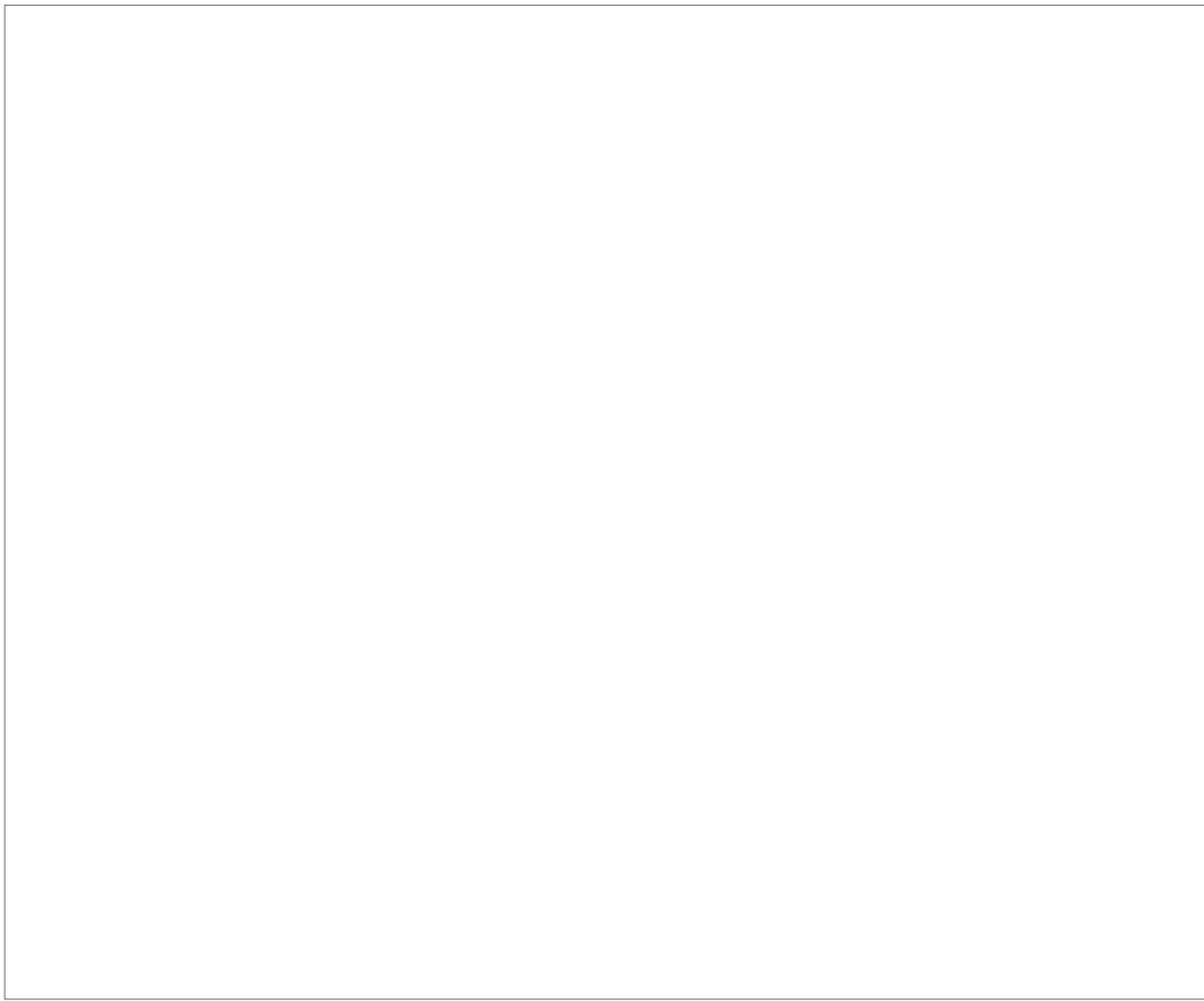


[647] DSP	Sync	IR; detect ICBM via IR, with limited low-thrust detection ability
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\* Similar circumstance marked the development and introduction of HEXAGON in the period 1965-1970. HEXAGON was designed to provide the coverage of CORONA (the original surveillance satellite) at the resolution of GAMBIT. But in the five years between the start of intensive work on HEXAGON and its first use, the quality of GAMBIT photography improved enormously. For that matter, various proposed improvements of CORONA (which were rejected largely because HEXAGON was scheduled and because budgets would not readily accommodate both HEXAGON development and CORONA improvement) could conceivably have provided many of the realized HEXAGON capabilities at considerably less cost. In the event, GAMBIT proved to be indispensable.

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Three main points need to be made: (1) Soviet opportunities for interference with reconnaissance have improved because of the changing nature of U.S. systems and the improving quality of interference devices; (2) U.S. systems are more vulnerable, in several ways, and are more attractive targets for interference than was the case as recently as five years ago;\* and (3) the combination of improved opportunity and greater payoff appreciably enhances the attractiveness of interference. The risk of detection has decreased, the prospective returns are great, and the likelihood that the U.S. can quickly replace a damaged or demolished reconnaissance system is diminishing.

The implication of such development is plain: the assurance that U.S. imagery satellites of the late 1970s and early 1980s can routinely acquire *conclusive* evidence of non-compliance with arms limitations agreements exists only so long as the systems continue to operate without being interfered with and without encountering unexpected and extended interruptions of service because of accidental failure. If *conclusive* evidence of Soviet violations is not at hand, is there assurance of an effective U.S. response? Should a gap in coverage occur, however caused, the Soviet Union would automatically acquire the opportunity to deploy, undetected, any of several strategic systems. Soviet appreciation of such an opportunity could provide the justification for a decision to attempt to "break out" of the existing arms limitations limits without risking *verifiable* detection during the early stages of the maneuver.

Of course, without first making extensive preliminary preparations the Soviet Union could not arbitrarily and abruptly decide to incapacitate American reconnaissance satellites and then proceed to upset the strategic balance during an "intelligence gap." But undetected preparations are the essence of a breakout strategy. A plausible scenario need not be complex or particularly demanding of Soviet talents. As earlier noted, none of the essential preconditions for a development, test, and demonstration program are necessarily obvious to reconnaissance satellites. It would be contrary to Soviet R&D rituals to undertake the production of a major system before testing it extensively, but the Soviets have on occasion resorted to precisely that expedient. (Several Soviet aircraft proceeded from drawing board to factory without pausing for conventional testing during the Second World War.) Nor is it essential to a breakout scenario to assume the appearance of a novel weapon with unprecedented performance capabilities: mounting an SS-20 atop a third stage can instantly transform it into an intercontinental missile. It is not necessary either to test a warhead element at full range or to operate a

\* See Section IV.

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three-segment missile as a whole to have reasonable assurance that the total system will operate as planned. For practical purposes, *any strategic weapon that could be effectively deployed in nine months or less after having been in clandestine preparation for deployment over a sufficient period would represent a candidate for breakout.* Nor is it essential for a newly deployed strategic weapon to be spectacularly effective if coercion rather than war fighting is the goal of breakout: in most cases a convincing threat can be as effective a deterrent as a demonstrated capability.\*

The essential preconditions to a Soviet decision to break out could be few, and they need not be *dependent* on the expectation of an American intelligence gap, although that prospect certainly would make a breakout scheme more attractive to the Soviets.

First, if a "new" weapon were involved, the Soviets would have to devise means of determining that it could be adequately demonstrated without alerting the United States to the prospect of a major new deployment. As suggested above, that might not be particularly difficult and in some circumstances (for mobile ICBMs or some ABM weapons, for instances) could be quite easy.

Second, production would have to proceed without detection. For both disaggregated testing and production, communications security and conventional counterespionage measures would have to be effective, of course, but in those areas the Soviets are both experienced and capable.

The Soviets would undoubtedly find it useful--though not essential--to be able to deploy all or a major fraction of their new weapons complement without detection--which would require either degradation or extended interruption of U.S. reconnaissance operations. That circumstance could apply if the Soviets wished either to deploy the weapons and then disguise them, thus keeping them concealed after a resumption of U.S. "verification" operations, or if they felt it necessary to have a great quantity of weapons in deployed positions before their actions became known to the United States. For either case, firm Soviet confidence that no U.S. reconnaissance satellites could discover a pre-planned deployment phase would prove adequate.

Third (but probably first in sequence), the Soviets would have to decide that the game was worth the candle. Premature disclosure of

\* Quaker cannon are not common elements of Soviet military tradition or history. But that is a weak reed on which to hang U.S. national security interests. Knowing whether a threat is real or pretended is a vital precondition to any response.

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Soviet intentions would almost surely touch off a new arms race, destroy the credibility of Soviet assurances, and have other unwelcome consequences. However, reaction to extreme (withal less provocative) Soviet actions of the 1955-1975 period has not often had long-term consequences unacceptable to the Soviets. The Hungarian, Czechoslovakian, and Cuban adventures did not end all that badly for them.

Finally, if the Soviets could interfere with the continuity or effectiveness of American satellite reconnaissance in some fashion that would only ambiguously indicate that they were responsible, they might be yet more willing to risk the possibility of a responsive American strategic arms buildup. Skillful diplomacy in the wake of skillful interference would reinforce ambiguity and lessen the chance (or risk) of such an American response.\*

Perception of opportunity--and risk--appear to be the key. U.S. technological capabilities for imagery returns have improved enormously in the 1970s. But the total vulnerability of imagery systems is increasing proportionately.\*\* The considerations that presumably conditioned Soviet appraisals of opportunities and risks in the 1965-1975 period have also changed.

Verification was initially conceived of in terms of a process that would proceed under conditions of *no interference*. *New measures* of concealment and deception were prohibited by the terms of SALT I. But deception and concealment have increased and opportunities exist for further enlargement without violating the *letter* of the original agreement. To that extent, verification is now obliged to function under conditions of *passive interference*. Can breakout warning function effectively, as the United States must define that qualification, under conditions of *passive plus active interference*? What would be the American response to a breakdown of satellite imagery capabilities which could not *conclusively* be attributed to active interference?

To address such questions, one must first address the issue of what contributory capabilities the United States has or can assemble in support of verification efforts.

Seven general categories of overhead reconnaissance exist: imagery in the ordinary visual spectrum, signal intelligence, electronic intelligence, communication intelligence, infrared signals, active radar, and infrared imagery. Mostly the vehicles are satellites, although aircraft still have utility in peripheral reconnaissance. Additionally, agents, defectors, and open-source information contribute to assessments. Some

\* Several of these questions are discussed in greater depth by Becker.

\*\* See Section IV.

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are inadequate for verification purposes for various reasons; others are inapplicable. Communications intelligence can have extreme value--but in many circumstances it is not totally credible and, in any case, a decreasing stream of communications intelligence discloses nothing except that the source being interrogated is uncooperative. Without confirming imagery, much of the output of signal and electronics intelligence is of dubious worth because, by its nature, it becomes available through the implicit cooperation of the agency that originates the signal. In any case, Soviet expertise in suppressing emissions that contribute to communications, signal, and electronics intelligence is generally conceded to be high.

The chief arguments against using active radar over Soviet land areas in the past have been: (1) that a radar survey of the Soviet Union cannot be concealed or disguised in any way, (2) that it can provide no more information than most optical imagery (and in some instances considerably less); and (3) that because one of the most obvious applications of radar imagery is to provide detailed data of the sort most appropriate to a preemptive strategic strike it could be highly provocative.\* Both the United States and the Soviet Union have actually orbited radar reconnaissance systems (although the American system was a pure R&D system) and the Soviets have tested a radar ocean surveillance satellite in various applications. In the absence of optical reconnaissance capability, radar might provide some useful information about changes in previously observed force dispositions and such, but it is unlikely to return information of the sort required to confirm that the Soviets are deploying some strategic weapon in kind, quantity, or quality to constitute a new strategic threat.

Defectors and agents might be the most productive sources of information during a hiatus of overhead reconnaissance, but the credibility of their information may well be low. The Soviets have a remarkably effective security system and notoriously good counter-intelligence, while the United States has become increasingly dependent on technological rather than human sources for its intelligence inputs (and thus may be unable to obtain credible intelligence from agents in time of crisis and may be unwilling to base major decisions on such information). The prospects, overall, are not attractive.

Is there any alternative source of information with the credibility of the imagery returned by reconnaissance satellites?\*\* If the information being sought, or subject to confirmation, has to do with the rapid

\*The somewhat tortured argument assumed that the Soviets could (would?) interpret a radar survey of their strategic sites as an indication that a preemptive strike, either limited or disarming, was immediately pending.

\*\*The limitations of such imagery are considered hereafter.

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buildup of a new Soviet strategic capability, the answer probably is "no." Good communications security, including encryption, rigid discipline in radar operation, and routine jamming are likely to prove sufficient to forestall the acquisition of wholly credible source information if the Soviets dedicate their considerable resources to concealment of a buildup. Blinded, or partly blinded, the only effective response the United States could make to unverifiable indications of a Soviet buildup of strategic weaponry would be to invest in a counterpart buildup, and if the Soviets were successful in making extensive surreptitious preliminary provisions for a quick buildup, a delayed U.S. response might well be dangerously ineffective.

What capability that currently neither exists nor is programmed could provide some insurance against such events? The first and most obvious requirement would appear to involve the preparation of a backup capability for use in both strategic reconnaissance and verification activities. That response, which has been variously proposed at intervals during the past 15 years, is certain to be costly. Indeed, in the past that has been the chief argument against so proceeding. Nevertheless, creating a backup capability remains attractive.

Past proposals have generally conceived of a system with relatively low resolution (one to three meters) for scanning Soviet deployments. In an era in which high resolution has become an increasingly essential ingredient of assessment, in which concealment and deception have become more prevalent, in which the fine details of a suspect item or installation may be essential to understanding of capability or potential, scanning systems are unlikely to be wholly adequate. It is, for example, entirely reasonable to assume that the Soviets, if they set out covertly to deploy some new array of strategic weapons, might design whatever installations they proposed to be essentially undetectable at resolutions more gross than 90 centimeters (which is probably representative of their own best imagery capabilities as of 1975-1978). Were that true, a scanning system of the type proposed in the past would provide little useful information. It would have to be accompanied by, or supported by, a high resolution pointing system.

Short-lived scanning and pointing systems sent up to provide reassurance against Soviet strategic redeployment actions following the breakdown of routine imagery could conceivably return indications that suspect activities were in progress. However adroit some subtle interference with "routine" verification systems, and however ambiguous its indications, continued interference with short-lived, special-purpose verification systems would probably not escape notice, particularly if suspected in advance, and confirmation of Soviet efforts to prevent reconnaissance would almost certainly induce American authorities to assume that a Soviet breakout attempt was in progress.

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Defining or specifying the technical characteristics of a suitable system pair is beyond the scope of this discussion, as is any detailed consideration of cost tradeoff factors. But that appropriate systems could be designed cannot be doubted; film-optics systems, launch and orbital vehicles, and recovery methods appropriate to such applications have been accessible to U.S. designers for nearly a decade. As for cost, the investment requirements must be balanced against alternatives, and without high confidence means of confirming that the Soviets were not building a destabilizing strategic capability during a period of U.S. "vision impairment," the only sensible alternative would be to undertake an American buildup. Given the current costs of weaponry, no such buildup could cost less than several hundred times the costs of developing and maintaining an adequate backup verification capability.

One of the near-term problems created by consideration of such options is that some of the essential ingredients of an appropriate U.S. response are not as plentiful as in the past. Starting from scratch, two to four years might be needed to create the capability to manufacture appropriate photographic reconnaissance systems. Perhaps more pertinent, the ongoing shift away from expendable boosters to such reusable boosters as the Space Shuttle implies that special measures would have to be taken to ensure the continuing availability of boosters capable of putting such reconnaissance systems into orbit on short notice. Similarly, with the gradual rundown of GAMBIT and HEXAGON production and operations, routine capsule recovery could become troublesome. Nor is the availability of essential ground stations for command and control indefinitely assured; as the need for stations capable of controlling recoverable-capsule reconnaissance systems diminishes, they presumably will disappear. All in all, it is not a simple problem.

As with the most complex weapon systems, reconnaissance satellites of all types are taking longer in development, are costing more, and are providing smaller and smaller increments of performance improvement with each investment in quality improvement. The original CORONA photographic system experienced its first (unsuccessful) test flight roughly two years after development began and operated successfully about one year later. Six to seven years of effort devoted to the principal variants of the original SAMOS-series reconnaissance satellites proved fruitless; all of those photographic satellite programs had been abandoned by 1965. (SAMOS [redacted] and ELINT satellite variants were somewhat more successful.) GAMBIT, in its original form, was rather more than four years in development and took about five years to achieve its original design goals. The improved GAMBIT satellite, which used many of the key subsystems of the original, required about three years to develop. HEXAGON spent nearly six years in development after two years in planning gestation. KENNEN, which became operational in 1977, was in development for nearly seven years, although the first two of those years had more of a research than a development cast.

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Nevertheless, it is becoming increasingly apparent that the kinds of major improvements in performance that characterized earlier advances in reconnaissance technology are not readily come by today and are likely to be even more difficult of achievement and more costly in the future. If events in other fields may be used as indicators of what may occur for reconnaissance instruments, it is reasonable to conclude that as the United States approaches the limits of achievable performance, Soviet instruments and capabilities will progress along the lines of earlier American systems and, in five or six years, Soviet designers will not only be approaching the same physical limits, but will have a good appreciation of the maximum performance achievable by American devices. (Appreciations of reconnaissance capability usually precede achievement by about five or six years--the period required to proceed through development from concept to operational article--so the Soviets may today be approaching a good appreciation of present American capabilities in film-carrying systems.)

Such trends imply that Soviet understanding of American capabilities for verification probably do not lag far behind the reality of those capabilities. They also suggest that further major improvements *along traditional lines of coverage and resolution* are not probable. In that circumstance, should the Soviets conclude that it was possible to develop, produce, and deploy new strategic systems that could not be seen at or below the real threshold of U.S. detection capabilities, the option of attempting a clandestine breakout could become rather attractive.

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In the end, it can reasonably be argued that the technological capability of United States reconnaissance systems to verify Soviet compliance with the terms of arms limitations agreements in existence before 1977 is adequate. That assessment assumes no significant interference with the functioning of those systems and no increase in concealment and deception actions. But when account is taken of the possibility either of malfunction or of effective interference, the assessment rapidly loses validity. And, of course, bringing additional systems into the limitations agreement is quite another matter.

For example, the detectability of cruise missiles, or more properly, the ability of satellite reconnaissance to distinguish "short range" cruise missiles from counterpart missiles with intercontinental capabilities (when launched from forward carriers, either aircraft or submarines) is very limited. Technology current in 1973 supported the assumption that any air launched cruise missile with a volume greater than 125 cubic feet, and surface or submarine launched missile with a volume greater than 150 cubic feet, was a potential strategic weapon. Verifying intercontinental capability by monitoring infrared signatures of test missiles is an unlikely prospect; rockets with less than 10,000 pounds of thrust frequently are not picked up by infrared detectors; scan area and frequency limitations constrain the utility of existing satellite-borne detectors and conceivable improved versions. Cruise missiles could be tested adequately at less than their maximum operational ranges; indeed, normal Soviet practice in testing ballistic missiles has been to devote most initial testing to limited range operations and to conduct one or a very few maximum range tests. Further, the range of cruise missiles is not highly correlatable with observed size; merely inserting a larger fuel section can convert a nominal "short range" cruise missile into one with twice the presumed range.

In sum, most candidate restrictions on cruise missiles (size, test range operations, thrust) did not appear to be verifiable with sufficient assurance to provide confident assessments of compliance with any controls on the deployment or the development of cruise missiles.

Finally, if the adequacy of present reconnaissance systems for verifying present arms limitations agreements must be qualified, what of the possibility that present or conceivable new systems can provide breakout warning? This discussion has at least suggested that no currently conceivable species of reconnaissance satellite, no "national technical means" that are within reach can *guarantee* that the Soviets will not undertake a covert buildup; can provide assurance that a buildup would be detected early enough to permit effective U.S. counteraction; or can insure against a successful Soviet effort to

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develop, produce, and clandestinely stockpile a fund of strategic weapons against a later decision to deploy them.

Perhaps most alarming is the prospect that the Soviets could reliably anticipate a period of ineffective satellite reconnaissance or a lengthy gap in coverage. Soviet appreciation of that potential and a deliberate effort to exploit it--if only by undertaking a slow, cautious, and inconspicuous stockpiling of strategic weapons--constitutes a clear and persistent threat to the stability of the present strategic weapons balance. A Soviet perception of opportunity stemming from a Soviet appreciation of the vulnerability of U.S. "national technical means" represents the basic threat. Without such a perception the likelihood of breakout is lessened; with such a perception, it must inevitably increase.

What, then, are the vulnerabilities? And how serious?

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IV. VULNERABILITIES AND COUNTERMEASURES\*

United States verification capabilities can be adversely affected if existent systems are *degraded*, if their operation is *interrupted* for any significant period, or if they are *prevented* from performing their assignments. Those effects can arise from active interference, passive concealment and deception, or any combination of the two. The consequence is much the same whether satellite functioning is affected (active interference), concealment and deception measures effectively degrade that function (passive interference), or political measures inhibit capability (jurisdictional interference).

GAMBIT, the most useful of space reconnaissance systems for acquiring high resolution images of Soviet weaponry, installations, and facilities, will provide about 120 days of on-orbit coverage of Soviet territory annually during and after 1977. HEXAGON, which provides broad area coverage by way of daily surveys of most areas of interest within the Soviet Union, will be on orbit for about 180 days a year from 1977 through 1979. (HEXAGON presumably will be phased down as KENNEN proves its worth.) HEXAGON and GAMBIT have distinctive orbital signatures, although their somewhat different inclinations (97 degrees and 116 degrees, respectively) have on two occasions (as of late 1976) been exchanged. The first such instance apparently confused Soviet trackers, with the result that GAMBIT, in a nominal HEXAGON orbit, observed previously concealed events and equipment. Since 1975, Soviet space track monitors have readily identified and distinguished between the two, with the result that some items that GAMBIT could detail have been left visible to HEXAGON passes but have been removed or covered when GAMBIT was overhead. That practice effectively degrades the performance of the GAMBIT system; different measures are effective against both systems.

The relative frequency of GAMBIT and HEXAGON coverage makes Soviet concealment of major construction enterprises, installations, and test operations difficult: for all practical purposes only 60 to 90 days a year, splintered into rather brief periods, have recently been devoid of either HEXAGON or GAMBIT operations. Nevertheless, determined evasion probably could conceal from GAMBIT conclusive indicators of "small" systems not dependent on major site construction programs; the still lower levels of HEXAGON resolution makes that system still more susceptible to concealment and camouflage. Planning around GAMBIT missions is

\*This section deals with the possibility of detecting and identifying the *deployment* of strategic weapons. As noted in the previous section, that possibility arises in the assumed capability of the Soviet Union to demonstrate and to produce such weapons without detection by "national technical means."

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the easiest Soviet evasion measure, but with its "best" resolution capability of [ ] GAMBIT can conceivably detect some subtle indicators of certain evasions. Further, both GAMBIT and HEXAGON are subject to irregular degradation of returns by the presence of an average 60 percent cloud cover over the Soviet Union. And, of course, neither is effective unless the sun is well above the horizon.

GAMBIT and HEXAGON are fundamentally incapable of providing useful information about such installations as mobile ICBM systems that resemble earlier IRBM systems, non-standard ABM installations, warhead variations, and other items and activities similarly lacking in previously identified or strikingly distinctive "signatures." Given the frequency and high predictability of cloud cover, plus the invariability of satellite orbits, the Soviets can both schedule activities when no reconnaissance satellites are in the vicinity and conduct particularly sensitive activities in darkness or under seasonal cloud cover. Slightly non-standard installations might go unnoticed or unremarked, a prospect that makes the possibility of something like a subtly upgraded SAM with concealed ABM capability worrisome. Verification of suspicious activity of that sort could well require better resolution and more frequent coverage than GAMBIT provides. As recent experience with grain storage sites and underground factories has demonstrated, unremarkable installations without familiar, known site signatures tend to go unremarked or, if noticed, to be classified as of uncertain purpose. Providing a rather mundane, seemingly common "signature" for some construction activity the Soviets wanted to go unremarked would not be difficult if a determined effort to do so were made. Nor, of course, can photography penetrate opaque surfaces. The abundance of "light industry buildings" in the Soviet Union, and the rather great size of some, provide opportunities for conducting virtually any activity but operational or field tests under the cover of roofs and walls.\*

Interruption of GAMBIT and HEXAGON coverage by reason of either interference or accident is not implausible. The timing of random accidents cannot be predicted, which makes them difficult to exploit, but "accidents" can be arranged and in such circumstances are likely to be exploited. For many years the United States treated Soviet interference

\*Harris, R-2093-ACDA, considers passive measures in greater detail.

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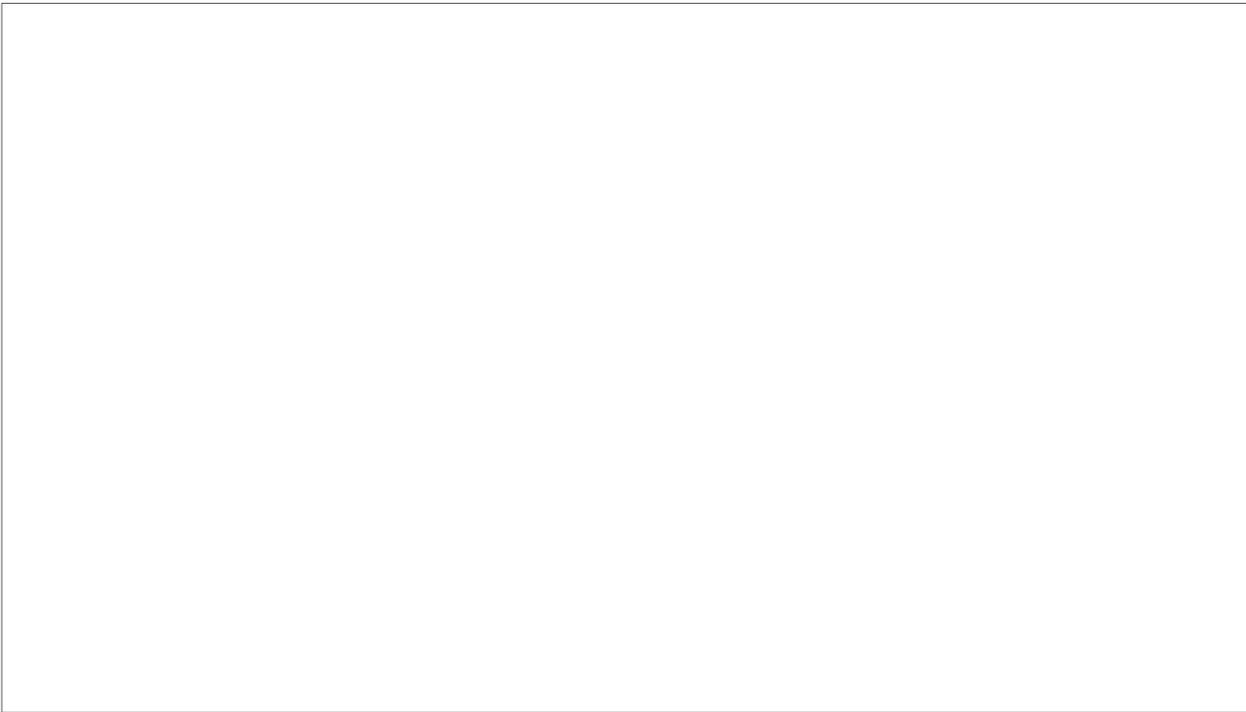
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The likelihood that the Soviet Union would attempt to attack American photo reconnaissance satellites has not had great credibility in the United States since signature of the arms limitations treaty with its "no interference" proviso. Earlier concern lessened because of growing Soviet dependence on their own satellites for surveillance of Chinese and Middle Eastern activities.

There is, however, a second set of rationales for Soviet attacks on various of the U.S. reconnaissance satellites. It stems from the premise, earlier discussed, that the Soviet Union's technical intelligence specialists have only recently become aware of the remarkable performance potential of American satellites and from the persistent Soviet distinction between verification and espionage. What would be the U.S. response if the Soviet Union declared that operations of HEXAGON-like systems were permissible under the "National Technical Means" clause, but that GAMBIT represented an espionage capability? That seems unlikely for a great many reasons--but so did the emplacement of Soviet missiles in Cuba in 1962. Would a "space war" result? How implausible is such a scenario?



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or consecutively affect several critical surveillance, reconnaissance, or verification systems, the U.S. has at best a quandry and at worst a crisis to contend with. If the Soviet Union does not honor the assumption that U.S. technical means can indeed verify a breakout attempt, such a breakout attempt becomes that much more likely.\*

In the past, U.S. concern for the possibility of some clandestine development program that would lead to a Soviet technological breakthrough and destabilize the strategic arms balance has been offset by the assumption that the United States would be able to detect such a development program well before it could have important consequences. Intercepted test range information (particularly telemetry from test articles), construction activity, and sightings of prototypes or test articles have often provided early evidence of Soviet development enterprise in the past. But are the Soviets necessarily conducting developments of the late 1970s along the same lines that produced signals indicative of intent and progress in the 1960s?\*\*\* If Soviet institutions and processes are changing, if concealment and deception are increasing, U.S. intelligence gathering mechanisms can function as effectively as in the past only if U.S. means of intelligence gathering and interpretation improve at about the rate that Soviet countermeasures improve. Is that a realistic premise on which to base U.S. policy?

Difficulties of finding and interpreting the purposes of novel Soviet construction enterprises have increasingly troubled U.S. intelligence analysts in recent years. The underground grain storage sites provide an interesting case in point. Emigre-provided information was the key to locating and identifying those sites; their construction and their unremarkable but identifiable site signatures had been photographed for

\* In such circumstances covert preparations for an eventual deployment might be cloaked by communications security, camouflage, or concealment, and deployment conducted under cover of an arranged degradation or a gap in coverage.

\*\* Until the late 1960s, Soviet R&D practices were highly predictable, tended toward the avoidance of technological risk, and almost always included a phase of extended R&D and operational testing visible to reconnaissance satellites. There were some significant exceptions, however. The 1970s have been marked by enterprises invoking higher technical risk, by investment in large numbers of advanced technology programs with objectives obscured from U.S. understanding, and by overlapping development/production programs. For practical purposes, the period of visibility that extended from the completion of research to the start of operational use for any major system was relatively long until recently, but has both shortened and been conducted under different rules since 1970. Recognition patterns have changed, making early and certain identification of major Soviet R&D programs increasingly difficult.

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several years, but no one interpreted them correctly--or noticed them at all.

U.S. observers appear to be losing their ability to explain Soviet intent and Soviet goals in technology, to understand why the Soviets have invested in some kinds of testing or built installations that have no U.S. counterparts. The numbers of identifiable "enigmas" has grown appreciably since 1970, perhaps because the continuing improvement in the quality and frequency of reconnaissance returns has made "enigmatic" activity more apparent.\* But it is also conceivable that the United States can no longer anticipate the directions and purposes of Soviet R&D. Inability to identify the function or importance of obvious facilities is as disturbing as inability to locate facilities or installations that may have alarming implications.

Given such uncertainties, what should verification and breakout-warning capabilities focus on? Concealment and deception are well established Soviet practices; *maskirovka* is the common term for a doctrinal policy of concealment and deception in strategic or tactical matters. The Soviet objective, in all instances, is to confuse an antagonist's appreciation of the location, size, and capability of Soviet forces. Thus, the Soviets routinely make every effort to prevent unfriendly access to technical details which might disclose performance characteristics of their military systems. Cloaking readiness status is another routine precaution. Past Soviet actions have included constructing dummy installations, covering production and weapons sites, and camouflage. That those efforts have been regularly detected may say something for the quality of U.S. surveillance, but it is conceivable that other and more successful measures of concealment and deception have escaped notice. The lack of evidence to that end does nothing to lessen the possibility.

There has been, from time to time, some U.S. consideration of the possibility that the Soviets are selectively clumsy and ineffective, or that an obvious, discernible camouflage scheme is intended to divert attention from some other, far better concealment effort. The reality of that threat is difficult to establish; penetrating some hitherto unsuspected camouflage arrangement would presumably demonstrate that the Soviets are more capable than we might earlier have assumed, but it would neither prove or disprove the thesis. There is comfort in the assumption that Soviet reconnaissance satellites are less capable than their American counterparts and that the Soviets have no real appreciation of American capabilities. The ability of a GAMBIT camera system to resolve camouflaged details that frustrate HEXAGON would suggest a certain insensitivity on the part of Soviet camouflage experts, but again the experience neither proves nor disproves anything.

\*Caspian Sea monsters and the "Peanuts" facility are two of the more widely publicized "enigmas"; the purpose of each remains uncertain notwithstanding several years of photographic coverage of each.

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other and less obviously threatening installations exist or are under construction elsewhere. Were that the case, an interruption of surveillance anticipated by the Soviets could provide the opportunity for any of several conceivable enhancements of the Soviet strategic force structure. The best that the United States could hope for would be to discover the buildup upon the resumption of surveillance. A worse case could include a non-attributable interruption followed by a refusal to permit a resumption of surveillance once the United States regained the capability for it. The worst case presumably would involve resumption of surveillance after the evidence had been appropriately disposed of and the offending installations effectively concealed or camouflaged.

For all such scenarios, a minimum assurance requirement for the United States would be means for ensuring that no lapse of coverage could be lengthy enough to permit the completion of a clandestine Soviet strategic weapons deployment.\* That implies having a stock of backup systems at least sufficient to fill the gaps created by the failure of one or more verification systems or, alternatively, a dedicated crisis response system sufficiently capable (in coverage and resolution) to return information at the required level of detail. Announcing, demonstrating, or even leaking information about the existence of such a capability presumably would discourage the Soviets from attempting to exploit a contrived gap in routine surveillance.

Disagreements about resolution and coverage requirements for a crisis or backup reconnaissance system have attended earlier proposals. Most such proposals have been dismissed, in the end, on grounds of unwarranted cost or uncertain need. For a system adequate to the needs of verification during a breakdown of the ordinary surveillance process, it is likely that *both* high resolution and broad area coverage would be needed, the first to identify suspicious sites, the second to inspect their details. That is not an impossible requirement. For example, GAMBIT has a potential for still better resolution than it routinely generates: in the 1960s, GAMBIT was accidentally but successfully operated at altitudes of less than 60 miles with excellent returns. And in another mode GAMBIT is capable of operating, at least marginally, in an area-coverage role. In 1970, when there appeared to be some possibility that the inventory of CORONA satellites would be exhausted before HEXAGON became reliably operational, the National Reconnaissance Office sponsored the development and fabrication of "HIGH-BOY" and "HIGHERBOY" kits which, when installed in a GAMBIT reprogrammed for operations at

\* For this illustration it has been assumed that the deployment would indeed be visible to U.S. reconnaissance satellites or that the Soviets assumed such to be the case.

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altitudes above 300 miles, would provide adequate area coverage.\* A film-readout system with near-real-time potential has been designed for GAMBIT, obviating reliance on capsule recovery and lessening the time needed for information retrieval.

Were minimum cost to become an objective of a crisis capability reconnaissance system, GAMBIT might be ruled out. In that case, a cheaper (but still costly) course could be to build a small set of CORONA-style satellites adaptable to launch from any of several expendable boosters which could be kept in ready storage for several years. The frequently proposed but never approved CORONA J-4 system probably would represent a reasonable starting point; in combination with Thor boosters it might serve the intended purpose quite capably. Several alternative crisis systems have been proposed over the years. But again, consideration of appropriate systems must await a policy decision to invest in some backup or crisis surveillance system.

Quite apart from the problems posed by the possibility of Soviet covert or overt interference with American verification instruments lies the issue of third-party interference or interference by what appears--or is alleged--to be a third party acting on his own. Two classes of events require consideration: successful attempts by some third power to prevent surveillance of *its* territory, and the side effects of upper-atmospheric tests of nuclear weapons by a non-signator of the test ban treaty. Either could put both Soviet and U.S. reconnaissance satellite systems out of commission for considerable periods.

Like the Soviets, the Chinese vigorously oppose activities they classify as espionage. They are aware of the potential of satellite reconnaissance and have demonstrated some interest in developing their own capabilities. They have also invested heavily in concealment and camouflage of their own installations. Although it may be reasonable to conclude that the Chinese would refrain from interfering with American reconnaissance satellites on grounds of self-interest (while Sino-Soviet antagonism was pronounced the United States might warn the Chinese of any major buildup of Soviet forces in Manchuria), that situation could change radically with a realignment of internal Chinese policies. It is also entirely conceivable that the Chinese could develop their own anti-satellite weapon and dispatch it at *all* interlopers, whether Soviet or American. That does not have the odor of a near-term threat, but Chinese missile and satellite capabilities are developing at such a rapid pace that the threat cannot be forever discounted.

\*This description is intended to be a representative example of one of several potential expedients; it should not be interpreted as advocacy of *one* possible response among the many that have been proposed since crisis response first was evaluated in the early 1960s.

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It is quite impossible to overfly the Soviet Union by satellite without also overflying China. In the instance of a Sino-Soviet rapprochement, would the Chinese consider interfering with American satellites, perhaps using techniques or weapons provided from Soviet inventories, while permitting Soviet satellites to operate unchallenged? The ideological argument that American satellites are conducting espionage while satellites of the Socialist Coalition are merely protecting world interests is not impossible of composition. Would the United States respond by recommencing a strategic arms buildup?

Another possibility is an atmospheric test of nuclear weapons as part of a long-range program to develop an ABM capability. The functions of most American (and presumably most Soviet) satellites are degraded by the radioactive debris of a nuclear explosion.\* In particular, film-carrying satellites are affected adversely. The Chinese might simply ignore such possibilities on the grounds that their interests required nuclear tests in space and that consequences for satellites were not their only concern. Or they could consciously decide to undertake such tests, fully knowing the consequences but reasoning that degrading Soviet reconnaissance returns was more important to the Chinese than any consequent rundown of American capabilities. The calculation of intent and motive is complex and, moreover, is subject to fluctuation as Chinese policy perceptions change in the post-Mao era.

The purpose of this discussion has been to illustrate several of the most worrisome political and technical vulnerabilities of the American satellites currently charged with verification tasks and inferentially responsible for providing breakout warning. This by no means constitutes a catalog of possibilities, of vulnerabilities, or of potential responses. It does, however, indicate that assumptions of the adequacy of the verification and breakout warning system are critically dependent on Soviet cooperativeness, even for imaging satellites. The opportunities for degrading satellite effectiveness are extensive.

If a benign Soviet attitude toward overflight by reconnaissance satellites can be assumed, and if the United States maintains confidence in the fundamental adequacy of its reconnaissance satellite capabilities, there is slight reason for concern about the future of the arms limitations agreements or their implications. But if either of those premises becomes flabby, concern for the future may be justified.

American verification capabilities are subject to disruption, degradation, or extended interruption from a variety of sources. Provisions for responding to any of those developments are lacking.



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Current arms limitations agreements can probably be adequately verified by existent means, but breakout warning is quite another matter. Whether appropriately credible measures for detecting a cleverly concealed buildup for breakout can be constructed seems uncertain. It probably is not possible to devise a complex of satellite systems that can certainly detect a cleverly concealed buildup for eventual breakout. The Soviets presumably would not attempt to emplace substantial numbers of recognizable strategic weapons unless they were either ready to disclose their intentions or confident that the emplacement process could be concealed from the United States. Interference with the functioning of American surveillance systems would seem unlikely if the Soviets could not depend on the complete success of an interference attempt and wanted to avoid being found out--which strongly suggests the advisability of having an American backup or crisis systems available against the contingency of a breakdown in the existing verification system. The existence of such a backup capability would at least protect against the necessity of having to make critical U.S. commitments to a new strategic arms buildup--or against one--in a situation of total uncertainty about Soviet actions and their implications.

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battle information. No U.S. reconnaissance, surveillance, or monitoring satellites were developed solely in response to a formal requirement originated by the United States Intelligence Board or the President's Foreign Intelligence Advisory Board or any predecessor or successor organization. "Requirements," when they appeared, tended to be expressions of desired system performance phrased in terms of some newly conceived or recently tested technological capability.

When first considered wholly in light of what "national technical means" might support, verification was viewed as an alternative application of an existing capability. Perhaps the nature of the verification process, as then perceived, made that inevitable. But the trend of satellite reconnaissance system evolution has made that an increasingly complex calculation. In 1967-1968, when for all practical purposes the United States concluded that the Soviet Union would never accept effective on-site inspection as a condition of an arms limitation agreement, CORONA and GAMBIT provided the nation's photographic reconnaissance capability,\* communications intercept from satellites was minimal, and most ELINT collection dealt with radar order-of-battle and technical data collection. CORONA and GAMBIT launches were relatively frequent (they were gradually tending down from a rate of one a month), most systems were comparatively inexpensive (CORONA cost about \$10 million, on orbit, per launch), and procurement needs were sufficiently large to warrant the creation and maintenance of a sizable reconnaissance satellite production capacity. HEXAGON was an order of magnitude more capable than CORONA, but it cost more in about the same proportion, and rather than being replenished at two to four-week intervals, it was destined to remain in orbit for three months (and later four). The progression to an improved GAMBIT was along the same lines: the system became more costly, more capable, in terms of resolution, and lived longer (90 rather than 30 days).

HEXAGON in

If one were writing requirements for an imaging satellite system capable of verifying the terms of the existing strategic arms limitation agreements, would he settle on systems resembling HEXAGON, GAMBIT, and

The answer might be "yes." Indeed, a

But that "yes" answer would have to be qualified to some extent by anticipations of Soviet actions. One or two HEXAGON and GAMBIT systems are to be procured and launched each year (and perhaps only one or two GAMBITS, in all), while

\*"Best" resolution obtainable from GAMBIT was then on the order of 50 centimeters.

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In the same context, a requirement for verification of compliance with arms limitations agreements would have to consider vulnerability and its influence on both the nature of systems and the prospect of providing substitute capability were the primary systems to be incapacitated.

What institution will support requirements of that sort? In theory, the United States Intelligence Board (or its replacement) should do so. But USIB-style organizations have for 15 years been the captives of attractive new technology. Another problem arises in the relationship between the USIB and the Central Intelligence Agency, which is not merely the intelligence-using agency but also assesses reconnaissance satellites. Except casually, the Arms Control and Disarmament Agency has had no effective voice either in the "requirements generation" process or in the selection of systems. Verification may not be the paramount justification for maintaining an effective satellite reconnaissance capability, but it certainly has a better claim to that status than do some of the more time-honored "requirements."

And none of this frontally addresses the breakout issue. For practical purposes, of course, a surveillance system (including COMINT and ELINT as well as imaging capabilities) that protected against breakout contingencies would by its nature protect against violations of arms limitations agreements. But, as has been observed earlier, no presently conceivable system wholly dependent on satellite operations can adequately insure against the contingency of an artfully conducted buildup for eventual breakout; the current complex of systems is at best marginally capable of detecting some conceivable deployment activities even if operating unhampered; all available satellite systems with verification potential are susceptible to energetic concealment and deception activities; and the system as a whole can be degraded or interrupted for considerable periods without necessarily alerting U.S. authorities to the source of that interference.

\*The question of providing reserve systems was being considered by the NRO late in 1976, but no decision on action had emerged.

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The rationale for dedicating a satellite system to verification purposes was first worked out more than 15 years ago. It prompted the assembly of numerous studies and analyses some 10 years ago, but became increasingly less influential thereafter.\* The justification seemed inadequate. But if Breakout is now viewed as a potentially serious threat to the continuing security of the United States, then it follows that many--even most--of the classical tasks of satellite reconnaissance may have more current relevance to verification (or breakout warning) than in the past.

There would appear to be some value to a dispassionate evaluation of the national requirements for dedicated verification devices with emphasis on satellite reconnaissance systems, taking account of contingent requirements for capabilities, for assessing the vulnerabilities of current and proposed systems, and for insuring the continuation of both broad area and high resolution coverage in the event of a temporary breakdown of the principal reconnaissance systems.

Even more fundamental is the need for a reassessment of the rankings of various requirements, including the requirement for data relevant to the verification task. Can validation needs be adequately satisfied by drawing on the fund of intelligence collected in pursuit of technical intelligence and strategic disposition information? Again, the obvious answer would appear to be "yes, if ..." The "if" covers that intangible quality of assured coverage, security from serious degradation of returns, and insurance against interruption (or the effect of interrupting routine coverage).

It would appear that a requirement focused on breakout warning, which adequately comprehends the verification of present and currently proposed extensions of arms limitations agreements, should be at least as much concerned with the detection of capability buildup indications (signals of a potential for later and an indication of prospective intent to attempt a breakout) as with indicators of an effort to deploy additional (or new) strategic systems. As in the case of the underground grain storage sites,

\* See, for instance, ACDA memo to Assistant Secretary of Defense/ISA, 18 February 1963; a five-volume study titled, "Project Fair, Observation Satellites for Arms Control," was available in 1965; NRO studies of an "Arms Control Satellite" were underway in the spring of 1969; extensive studies of the capabilities and limitation of existing reconnaissance satellites in arms control and verification applications were undertaken by the Electromagnetic Systems Laboratories (for the CIA) in 1969 and continued into 1975; 1962 Woods Hole Summer Study Report (Project RIPOSTE): Verification and Response to Violations of Arms Control Agreements.

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information acquired by means other than satellite reconnaissance may conceivably be necessary to focus attention on indicators of capability buildup. But the grain storage site incident also demonstrates, again, the considerable potential for missing or misinterpreting inconspicuous or ambiguous indicators picked up by satellite photography.

Any new requirements review process should extend to consideration of the extent to which particular effort might be applied to locating and interpreting specialized but obscure indicators of research and development activity, of unusual test installations, or of construction activities or production innovations. The resources available to the United States are considerable; intelligent and persistent application to questions of breakout potential or preparations conceivably could have unexpectedly high payoffs.\*

It seems apparent that greater consideration should be given to defining the requirements for adequate breakout warning. If satisfying such requirements necessitate a larger investment in both intelligence gathering and data assessment, as seems likely, the acceptability of such costs must be weighed against the prospect of a belated discovery that the Soviet Union has *not* been benign and open in its arms limitations activities.

At the end, however, one additional prospect must be very seriously considered. "National technical means" of verification probably were adequate to the basic needs of the United States between 1968 and 1974, but they are not obviously capable of satisfying the very different needs of the late 1970s and the 1980s. The Soviet systems against which the United States earlier felt obliged to protect itself are not necessarily the most threatening systems of late 1970s and the 1980s. Nor is the concealment, deception, and degradation-interference environment of the 1968-1972 Soviet Union necessarily representative of that against which

\* As inferentially suggested earlier in this section, the United States might usefully invest more heavily in improving its understanding of Soviet R&D processes, which appear to be changing dramatically, on the grounds that it may be easier to look for indicators of Soviet weapons development in particular places and at particular times than to search randomly through a multitude of increasingly tenuous indicators.

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verification systems of the late 1970s and 1980s must operate. It is entirely conceivable that a careful, objective, wide-ranging evaluation of requirements and capabilities for breakout warning (and verification) in the 1980s will conclude that adequate warning *cannot* be provided by existing or achievable "national technical means." In that not implausible circumstance, the United States must be prepared to acknowledge that the rationale for the 1972 arms limitations agreement no longer pertains, that national security requires greater assurance of Soviet compliance with both the spirit and the letter of arms limitations agreements than was earlier deemed essential. On-site inspection, perhaps qualified in various ways but nonetheless assured, could become for the United States the only acceptable means of verifying Soviet compliance with future arms control treaties.

The questions of national will, arms race resumption, and risk of war thus generated may not be addressed here. They are for another forum.

But if breakout is indeed the credible and highly dangerous threat that it seems to be, those issues too must ultimately be confronted.

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VI. FINDINGS AND IMPLICATIONS

This Report has addressed questions having to do with requirements for verification, with U.S. capabilities for providing credible indications of Soviet actions (and to some extent, intentions), with perceptions of the adequacy of verification, with vulnerabilities, with a range of potential responses to perceived inadequacies, and with some of the institutional, technological, and political problems of providing breakout warning. It has been addressed, in all instances, to those aspects of the verification process that bear on the possibility of a Soviet breakout.

Fundamental to U.S. acceptance of the strategic arms limitations agreements of the past five years has been the premise that U.S. national technical means of verification will adequately satisfy the national interest. That premise arose in several widely accepted, inter-related assumptions. The first was that U.S. national technical means -- by which was principally meant reconnaissance satellites -- were technically capable of detecting and confirming any Soviet attempt to evade the agreed arms limitations. The second, which derived from the first, was that the non-interference clause was largely self-ensuring: subtle active interference with American satellites would be so technically difficult as to pose great risks of disclosure, while the political consequences of detection would presumably be unacceptable to the Soviets. It was further assumed that a growing Soviet dependence on satellite reconnaissance (and other space systems) would discourage any Soviet efforts to interface with American satellites.\* A final assumption, woven through the others, is that pending American reconnaissance satellite capabilities would provide adequate insurance against the success of any Soviet effort to exploit developing concealment and deception capabilities.

Nonetheless, a variety of political and technological opportunities for compromising the adequacy of existent and planned American verification capabilities have been suggested here. Some arise in the terms of the arms limitations agreements, or in potential interpretations of those terms. The Soviet Union has repeatedly demonstrated that it does

\*One aspect of the calculation that has not been addressed here is the credibility of a tit-for-tat U.S. response to Soviet attacks on American satellites. In fact, no effective U.S. anti-satellite system currently exists, although proposals for its creation were being evaluated in 1977. But the prospects of war in space lie beyond the scope of this study. And, of course, responses other than in kind are readily conceivable.

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not consider itself bound to honor the terms of any unilateral U.S. interpretation of those agreements. The case of the III-X silos--or "control centers"--is informative. The Soviets carefully observed the mutually agreed restrictions on building new silos, but the "spirit" of the prohibition was ignored. Similarly, the Soviets agreed to limit increases in the *dimensions* of existing silos to 15 percent, and did so in the case of the replacement of SS-11 by the SS-19--but they ignored the unilateral U.S. statement that an increase in the *volume* of the missile by 30 percent or more would be viewed as a breach. As Secretary Schlesinger put it, "... there is a violation of our interpretation of our unilateral statement, but I am not sure what binding force that has on the Soviets."\*

Among the politically uncertain elements of the arms agreements is that arising in the lack of a definition of "national technical means." The Soviet position on the distinction between espionage and verification may well be critical. Concealment clauses are also vaguely specified--by design.

In a technological sense, the increasing complexity, fragility, long on-orbit lifetimes (coupled with consequent long lead times for replacements), and costs of U.S. reconnaissance satellite systems, when viewed in the light of improving Soviet capabilities for interference with those satellites, could have ominous implications for the future.

Such circumstances provide both openings for Soviet exploitation of opportunities that may arise and invitations to explore the openings. They also serve to identify vulnerabilities in U.S. positions, and technologies. So long as the Soviet Union credits the assumption that U.S. national technical means of verification are adequate, no major effort to subvert them is likely. But it is also reasonable to assume that past Soviet performance is a good guide to the future, and that an obvious and easy opportunity to subvert American capabilities is likely to be explored. The United States has no present means of assuring that subtle Soviet interference with the functioning of reconnaissance satellites will be promptly detected, and (more important) no real capacity for promptly replacing surveillance satellites that for uncertain reasons have become disfunctional. A lengthy gap in coverage of Soviet strategic weapons dispositions would be alarming enough in its own; a gap anticipated--or precipitated--by the Soviets would provide what might be an irresistible opportunity to emplace new strategic weapons without detection. Were that emplacement subsequently concealed, the Soviets could acquire a lasting and appreciable strategic advantage: mobile ICBMs, a significant enhancement of ABM capability, or the deployment of massively improved

\*Hearing before the Subcommittee on Arms Control of the Committee on Armed Services, United States Senate, 6 March 1975.

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ICBMs would represent such an advantage. Were such an emplacement impossible to conceal after it had been completed, the Soviets would at least acquire a momentary advantage and a major lead in a new arms race.

No existing U.S. national technical means were designed for the purposes of arms control verification though they adequately serve present and past needs as defined by current treaties. Future needs may be quite different. The requirement for verification adequacy may not be satisfiable, in the long term, by continued reliance on systems designed to serve diverse national needs but without explicit concern for verifying Soviet compliance with arms limitations agreements. At the least, the requirements process should be reviewed to ensure that the principal needs of verification have been given adequate weight. In particular, there appears to be a valid need for readdressing the requirement for a backup system (or systems) that could be called into service if one or more surveillance satellites are incapacitated. Adequate technological resources still appear to be available, although the course of satellite development makes their continued survival uncertain: by 1980, if present trends do not change, the capability of creating and producing a backup satellite system may have been compromised.

The existent arms agreements do not, of course, inhibit the development or deployment of strategic weapons not covered specifically by the terms of those agreements. The ability of U.S. analysts to interpret the intent of and to discern the proposed applications of novel Soviet technological developments does not seem to be improving with the passage of time. That, too, may become troublesome in five or ten years. It could become particularly troublesome if, at some near future time, the United States were to be wholly reliant for verification purposes on one or two verification systems that were vulnerable to unattributable degradation or interruption of service, or that could be precluded from adequately performing their assignments.

In the end, it would seem that many of the principal assumptions about the long-term adequacy and credibility of U.S. verification processes are flawed. Technological opportunities for Soviet interference are improving, the probability of being found out is diminishing, the penalties may seem smaller as the advantages of a successful breakout become more attractive, and the range of potential U.S. responses to interference with national technical means is narrowing through the winnowing away of system options.

Finally, and perhaps most important, reconnaissance satellites cannot detect and interpreters cannot currently identify most of the ingredients of a carefully concealed production buildup in preparation for subsequent deployment of new strategic weapons. Should the Soviets elect a breakout strategy, neither U.S. national technical means nor

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Soviet concealment, deception, or interference technology is likely to constitute a formidable barrier to success. The penultimate stages of a Soviet breakout would probably be detected by American reconnaissance satellites--if they were unhampered in their operations and if the deployment involved weaponry identifiable as a strategic threat. But the current and potential prospects of U.S. national technical means are not such as to provide great assurance that those conditions can be satisfied through the foreseeable future.

Whether the Soviet Union might choose to act on opportunities and vulnerabilities of the sort noted above depends on more than perceptions of technology, of course. The excuse or justification presumably would arise elsewhere, in the complex political, economic, and diplomatic developments of a troubled international age. But if for some reason the Soviet Union should choose to explore the opportunities for upsetting the strategic balance without necessarily alerting the United States either to the decision or to subsequent enabling activities, a Soviet perception of vulnerable U.S. verification processes and technologies could only serve to encourage a breakout decision. Offsetting any Soviet perception of such U.S. vulnerability may be as important as the reality of assured U.S. means of detecting a Soviet breakout attempt in its embryonic stages.

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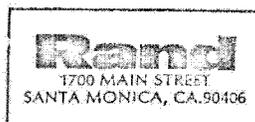
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PROSPECTS FOR SALT VERIFICATION AND BREAKOUT WARNING:  
KEY FINDINGS (U)

Report R-2093/1-ACDA

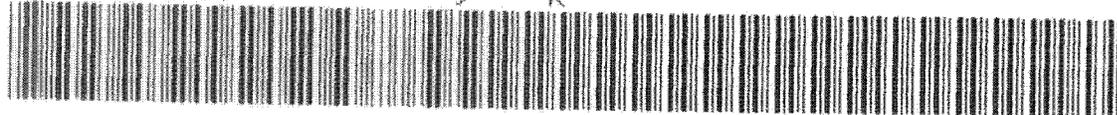
William R. Harris

30 November 1977



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Prepared for the U.S. Arms Control and Disarmament Agency  
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PREFACE

This Report presents the *key findings* of a more highly classified report entitled, *Prospects for SALT Verification and Breakout Warning (U)*. This Report was prepared for the U.S. Arms Control and Disarmament Agency pursuant to ACDA Contract AC6AC406 with The Rand Corporation.

This Report is one of three undertaken in connection with ACDA Contract AC6AC406. Readers may be interested in the other project reports:

Abraham S. Becker, *Breakout as a Soviet Policy Option (U)*, Unclassified, Report R-2097-ACDA, The Rand Corporation, Santa Monica, California, 1977.

Robert Perry, *Breakout Warning: A Problem of Verification (U)*, Report R-2094-ACDA, The Rand Corporation, Santa Monica, California, 1977. TOP SECRET/SPECIAL COMPARTMENTED INFORMATION.

The U.S. Arms Control and Disarmament Agency established study objectives by classified letter of September 17, 1975. Study objectives included evaluation of Soviet considerations of a breakout policy, treated in Report R-2097-ACDA, and evaluation of "U.S. capability to detect steps toward breakout," plus recommendation of "possible ways of improving U.S. capabilities to recognize and measure accurately pre-breakout activity."

Acknowledgments, a disclaimer that reflects diverging views, evidence, analysis, and references are contained in the full report. The *key findings* presented below are identical to those presented in the full Report.

KEY FINDINGS

## PROSPECTS FOR SALT VERIFICATION AND BREAKOUT WARNING (U)

## I. A FRAMEWORK FOR EVALUATION OF SALT VERIFICATION AND BREAKOUT WARNING

- Soviet breakout preparations constitute a warning problem distinct from verification of treaty compliance or non-compliance.
- Hidden or reserved deception resources (those not found or not deployed) permit estimation of only a lower bound of resources of surprise.
- Understanding only a lower threshold of Soviet deception capabilities should encourage sensitivity testing of breakout warning to variations in: (1) the permissibility of concealment measures under SALT agreements; (2) compromises of the national technical means (NTMs) of verification; and (3) U.S. adaptive measures to cope with warning degradation.

## II. THE LAW OF VERIFICATION AND PERMISSIBLE INTERFERENCE UNDER SALT AGREEMENTS

- Because the commitment "not to use deliberate concealment measures" relates to ABM Treaty and SALT constraints, expanding the scope of agreements expands the scope of impermissible concealment and impermissible interference with NTMs.
- Extension of the SALT I Agreement by oral declaration in October 1977, rather than repromulgation with a 1977 start date, preserves for SALT II and SALT III opportunities to restrict innovations in Soviet concealment practices of the 1972-1977 period. These include flight test telemetry encryption, solid cover for new construction and floating submarine drydock facilities, and modular design of regulated (ICBM) and unregulated (IRBM) systems. Systematic exploitation of the night reconnaissance gap, and use of solid cover for strategic missiles predate the 1972 SALT agreement, and are unaffected by extension rather than repromulgation with a 1977 start date.

- A designated *verification satellite* system would undermine juridical protection of other NTMs and legitimate concealment measures designed to cope with them.
- A combination of mandated self-disclosures and restrictions on night transportation or deployment of inter-continental missiles would both enhance breakout warning and clarify juridical protection of space-based NTMs with night sensing capabilities-- electronic, communications, electro-optical, and synthetic aperture radar satellites.
- The value of mandated self-disclosures depends in part upon a capacity to validate samples or key indicators, and this capacity may be eroded by compromise of NTMs, treated in Section 3.

### III. ASSESSING COMPROMISES OF NATIONAL TECHNICAL MEANS OF VERIFICATION

- Deception in support of covert preparations for breakout is possible without specific understanding of the U.S. NTMs. Approximate Soviet understanding of the bounds of U.S. knowledge and ignorance (compromise of the *scope* of collection) facilitates planning of contingent Soviet preparations for breakout, allocation of effort between concealment and deception, and possibly testing of breakout capabilities.
- If the Soviets understand the principal missions of every U.S. space reconnaissance system (all-system mission compromise), then the Soviets are likely to have identified night and other U.S. collection gaps, and targets for deception that would include space-based communications intelligence systems. Lacking persuasive evidence to the contrary, it is prudent to assume all-system compromise of principal NTM missions. Fragmentary evidence is consistent with the hypothesis that all principal U.S. NTM missions are generally understood by the Soviets, as of late 1977.
- In parallel with U.S. development of a system for space-based photoreconnaissance, in the late 1950s the Soviets identified night gaps in U.S. reconnaissance as opportunities for concealment of long-term construction and missile location.
- Inferences from Soviet exclusion of particular U.S. reconnaissance satellites from a *PVO Strany (OMEGA)* warning bulletin are weak, because of likely Soviet expectation of U.S. access to these *OMEGA*

bulletins and because of indicators that OMEGA-excluded U.S. satellite systems have provided opportunity for Soviet interrogation or other collection, or opportunities for the transmission of deceptive intelligence.

- Based upon Soviet press coverage of U.S. satellite reconnaissance (embargoed since 1972), intercepted Soviet warnings, and indicators of Soviet open source, human source, and other access, it appears more likely than not that every U.S. space reconnaissance system mission is, at the outset of SALT II, generally understood by the Soviets.
- Substantial Soviet knowledge of U.S. electronic intelligence collection and the association of a radar sensing "bit package" with the KH-9 system would facilitate Soviet evasion, without detection, of the ABM Treaty of 1972.
- Because Soviet ballistic missile tests have been conducted with at least substantial knowledge of U.S. electronic intelligence practices, and because of at least ambiguous evidence of telemetry deception affecting ICBM and aircraft tests, periodic reevaluation of the dependence of technical intelligence estimates upon collection by compromised or unexpected means of collection is appropriate.
- A new generation of Soviet intercontinental and submarine launched missiles will be designed for testing in the late 1970s and early 1980s. Compromise of NTM mission concepts, and with regard to at least one space-based Elint system, compromise of system engineering, is likely to affect Soviet design of test instrumentation. Notwithstanding plans to increase the collection sensitivity of proposed follow-ons to compromised systems, it is prudent to assume further loss of U.S. intelligence, without Soviet loss of requisite test information, unless encryption restrictions are included in future SALT agreements.
- Space-based communications intelligence is the primary source of U.S. estimates of Soviet production, production cutoff, and deployment data for SS-16 and SS-20 ballistic missiles. Circumstantial evidence indicates but does not prove that the principal source of these data was conceptually compromised between the Spring and Fall of 1975. Periodic reevaluation of the dependence upon this

collection system and the reliability of estimates respecting regulated (SS-16) and unregulated (SS-20) deployments are appropriate during a future SALT agreement.

--- Notwithstanding diverse indicators of U.S. space reconnaissance missions in the open literature and other sources available to the Soviets, the Soviets appear to have recurringly misconnected spacecraft launches and missions, even without intentional U.S. deception. Beyond identifiable errors in the OMEGA system (possibly for U.S. consumption), Soviet failures of observation and emissions security support the conclusion that the Soviets are vulnerable to mismatching of U.S. system launches and spacecraft functions, and Soviet countermeasures. Samples of U.S. intelligence from misconstrued missions are critical for checking the reliability of data or deception themes transmitted across systems that are presumed to be compromised. A capacity to exploit indicators of Soviet concealment and deception (that would be associated with covert preparations for breakout) is a key element of breakout warning and possible deterrent of a Soviet commitment to covert breakout.

--- Opportunities exist to facilitate, though systematic deception planning, Soviet misunderstandings of existing U.S. NTMs, incremental capabilities planned for these NTMs, and future U.S. NTMs. With improved communications and launch security, a mutuality of "cover" for defense and intelligence spacecraft, common launchings aboard a "space shuttle," and systematic deception planning, unexpected forms and times of collection are possible. It should be feasible to protect from Soviet understanding specifically compartmented missions or capabilities, tasking relationships between most space systems, the composition of the U.S. space force, system status, aspects of space force operations and employment, and the synergism of coordinated collection and analysis.

#### IV. DEGRADATION OF BREAKOUT WARNING CAPABILITIES

--- Soviet planners requiring security for long-term construction or deployment activities would be likely to utilize identified gaps in U.S. reconnaissance that were both administratively convenient and dependable. Night-only operations appear to be less risky than dependence upon expected gaps and reliable warning of U.S. daytime reconnaissance, continuation of poor weather, or untimeliness of backup U.S. launches in event of equipment failure.

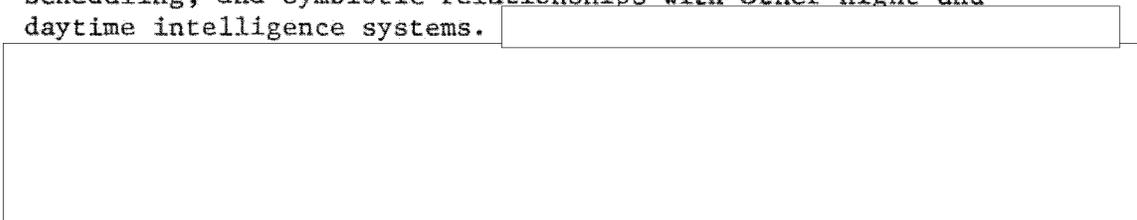
- Soviet night-only operations have employed light concealment, lights-out construction, and possibly passive starlight-illuminating devices, despite risks of industrial accidents. These activities were "current practices" at the time of the SALT I agreement, and their permissibility under SALT II or SALT III should be presumed unless specific prohibitions are included in future agreements.
- During the next five years (1978-1982) U.S. capabilities to identify night-only construction or deployment activities within the Soviet Union will be modest, and will depend in part upon failures of personnel security, illumination concealment, communications security, or predawn camouflage.
- Active Soviet interference with U.S. NTMs need not be a prerequisite of covert preparations for breakout. Soviet knowledge of U.S. night reconnaissance gaps, daytime collection routines, and deep space collection systems vulnerable to deception provide opportunities for Soviet breakout planners. Selective interference that does not provide unambiguous warning remains among Soviet options, but depends upon knowledge of U.S. spacecraft vulnerabilities and attack warning sensors that the Soviets do not necessarily possess.
- The most attractive breakout pathways are likely to be those involving regulatory ambiguities. In event of premature detection, juridical or technical ambiguities protect politicians: ambiguities justify actions, mute warnings, delay responses, or facilitate midstream cancellation of breakout plans. Candidate pathways include: modular construction of permitted and prohibited strategic systems; geographic relocation or refueling of range-limited systems; and development of new technologies serving both permitted and prohibited functions.

#### V. ADAPTIVE MEASURES

1. The Arms Control and Disarmament Agency staff should evaluate impacts of enlarged SALT agreements upon concealment and interference with NTMs, and associated expansion of breakout warning indicators.

2. The Arms Control and Disarmament Agency staff should evaluate the verification costs and benefits of restriction on night construction, deployment, or overhaul of strategic systems in future SALT agreements. This evaluation should include an assessment of U.S. capabilities to verify compliance by the U.S.S.R.
3. The Arms Control and Disarmament Agency staff should evaluate alternative SALT provisions for mandatory self-disclosure of production, deployment, and movement of strategic offensive and defensive systems. This evaluation should include an assessment of U.S. capabilities to validate Soviet ICBM production and deployment data, with explicit treatment of the possible compromise of space-based communications intelligence systems.
4. The Arms Control and Disarmament Agency staff should implement evaluations pursuant to the Derwinski Amendment of 1977 by projecting alternative evasion pathways rather than subjective probabilities of unidentified evasion.
5. The Arms Control and Disarmament Agency staff should treat explicitly questions of NTM system compromise pursuant to the Derwinski Amendment, regarding "any significant degradation or alteration in the capacity of the United States to verify the various components" of arms control agreements or treaties.
6. The Director of ACDA should request that the Director of Central Intelligence sponsor a study of verification intelligence and breakout warning requirements, and the intelligence capabilities now and foreseeably available to meet those requirements. This study should treat explicitly variations in assumptions about the compromise of existing and planned NTMs, variations in selection of new NTMs, Soviet capabilities to degrade or evade NTM systems, the reliability of NTM sensor warning of active interference, and the adequacy of backup ground facilities, launchers, and spacecraft to assure that gaps in coverage will not permit covert breakout.

- 7. The Director of ACDA should request that the Director of Central Intelligence establish within the intelligence community an Office of Quality Assurance that, among other functions, advises the Director of ACDA regarding "any significant degradation or alternation in the capacity of the United States to verify" arms control agreement of treaties. Pursuant to the Derwinski Amendment to Public Law 95-108, this Office should advise the ACDA Director of any significant alteration in the status of any NTM system of the United States, including any significant evidence of compromise, misunderstanding, or interference with NTM systems.
- 8. The Director of ACDA should request that the Director of Central Intelligence initiate an evaluation of the likelihood and significance of compromises of U.S. NTMs other than space systems that are the subject of this and other reports.
- 9. The Director of ACDA should request that the Director of Central Intelligence furnish the Director of ACDA a copy of any intelligence community evaluations of the knowledgeability of the Soviets about U.S. space reconnaissance systems, or other intelligence systems that contribute to SALT verification or breakout warning.
- 10. The Director of ACDA should recommend that the Director of Central Intelligence establish within the National Foreign Assessment Center an Office of Counter-Deception Analysis. Among other functions, this Office should identify and evaluate indicators of Soviet preparations for breakout, and develop methodologies to cope with strategic deception. Through this Office or otherwise, the Director of Central Intelligence should advise the Director of ACDA of alternative SALT evasion pathways that might be feasible for the Soviet Union, and information on the estimated cost in money, time, and risk of detection associated with alternative evasion pathways.
- 11. The Director of ACDA should support the Director of Central Intelligence in efforts to close significant night reconnaissance gaps. The Director of ACDA or his representative should participate in a study of alternative night collection systems, their scheduling, and symbiotic relationships with other night and daytime intelligence systems.



12. The Director of ACDA should support the Director of Central Intelligence in efforts to protect night reconnaissance "source and methods" from compromise and degradation. Under the National Security Act of 1947, as amended, the DCI has statutory authority to establish security compartments necessary to protect sensitive intelligence sources and methods. A night collection compartment and a night intelligence product compartment would enhance prospects for Soviet misunderstanding of the exact and limited night intelligence capabilities of the United States. The fact of the establishment of these compartments need not be classified, and could contribute to Soviet realization that night-only operations are of priority intelligence concern to the United States. In association with these compartments, the DCI may exercise existing statutory authority to establish a coherent strategic deception program designed to protect U.S. NTMs from unauthorized disclosure.
13. The Director of ACDA should take the lead in distinguishing between the functions of *SALT verification* (monitoring treaty compliance) and *breakout warning* (monitoring strategic stability). Without this distinction, concerns about risks of Soviet breakout are translated into unattainable demands for perfect SALT verification. These unrealistic expectations invite the narrowing of strategic agreements, thus also the narrowing of juridical protection from deliberate concealment measures under SALT. Without agreed limits, the warning value of newly-identified strategic initiatives is reduced. The Derwinski Amendment will work best if its mandate is applied realistically to *verification*, while at the same time emphasizing the primacy of *breakout warning* in the management of intelligence support for SALT.