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MODEL FREEZE

## VERIFICATION OF A FREEZE: SOME GENERAL OBSERVATIONS

**In support of the proposition that a comprehensive freeze on much of the testing, production, and deployment of nuclear weapons and their associated delivery systems is verifiable, one can make the following general assertion:**

> ***The marginal utility of additional weapons is small in comparison to the survivable destructive potential already amassed by both sides.***

**Since each side can be devastated by the explosive equivalent of 400 one-megaton bombs, and since each side has long ago assured the delivery of at least this capability even after surprise attack, any clandestine additions to either side's destructive potential are going to have sharply limited significance.**

**This does not suggest that compliance with treaty provisions does not matter. Rather it suggests that compliance or non-compliance with treaty provisions is unlikely to affect nuclear deterrence itself. In other words, verification of a freeze agreement is not, as it is so often portrayed, a matter of the "survival of the nation." The risks involved in possible Soviet cheating under a freeze regime are, in the first instance, political risks, involving each side's perceptions of who is moving ahead, or falling behind, in the arms race.**

**Indeed, the major risk involved in Soviet cheating on a freeze is that its discovery would lead: to a quantum leap in mistrust on the American side; to vigorous renewal of the arms race; and to a dangerously confrontational international atmosphere. In effect, both sides would end up right where they are today, only worse.**

**Since the Soviets are known to favor some sort of freeze over continuation of the arms race, it should be pointed out that this fact—that the most likely U.S. response to Soviet cheating would be reversion with a vengeance to the arms race—represents a most powerful incentive for Soviet compliance. It applies,**

*(Continued on page 2)*

## VERIFYING A MODEL FREEZE

This issue is an effort to bring the concept of a strategic weapons freeze into sharper focus. It contains three elements.

First, there is an editorial (above) describing some fundamental premises underlying verification—without agreement on these or other such premises, no consensus on "verifiability" is possible.

Second, some background information is provided on the many, and astonishingly effective, means of verification which are at our Nation's disposal. Last, but obviously not least, is a sketch of one way in which a freeze might be defined.

We hasten to add that this yeoman effort by two of our staff (Christopher Paine and Thomas Karas) has many loose ends, some of which we hope to treat in later issues. There is the question of controls on defensive weapons. There is the linkage between the freeze and subsequent reductions; no freeze is going to be stable indefinitely and, by the same token, no freeze is going to be politically or strategically defensible if viewed in steady state. There is the question of how the freeze might be implemented. There are obviously a host of definitional questions. And so on.

Indeed, this freeze is only a sketch of one of a variety of treaty possibilities in each of which enough is frozen to justify the word "freeze." In its design, there are necessarily branch points, not all of which are fully exposed and for none of which was there space to justify the choices. Thus for long-lived weapons such as nuclear submarines and nuclear bombers, need replacement provisions be included in the freeze? And can the same be said of missiles? What is the real meaning of this model freeze's decision to close down final assembly plants for missiles but not to prevent missile components from being manufactured and installed?

Accordingly, it might be well to state briefly here what distinguishes the freeze approach from other approaches. Obviously, in neither case can one halt more than the two sides can agree on, and verify. But in the one case the presumption is that the negotiation is aimed at isolated weapons systems most vulnerable to agreement, and that no effort will be made to put together a really comprehensive package.

In the freeze approach, on the other hand, the presumption is that an effort will be made to end, or dramatically slow, the arms race rather than simply to manage it. In this context, the presumption is that serious negotiating efforts will be made to stop the central manifestations of the arms race. Weapons systems testing, production or deployment would be permitted to continue only if the negotiators saw no way to stop it, or if it would hopelessly complicate or burden the agreements they could otherwise reach.

In sum, what is contained within is designed simply to stimulate more concrete thought on a subject which now commands the support of solid majorities from the most diverse walks of American life. It behooves all interested in arms control to begin to think through the details of what can, and what cannot, be done with this public support. Readers are encouraged to write. ☐

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**in particular, even to those treaty provisions the Soviets might know could be verified only with low-to-moderate confidence. In point of fact, however, Soviet military planners do not know the full range and extent of U.S. monitoring capabilities. What they do know is that the probability of detection is never zero, and that it approaches 100% for major projects of significant duration.**

### Low probability but high risk

**Thus, according to former Secretary of Defense Harold Brown, "A somewhat less than even chance of U.S. detection would probably appear as a prohibitively high risk to a Soviet planner contemplating cheating, particularly when he considered the likely U.S. reaction to such a discovery." And yet, Brown noted, "anything less than a 50% chance of detection. . .we consider as providing 'low confidence' in our monitoring capability."**

**This disjunction—between what we consider adequate for verification and what is required to reliably deter Soviet planners—is noteworthy. The Soviets must necessarily consider that the U.S. monitoring capability—which is actually an aggregate of many individual capabilities—has a composite probability of detection that is highly variable. To this must be added the compounding factor that over time, the secret project could be exposed by an accident, a defector, a dissident participant, an intelligence source, inadvertence, and so on.**

**Moreover, let us not forget that the Soviets would enter into a treaty precisely because they wanted the *U.S.* bound by its terms! Cheating involves the danger that the treaty will come apart when the cheating is discovered. Why should they run this risk for no particular military utility?**

### The Ghost of "Type III"

**But *cheating* under a treaty, if discovered, does more than end the treaty! It risks ending it with a bang—a much bigger bang than would, for example, Soviet public withdrawal. Years ago, Herman Kahn coined the term "type III deterrence", by which he meant the deterrence afforded by fear of making the other side angry. This applies to deliberate treaty violations, in particular. If the Soviet Union is found to be cheating under an arms race agreement, the U.S. can be expected to renew the arms race with special force, and to reject future agreements with the Soviet Union for a long time.**

**Under these circumstances, so long as the most significant aspects of the agreement can be verified by the U.S. with high confidence, then low-to-moderate short-term monitoring confidence—and a related greater than 50% long-term monitoring confidence—for the remaining provisions should suffice in order to deter Soviet violation of the entire agreement.**



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## National Technical Means*

### Imaging Reconnaissance Satellites

**"KH-11"**

The KH-11 satellite won fame in 1978 when CIA employee William Kampiles went to jail for selling its interpretation manual to Soviet agents. The big spacecraft, which probably weighs about 10,300 kilograms, usually flies at altitudes of about 300 to 600 kilometers. That means that its imaging system probably returns fairly wide-area pictures of the ground. But if it also carries longer focal-length telescopes, it could zoom in on more interesting targets for greater detail. The "ground resolution"—meaning the smallest size of objects distinguishable—of KH-11 images is probably between 2 and 5 meters, depending on what assumptions we make about its telescopes and sensors.

The military virtue of the KH-11 is that it operates nearly in "real time." It doesn't use cameras with photographic film, but instead forms images on an electronic focal plane. A scanning mirror sweeps across the satellite's field of view, and the light from the mirror registers on the focal plane as a series of electrical impulses which become digital "bits" of data, either recorded for later playback or directly transmitted to the earth stations of the U.S. Air Force Satellite Control Facility. It is possible, but not certain, that KH-11 data is beamed upward to the satellites of the Air Force Satellite Data System, from which it is relayed to ground stations. In any case, the Satellite Control Facility Remote Tracking Station in Greenland can pick up KH-11 signals minutes after the satellite has passed over the Soviet Union. Again via the Satellite Data System satellites, the Remote Tracking Station can pass the data immediately to the Air Force satellite headquarters in Sunnyvale, California for further processing. Because this is a CIA-owned satellite, at some point the images go to CIA headquarters for analysis.

Most likely the sensors on the KH-11 are multi-spectral—they form images in several bands of visible and infra-red light. These images can carry information that is just as valuable as the details of size and shape produced by the finer resolution of "close-look" photographs, as we shall see below. The KH-11 satellites keep recording images and transmitting data until their maneuvering fuel runs out—which takes upwards of two years. The U.S. seems to keep two of these spacecraft operating at any one time.

**"Big Bird"**

The "Big Bird" satellite,primarily an Air Force vehicle, stays up about six months, weighs about 11,000 kilograms, and flies somewhat lower than the KH-11—between about 160 and 280 kilometers. Maneuvering at lower altitudes, where some air resistance against the vehicle accumulates, probably uses up a good deal of thruster fuel. But the main limit on the satellite's lifetime is its use of old-fashioned photographic film to record images. The satellite surveys larger areas with a camera developed by Kodak that develops the film on board and then transmits a television-scanned image of the developed picture. The satellite also carries a few (some say 4, others 6) film pods that it can send back to earth for development. These are no doubt used to have the satellite take a more detailed look at specially chosen targets.

**"Close-look"**

A third type of imaging satellite can take quite close-up pictures, resolving objects on the ground which are perhaps six inches across. This "close-look" satellite can swoop in to altitudes as low as 80 or 90 miles, photographing the ground with color film. The film is released on command for re-entry and then caught in mid-air by special airplanes based in Hawaii. The close-look satellites run out of fuel and film more quickly than the other types, and they usually stay in orbit for 60 days or so.

Since the "Big Bird" became available, the Air Force has flown the close-look satellites much less than before and apparently is almost out of them. The most recent went into orbit at the end of February, 1980. According to the trade press, both the "Big Bird" and the close-look satellites will be replaced in 1984 with a large satellite that will have a long lifetime and take very detailed pictures as well.

### ELECTRONIC RECONNAISSANCE

**"Ferret"**

From time to time, when the Air Force launches a Big Bird, it attaches a much smaller satellite which jumps up to a higher orbit, over 400 miles up. This smaller satellite probably collects information about Soviet radar, indicating what frequencies and types of signals the Soviets are using to watch out for incoming planes and missiles. Since the U.S. has flown very few of these in recent years, one might speculate that the Big Bird or the KH-11 can collect some of the same types of information.

**"Rhyolite-Chalet"**

The United States has also sent up a series of geosynchronous satellites—they revolve around the equator once every 24 hours, thus hovering over one spot—for intelligence purposes. In a spy trial a few years ago, this type of satellite was identified as "Rhyolite," although the name has probably changed by now (the new name may be "Chalet"). The Rhyolite type of satellite collects the telemetry—the information on rocket performance—sent back by Soviet missiles when they are tested. It may pick up other kinds of military communications inside the Soviet Union as well.

A likely candidate for the most recent satellite in the Rhyolite series is one launched in March, 1981. It probably has more sensitive listening devices than the earlier versions. Senator John Glenn, who in 1979 expressed doubts about the verifiability of the SALT II agreements, now says he thinks new developments do make them verifiable. In 1979, Secretary of Defense Brown said that in a year or so we could replace the eavesdropping capabilities we lost in Iran. Apparently we have. (We also have ground-based listening posts in China.)

### OCEAN RECONNAISSANCE

The Navy has another kind of electronic intelligence

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satellite for monitoring the oceans. These satellites fly in a series of four—a "mother ship" and three sub-satellites nearby. By detecting the radar and communications signals of ships from more than one receiving point, the Navy can locate the ships. If necessary, the imaging reconnaissance satellites or aircraft could be assigned to take pictures.

### "UNKNOWN"

In January, 1982, the U.S. launched yet another type of intelligence satellite, one from which apparently three sub-satellites split off. This set of satellites flies at about 360 miles up, not 600 like the ocean reconnaissance type. And while the plane of the ocean reconnaissance satellite orbit is inclined about 62.5 degrees to the equator, the inclination of this new type is 97 degrees. That brings the satellites closer to the poles and allows them to cover more of the earth's surface. They would have a better view of the Soviet naval ports north of the Arctic circle than do present U.S. ocean reconnaissance satellites.

### MISSILE WARNING

**Defense Support Program (DSP)**

With 3 satellites in geosynchronous orbit (1 over the Eastern Hemisphere and 2 over the Western Hemisphere) the DSP system provides early warning of ICBM and SLBM launches by infrared detection of rocket plumes. The satellites also carry visible light detectors and radiation sensors for detecting nuclear explosions and provide surveillance of missile test launches.

### NUCLEAR EXPLOSION DETECTION

**"Vela Hotel"**

Launched in the 1960's into orbits 60,000 miles up, these satellites carried "bangmeters," or nuclear explosion detectors for monitoring the atmosphere and space for violations of the partial test ban treaty. The last working pair of these satellites still provide some data.

**Defense Support Program**

The U.S. missile early warning satellites also have some ability to detect the electromagnetic radiation from nuclear explosions.

**Global Positioning System (GPS)**

The new military navigation system satellites also carry a system called "IONDS"—the Integrated Operational Nuclear Detection System. Combinations of signals from the ultra-violet and x-ray sensors which will eventually be carried by all 18 of the GPS satellites will give the precise locations, using time of flight measurements, of any nuclear explosions in the atmosphere or in space out to 11,000 miles.

**Seismic Sensors**

Seismic stations around the globe detect underground nuclear explosions. In connection with the incomplete draft treaty for a Comprehensive Nuclear Test Ban Treaty, the Soviet Union has agreed to the placement of additional unmanned stations on Soviet soil.

### UNDERWATER ACOUSTIC SURVEILLANCE SYSTEM

The U.S. Navy has the world's oceans virtually "wired for sound," using both seabed and mobile acoustic sensors. These are useful not only for keeping tabs on nuclear-capable Soviet ships but also for detecting any nuclear tests in the oceans.

### GROUND-BASED MONITORING POSTS

The U.S. Intelligence Community maintains a network of electronic "listening posts" and test observation radars near most of the major Soviet missile-testing areas. For example, posts in Turkey monitor the IRBM and developmental SLBM testing range at Kapustin Yar, while two listening posts in Sinkiang, China's western-most province bordering on Soviet Central Asia, monitor the main ICBM test complex at Tyuratam. Listening posts in Norway monitor operational tests of SLBMs fired from submarines in the White Sea. Additional facilities are believed to exist at other locations.

### OTHER SPECIAL RADARS

Soviet test warheads descending to their impact areas on the Kamchatka Peninsula or in the Western Pacific are tracked during the high-altitude portion of their flights by the giant "Cobra Dane" phased-array radar at Shemya Air Force Station, Alaska, and during their near-earth trajectories by the shipborne "Cobra Judy" phased-array radar.

### PLANES AND SHIPS

**SR-71, U-2, and TR-1 Aircraft**

These high-altitude reconnaissance platforms, based in the United States, Europe, and Japan, fly along coastlines and border areas of the Soviet Union and Warsaw Pact nations, peering into the foreign territory with side-looking radars, cameras, and electronic intelligence receivers.

**Electronic Intelligence Submarines and Ships**

So-called "Holystone" submarines—Los Angeles-class nuclear attack submarines specially configured for signal and communications intelligence missions, eavesdrop along the coastlines of the USSR. Intelligence-gathering surface ships overtly perform a similar mission.

### HUMINT

Intelligence analysts also garner information from agents, defectors, emigrés, defense attachés, businessmen, tourists, and from the painstaking collation and sifting of published literature.

### ON-SITE INSPECTION

Under the Protocol to the 1974 Treaty on Underground Nuclear Explosions for Peaceful Purposes, the Soviet Union and the United States agreed to detailed "on-site" inspection procedures whose general principles were carried over into the negotiations for a comprehensive ban on all nuclear tests. While not immediately available to the intelligence community to assist in verifying agreements, such inspection arrangements are clearly not as far out-of-reach as they once were.

In verifying the delivery vehicle and nuclear warhead production bans which could be a part of a far-reaching comprehensive nuclear freeze agreement, on-site verification would be selectively employed to further investigate—with the intent of definitively identifying—ambiguous activities which are detected by national means but whose explanation remains unclear. □

## VERIFICATION OF A MODEL FREEZE: MONITORING TASKS

A comprehensive freeze on the testing, production, and deployment of nuclear weapons and their primary delivery vehicles could be broken into seven key provisions which are distinct for the purposes of negotiation and analysis but interlocking and mutually reinforcing from the perspective of verification:

(1) a freeze of "indefinite duration" (like the ABM Treaty), without modernization,* on the deployment of ICBMs, SLBMs, IRBMs, and (if necessary) GLCMs;

(2) a numerical freeze—permitting modernization and one-for one replacement of delivery vehicles, but with no increase or modernization of weapons load—on strategic bombers, other "dual-capable" aircraft assigned a nuclear role, nuclear-armed ships and subs, and nuclear artillery and battlefield missiles;

(3) a prohibition on the flight testing of "new" or significantly modified ballistic missiles, and a low limit on the number of operational ballistic missile flight tests;

(4) a Comprehensive Test Ban (CTB) on nuclear explosions;

(5) a shut-down of existing main assembly facilities for intercontinental, submarine-launched, and intermediate-range ballistic missiles, and a prohibition on the transfer of this activity to other sites;*

(6) a shut-down of existing key nuclear component fabrication and final assembly facilities for nuclear weapons, and a prohibition on the transfer of this activity to other sites; and

(7) the international inspection and installation of safeguards at all nuclear facilities to permit a verifiable cutoff of weapons-grade nuclear materials production and the conversion or disposal of existing stockpiles.

**I. The Deployment Freeze.** Few would dispute that a freeze on the number of deployed strategic nuclear delivery vehicles can be adequately verified. Soviet missiles are unambiguously identified with either fixed ICBM launchers, in the case of large liquid-fueled ICBMs, or easily counted submarines, in the case of submarine-launched ballistic missiles. As Secretary Brown testified during July 1979 Senate hearings on ratification of the SALT II Treaty, "We have high-confidence in our ability to monitor the number of fixed ICBM launchers, SLBM launchers, and heavy bombers ("high-confidence" means a counting error of 10% or less—see chart). Brown noted that ICBM silos are "readily identifiable during construction, and take a year or more to build."

The missiles themselves, he reported, "require extensive support facilities, including missile handling equipment, checkout and maintenance facilities, survivable communications, and nuclear warhead handling, storage, and security facilities. Our intelligence collectors regularly examine the existing ICBM fields, but in addition they also conduct extensive surveys of the Soviet Union at periodic intervals for evidence of additional ICBM activity. The intelligence community judgment is that we would detect a Soviet effort to deploy a significant number of excess fixed ICBM launchers even if they departed substantially from

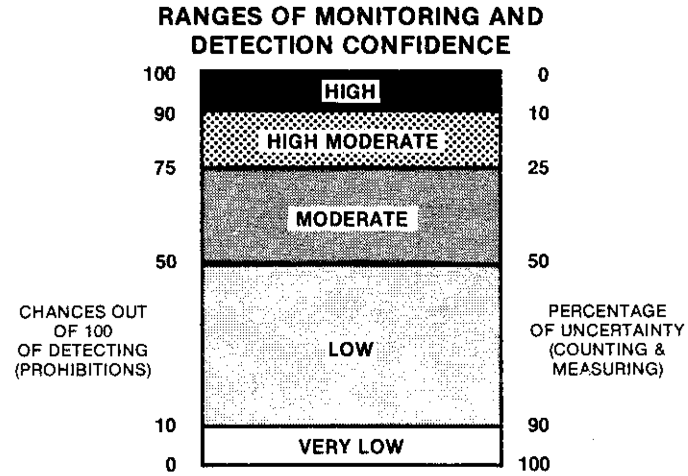


*Chart provided by Secretary of Defense Harold Brown to indicate the ranges of monitoring and detection confidence afforded by U.S. "National Technical Means" of verification.*

their current deployment practices." In other words, even if the Soviets were to deploy their missiles in salt mines or grain elevators, U.S. ability to monitor ICBM-associated support, transport, communications, and security measures guarantees a high probability of detection.

"Turning to SLBMs," Brown testified, "we monitor the launch, fitting out, and sea trials of each submarine. We also monitor Soviet ballistic missile submarines at operational bases, at sea, and at overhaul facilities. In addition, we search for evidence of SSBN-related activity at other facilities, and we monitor naval activities generally with a wide range of intelligence collection systems. We are confident we can monitor closely the number of SLBM launchers."

As for strategic bombers, Brown said, they are "large in size, built at a small number of plants, and deployed at a limited number of operational bases which are closely monitored. The total inventory of heavy bomber-type aircraft can be monitored with confidence."

Potential prohibitions on major modernizations (e.g., adding a new stage, more reentry vehicles, etc.) and system replacement for new production are primarily verifiable through monitoring other aspects of the Soviet weapons program, for the simple reason that before a new missile or reentry vehicle can be installed in a silo, it must first be developed, tested, and produced. Under one scheme, the only replacement permitted would be for missiles fired in operational tests, and since no new production would be allowed under a freeze, this would foster a tendency to conserve missiles, leading to few tests and therefore few "opportunities" for replacement. However, since transporting a Soviet missile from its storage area and loading it into a silo requires, according to official testimony, "a minimum of two or three days," there is a significant chance that missile replacement in violation of the freeze would be detected by imaging reconnaissance satellites.

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*See box entitled "Should Limited Production and Replacement be Permitted?"

# VERIFICATION OF A NUCLEAR FREEZE: TASKS AND SYSTEMS

| MONITORING TASKS: / INTELLIGENCE SYSTEMS: | Imaging Reconnaissance Satellites | Electronic Reconnaissance Satellites | Ocean Surveillance Satellites | Missile Warning Satellite | Nuclear Explosion Detection: Satellites "Vela Hotel" IONDS | Nuclear Explosion Detection: Ground-based Seismic Sensors | Acoustic Underwater Surveillance | Ground Based Monitoring Posts | Test Observation Radars | Aircraft and Ships | HUMINT and Overt Collection | On Site Inspection | Overall Monitoring Confidence Level (estimate) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **I. Deployment Freeze** | | | | | | | | | | | | | |
| A. Count fixed ICBM/IRBM launchers* | X | X | | | | | | | | | | | high |
| B. Count mobile ICBM/IRBM/GLCM launchers* | X | X | | | | | | | | | | | high moderate |
| C. Count SLBM launchers* | X | X | X | | | | | | | | | | high |
| D. Count launchers for MIRVed missiles* | X | | | | | | | | | | Counting Rule | | high |
| E. Count strategic bombers (incl. ALCM)* | X | X | | | | | | | | | | | high |
| F. Count other primary nuclear mission aircraft (e.g., FB-111, Backfire...) | X | X | | | | | | X | | X | X | | high moderate |
| G. Count nuclear-armed ships/subs (incl. those with SLCMs, ASROCs, SUBROCs,...) | X | ? | X | | | | X | | | X | X | | high moderate |
| H. Count nuclear artillery/battlefield missile units, weapon depots | X | ? | | | | | | ? | | X | X | | high moderate |
| **II. Delivery Vehicle Testing Freeze** | | | | | | | | | | | | | |
| A. To monitor (prohibited) testing of new ICBMs/SLBMs/IRBMs, monitor flight tests of existing missiles to detect: | | | | | | | | | | | | | |
| 1. Changes in length, diameter, launch-weight and throw-weight (no greater than 5%) | X | X | | | | | | X | X | X | X | | moderate-high moderate |
| 2. Number of stages/type of propellant (no change permitted) | X | X | | | | | | X | X | X | X | | high moderate |
| 3. Number of RVs (no increase from maximum number tested for each type) | ? | X | | | | | | X | X | X | X | | high |
| 4. Weight of RVs (no decrease from lightest test flown) | | X | | | | | | X | X | X | X | | high moderate |
| 5. RV performance (no increase in ballistic coefficient above maximum already tested and no maneuvering) | ? | ? | | | | | | | X | X | X | | high |
| B. Monitor limit on operational ballistic missile flight tests (6 or less per year) | X | X | X | X | | | X[i] | X | X | X | X | | high |
| **III. Nuclear Weapons Testing Freeze (CTB)** | | | | | | | | | | | | | |
| A. Detect ambiguous seismic events | | | | | | X | X | | | | | | high moderate |
| B. Monitor activity/geography at potential test sites | X | ? | ? | | | | | ? | | ? | | | high moderate |
| C. Detect evidence of nuclear explosions on land/in sea/air/space | | | | X | X | X | X | | | X | | | high moderate |
| D. Identify ambiguous events | | | | | | | | | | | | X | moderate-high moderate |
| **IV. Ballistic Missile/Strategic Bomber/SSBN Production Freeze*** | | | | | | | | | | | | | |
| A. Monitor shut-down of existing main assembly plants and shipyard(s) | X | | | | | | | | | | | | high |
| B. Detect ambiguous activity at other facilities | X | X | | | | | | X[i] | X[i] | X[i] | X | | moderate |
| C. Identify ambiguous activity | X | ? | | | | | | | | | X | X | low-high |
| **V. Nuclear Warhead Production Freeze** | | | | | | | | | | | | | |
| A. Monitor shut-down of existing key nuclear component fabrication facilities | X | ? | | | | | | ? | | ? | X | | high |
| B. Detect ambiguous activity at additional facilities | X | ? | | | | | | ? | | ? | X | | low-moderate |
| C. Identify ambiguous activity at additional facilities | X | ? | | | | | | ? | | ? | X | X | low-high |
| **VI. Weapons-Grade Nuclear Materials Cutoff** | | | | | | | | | | | | | |
| A. Monitor military nuclear materials production facilities | X | ? | | | | | | | | | X | | high moderate-high |
| B. Detect ambiguous activity at civilian nuclear facilities | X | ? | | | | | | | | | X | | low-moderate |
| C. Identify ambiguous activity | X | ? | | | | | | | | | X | X | low-high |

*Comprehensive freeze could include a ban on replacement of these systems from new production.

X[i] = *indirect* assistance in monitoring provision.

*(Continued from page 5)*

Lesser modifications to the missile might be accomplished in less time and be considerably harder to detect, given that routine maintenance, including replacement of defective components, would be *permitted* under a freeze. Thus a prohibition on major modifications to existing missiles would be verifiable chiefly as a consequence of monitoring the testing prohibitions of the freeze agreement.

A freeze on mobile ICBMs and IRBMs, "while more difficult than counting silos," Brown testified, "is a manageable task.

"For example, the Soviets are now deploying the mobile SS-20 IRBM, and we can estimate the number of launchers deployed with reasonable confidence. If the Soviets made special efforts to conceal mobile ICBM launchers, or if they deployed a system without central support facilities, the uncertainties could be larger. But covert deployment of a force on a scale large enough to be militarily significant would be a formidable task, requiring successful concealment of a large number of deployed launchers, and of their production, support and training exercises as well, and deployment without central support facilities would entail operational disadvantages."

While complaining about the novel "instability" caused by the Pentagon's alleged inability to target the "highly mobile" SS-20s, the Reagan administration has issued regular updates on the exact number of SS-20 launchers deployed and the number of SS-20 sites at various stages of completion, even to the extent of having sufficient confidence to accuse the Soviets of violating their own unilateral SS-20 European deployment freeze by completing construction of bases begun before the freeze took effect. Clearly, a deployment freeze on at least this current generation of Soviet IRBMs is adequately verifiable.

All these conditions apply to the threatened potential unverifiability of ground-launched cruise missiles as well. Although the missiles themselves are small and probably in some cases not directly accessible to counting, they will be embedded in transport, security and launch-control systems that is monitorable, and during peacetime they will be deployed in main operating bases which can be surveyed from aircraft and satellites.

**II. A Numerical Freeze on Dual-Capable Launch Platforms and Delivery Vehicles.** To prevent circumvention of the freeze and diversion of superpower energies into a destabilizing tactical/theater-nuclear arms race, a freeze on the numbers and payloads of such systems would be desirable. However, because many of these systems perform both conventional and nuclear missions, and their production and support systems are intimately connected to those for conventional weapons, a freeze on replacement and modernization of these systems does not seem politically feasible for the immediate future.

What *would* be feasible in the near term would be to freeze the current inventories of such weapons by type, for example: long-range strategic bombers (B-52/B-1; Bear, Bison/new Soviet bomber); peripheral attack bombers (F-111, Backfire); long-range nuclear-certified attack aircraft (e.g., A-6, Blinder); nuclear-armed attack submarines (SSN-688, Charlie/Alfa classes) nuclear-cruise missile-equipped surface ships (Iowa, Kirov); and nuclear artillery/battlefield missiles (8-inch, 155mm artillery, Lance, Pershing 1-A, Frog, Scud and Scaleboard missiles). Also frozen would be the nuclear payloads of such systems. One-for-one replacement and modernization of the *delivery vehicles* could be permitted, and transfer of deployed or currently stockpiled weapons to these new platforms could be allowed, *but with no increase in weapons load.*

According to one retired member of the intelligence community, each side has a fairly good idea of which forces on the other side *actually are assigned* a nuclear mission, as opposed to being theoretically "capable" of performing one. Special training, communications, operations, and security measures accompany the deployment of "nuclear-certified" units in the field, making moderate-to-high-confidence verification of a numerical freeze on these systems quite feasible. In addition to imaging and electronic reconnaissance satellites, both countries maintain ocean surveillance satellites to keep track of world-wide naval deployments, and the United States has the added benefit of information gleaned from a unique worldwide acoustic surveillance system.

Deployments of theater and tactical nuclear weapons in and around Europe, the key area of confrontation for these systems, are also monitored by SR-71, U2R, and

## THE SYSTEMS CAN WORK TOGETHER

**The different types of reconnaissance systems, both imaging and electronic, can be used in conjunction with one another to improve the information "take." For example, the Defense Meteorological Satellites (not mentioned above) can let the controllers of the imaging satellites know when the areas they want to survey are free of cloud-cover, so that satellite maneuvers can be made and the cameras turned on. Analysts of the digital images from the KH-11 may find new missile sites of special interest that they want the Big Bird to take a closer look at, or that justify an even closer look by the high-resolution film-return satellites.**

**The detection of a missile launch by early warning satellite over the Eastern Hemisphere could help the radar operators in the North Pacific to prepare to monitor the re-entry into the atmosphere of Soviet test warheads.**

**Navy analysts might combine information taken from pictures of Soviet ports, the signals received by ocean reconnaissance satellites, data from their extensive underwater acoustic sensor system, and sightings from ships and aircraft to keep close tabs on Soviet naval deployments.**

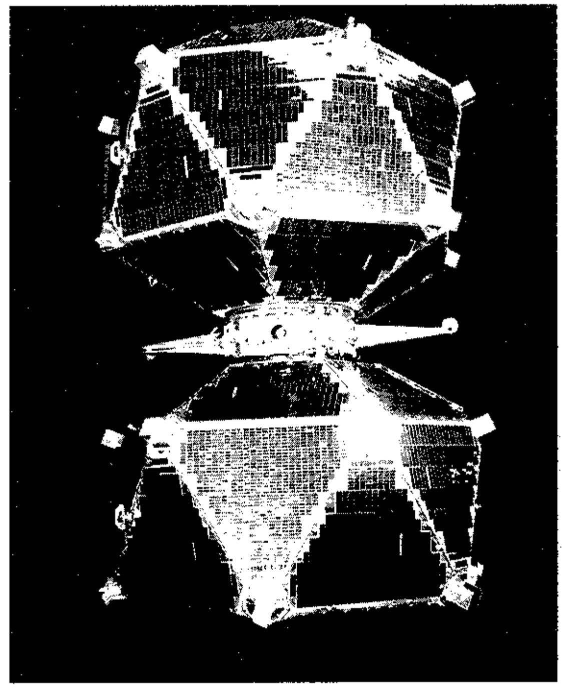
**Those who observe Soviet rocket tests might first learn that a test is under preparation from KH-11 images, then pick up the telemetry from the test using the "Rhyolite" satellite, then observe the re-entry vehicles (missile warheads) from a special radar ship in the North Pacific.**

other reconnaissance aircraft which overfly border areas and peer into Eastern Europe, monitoring activity at known nuclear weapons storage sites, and looking for signs of additional sites and dual-capable units. National Security Agency and military intelligence "listening posts" also gather vital signal (SIGINT) and communications (COMINT) electronic intelligence (ELINT) about the locations and operations of dual-capable units.

Based on our own intelligence analysis of Soviet dual-capable weapons payload capabilities, a common data base could be established with the Soviets on which systems should be included, and maximum allowable weapons load counting rules could be developed to ease verification tasks. For example, if one version of the *Backfire* can carry more weapons than another, then all versions might be considered as carrying the larger weapons load. The nuclear weapons themselves could not be modernized or replaced with newly produced versions. This provision would be verifiable mainly through the freeze on warhead production, which would preclude a supply of new warheads for tactical and theater systems.

Many observers have expressed the concern that the widespread deployment of cruise missiles threatens to make the freeze unworkable. Although cruise missiles are a legitimate cause for concern, they do not represent *that* great a departure from previous systems. It has already been suggested above how the deployment of GLCMs might be frozen and verified in a manner similar to mobile IRBMs.

Because deployed ALCMs must be attached to aircraft, which can be monitored with high confidence, ALCM deployment could be frozen and reliably monitored under a freeze, particularly if the parties adopted rules, as in SALT II, limiting ALCM deployments to heavy bombers.



*TRW "Vela-Hotel" nuclear explosion detection satellite.*

However, for a host of reasons—including Soviet dependence on a variety of short- and medium-range cruise missiles, difficulties in distinguishing between shorter- and longer-range versions, the fact that they use technologies and components in common with conventional weapons and can in theory be assembled in any one of thousands of light manufacturing facilities, and because their testing is not easily monitored—it will probably prove difficult to include cruise missiles in the nuclear delivery vehicle production and testing bans.

*(Continued on page 10)*

## SHOULD LIMITED PRODUCTION AND REPLACEMENT BE PERMITTED?

**In the view of many freeze advocates, the main purpose of the freeze is to halt the arms race rather than to eliminate the deterrent, in whole or in part, by degrading its reliability or otherwise diminishing its effectiveness. A conscious process of disarmament through year-by-year reductions in existing arsenals is the usual approach to reducing the size and destructiveness of the nuclear deterrent.**

**It is within this context, then, that the question arises as to how much replacement of worn-out weapons should be permitted under a freeze so as to preserve the deterrent's effectiveness pending disarmament. If, at the time a freeze goes into effect, both sides have adequate stockpiles of reserve missiles, permitting replacement could still be consistent with the shut-down of main missile assembly facilities. But it is also possible that either or both sides would insist on maintaining a capacity for producing spare missiles as a hedge against aging, technical failures, and breakdown of the treaty regime.**

**If production of spares for currently deployed missile systems were allowed to continue under a freeze, assuring that this output would not become a proxy for major modernization should still be possible through close monitoring of the testing restraints which would be part of any freeze agreement. However, foreclosing the option of production for replacement as well as for modernization would make the prohibited modernization of deployed or stockpiled missiles that much easier to verify.**

**Likewise, a ban on the modernization or replacement of strategic nuclear submarines and bombers could be included in a freeze agreement, but in their primary role as *launch platforms* for delivery vehicles (SRAMs, cruise missiles, SLBMs), they do not represent the cutting edge of the current arms race. As long as their *number* and *payloads* were frozen, bombers and submarines themselves could be replaced or even modernized without severe repercussions on the stability of the strategic balance. If only as a tremendous cost-saving measure, however, their inclusion might be desirable.**

*(Continued from page 9)*

Their deployment can be effectively hemmed in, however. The shutdown of nuclear warhead production facilities will, at a minimum, drastically curtail the number of cruise missiles which potentially could be armed with nuclear warheads. Those nuclear ALCM and GLCM deployments existing at the time a freeze enters into force can be frozen and monitored effectively. That leaves the problem of what to do about SLCMs—sea-launched cruise missiles.

Deployment of nuclear-armed SLCMs on submarines and surface ships could be restricted to those ships and subs which were commonly identified as having a nuclear role at the time the freeze is negotiated. Under the warhead production segment of the freeze, no new warheads could be produced for these systems, but, for example, existing warheads in the tactical airdrop inventory, such as B-61 bombs, could be redeployed on SLCMs, provided that for each eligible sub or surface combatant so equipped, the equivalent in weapons delivery capability is retired from whatever force gave up these weapons. As a purely hypothetical example, one squadron of A-6 carrier attack planes, or Blinder bombers, might be exchanged for the payload equivalent in attack subs armed with SLCMs. In other words, a technologically and numerically frozen, but free-floating, population of warheads might be redeployed, under agreed "exchange rates" based on real payload-carrying capacities, on a numerically frozen, but replaceable and upgradeable inventory of "dual-capable" delivery vehicles.

Finally, the deployment of conventially-armed long-range cruise missiles on vessels not included in the theater nuclear forces of either side might be prohibited in the interest of easing the task of verification.

**III. Delivery Vehicle Testing Freeze.** The verification of a ban on the testing of new missiles and major modifications to existing missiles could be accomplished under a freeze much the way it would have been under the SALT II Treaty. A set of percentage changes in key missile size and performance parameters would be agreed upon as constituting the boundary between "old" (permitted) and "new" (banned) missile testing. Over an extended test series of 20 to 30 firings required to validate a new design of major modification, these limits could be monitored with high confidence using a broad array of collection systems, including imaging and ELINT satellites, ground-based listening posts, test observation radars, and high-flying SR-71/U2R aircraft.

A limit on the number of operational tests would be monitored by these and other systems, including the DSP early warning satellites and ocean surveillance satellites.

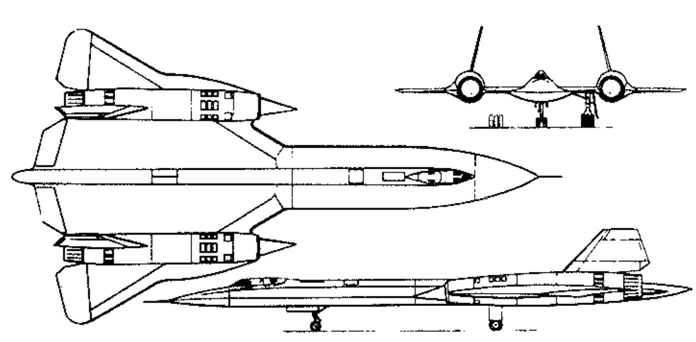
**IV. A Comprehensive Test Ban.** During the Carter administration, the United States, the Soviet Union, and the United Kingdom reached agreement on the broad issues involved in verifying a test ban agreement, but at least half the "details" of the verification scheme remain to be worked out. Agreement was reached, however, on placing unmanned seismic monitors on the territory of each of the three parties in such a way as to gather seismic data from all possible test sites. These data would not be the sole means for verifying compliance with the test ban, but instead would be integrated into the worldwide seismic monitoring network and, even more importantly, into the stream of data coming from other relevant U.S. collection systems, including imaging, ELINT and Vela satellites, underwater acoustic sensors, and atmospheric sampling aircraft to detect signs of "venting."

It was also agreed during the Carter-era negotiations that on-site inspections would be allowed in the case of doubts about suspicious events that could not be allayed by data exchange and consultation. More precisely, there could be a hierarchy of requests and mandatory responses that would lead to either an on-site inspection or a *prima facie* case that there was indeed something to hide. In short, a comprehensive test ban would be adequately verifiable. Debate on this point more often than not represents the displaced doubts of CTB opponents concerning its *desirability,* not the ability of U.S. monitoring systems to confine cheating under a test ban to occasional very-low-yield tests which themselves carry at least some risk of detection, if only through agents, emigres, and defectors.

**V. Ballistic Missile Production Freeze.** According to Secretary Brown's 1979 testimony, "our intelligence system has enabled us to build a comprehensive understanding of the Soviet ICBM system from design

**ACRONYM GUIDE**

**ALCM—Air-Launched Cruise Missile**
**COMINT—Communications Intelligence**
**CTB—Comprehensive Test Ban**
**DSP—Defense /Support Program (satellite)**
**ELINT—Electronic Intelligence**
**GLCM—Ground-Launched Cruise Missile**
**GPS—Global Positioning System (satellite)**
**HUMINT—Human Intelligence**
**ICBM—Intercontinental Ballistic Missile**
**IRBM—Intermediate Range Ballistic Missile**
**NTM—National Technical Means (of verification)**
**SIGINT—Signal Intelligence**
**SLBM—Submarine-Launched Ballistic Missile**
**SLCM—Sea-Launched Cruise Missile**
**SRAM—Short-Range Attack Missile (open bombers)**
**SSBN—Sub-Surface Ballistic Nuclear (missile submarine)**
**SSN—Sub-Surface Nuclear (attack submarine)**
**SOSUS—Sound Surveillance System**



*Three-view of the SR-71A high altitude reconnaissance aircraft operated by the U.S. Strategic Air Command (SAC)*

## IMAGE INTERPRETATION

**Techniques for interpreting pictures taken from the air were already highly developed by the end of World War II and probably did not change much during the early 1960's when the first spy satellites became available. Now, however, the advent of high-speed, high—capacity computers has given the image interpreters a whole new set of tools.**

**Traditionally, photo-interpreters have analyzed the pictures collected for them by examining the size and shape of objects, the shadows they cast, the patterns that objects and their surroundings form, the tone or shade of the light coming from the objects or their background, and the texture of the surfaces. The interpreters could then draw both on their own experience and knowledge and on specially designed "keys" to draw conclusions about the pictures. The key would probably consist of both verbal descriptions and actual pictorial examples of the different kinds of installations of military interest.**

**For example, the interpreter might see a picture with excavations, mine headframes, derricks, piles of waste, conveyor belts, bulldozers, power shovels, but with just a few buildings. His key would suggest that this is a mine. Special kinds of equipment, the tone or color of the waste piles and the ore piles, as well as knowledge of the local geology might further indicate that this was a uranium mine.**

**Another picture from a different location might show facilities for storing and handling large quantities of the same kind of ore observed coming out of the mine. Provisions for large sources of heat and mechanical energy and particular types of processing equipment identify the plant as a uranium mill. (The shadows cast by the equipment might help to determine its shape and measure its size.)**

**Still another plant, elsewhere, might show characteristics of being a highly enriched uranium fuel fabrication plant. Besides a few characteristic buildings, it would probably have extraordinary security arrangements (fences and watchtowers) and special facilities for handling radioactive materials. (A plutonium reprocessing plant for extracting fissionable plutonium from spent nuclear fuel would have those features and particular patterns of chemical processing equipment and waste storage facilities as well.) From the science of "cratology"—the study of special-purpose containers—the interpreters might get a very good idea of where the nuclear fuel was being shipped and why.**

**Modern image gathering and processing have greatly refined the traditional art of the photo-interpreter. For example, the intepreter doesn't just form a general impression of the tone of the light reflected from the surfaces in the picture. With digital images, he gets an exact measure of the amount of light which registered to form each pixel, or dot, making up the whole picture. Through "multi-spectral" imaging, the analyst has a record of how much light of different kinds was reflected, absorbed, scattered, or emitted by the same surface. With that information, the analyst can deduce more information about the surfaces in the picture. Camouflaging and the surrounding foliage, for example, would have different spectral reflectance properties.**

**Computers can take the image information gathered by the satellite and further enhance it in a variety of ways. Some of the techniques of image processing include:**

**Building multi-colored single images out of several pictures taken in different bands of the spectrum, making the patterns more obvious;**

**Restoring the shapes of objects by adjusting for the angle of view and lens distortions;**

**Changing the amount of contrast between objects and backgrounds;**

**Sharpening out-of-focus images;**

**Extracting particular features while removing the background;**

**Enhancing shadows;**

**Suppressing glint.**

**With two or more images of the same scenes, the computers can build three-dimensional "stereo" pictures, fit other pictures taken at difference angles onto the same grid, and detect how the scene has changed from one picture to the next. This change detection is useful, for example, in spotting new weapons deployments, such as mobile nuclear missile sites.**

**The image interpreters can use all these techniques to extract more information from the pictures they examine. But the computers can also use the techniques to help the interpreters decide which of the many thousands of pictures gathered every year to pay more attention to. The computers are learning themselves to recognize patterns. For example, the computer might be fed all the pictures of Soviet ICBM fields and told to display only those which show some difference with previous pictures; the difference might indicate construction of new launch silos.**

through deployment. We know that the Soviets have four design bureaus for the development of their ICBMs. We monitor the nature of the projects and the technologies pursued at these bureaus. We know which bureau is working on each of the new or significantly modified ICBMs known to be under development. We have a reasonably good idea of when they will begin flight testing of these missiles. Missile production takes place at several main assembly plants and at hundreds of subassembly plants, employing hundreds of thousands of workers."

Then-Undersecretary of Defense William Perry testified, "We monitor the Soviet activity at the design bureaus and production plants well enough that we have been able to predict every ICBM before it even began its tests."

*(Continued on page 12)*

*(Continued from page 11)*

Defense Intelligence Agency Director Maj. General Richard Larkin and Vice Director for Foreign Intelligence Edward M. Collins informed the Joint Economic Committee, in prepared testimony of July 8, 1981, that "there are 134 major final assembly plants involved in producing Soviet weapons as end products. In addition, we have identified over 3,500 individual installations that provide support to these final assembly plants." A table accompanying their report noted that "missile materiel" was produced in "49 plants," and they provided a table giving a five-year annual breakdown of Soviet missile production by type.

Clearly, our national intelligence system has amassed a considerable body of knowledge, over more than 20 years of constant observation, concerning the Soviet ballistic missile production system. This accumulated stock of knowledge, in conjunction with current monitoring capabilities, would permit a shutdown of ICBM, IRBM, and SLBM main assembly plants to be verified. Given a willingness to forego further development of conventional bombing capability, and bilateral agreement on what constitutes a "long-range strategic bomber," there is no technical reason why main bomber assembly plants could not also be closed down. And given the present state of knowledge and monitoring confidence concerning each side's production system, the freeze could very likely be extended to include major subsystem manufacturing facilities (e.g., for missile stages and reentry vehicles) as well. Since nothing would be coming in or out of these facilities in their shut-down condition, any significant alteration in their operating status would not long escape detection by the variety of sensors deployed on imaging reconnaissance satellites. Doubts about the mission of facilities not included in the freeze could be resolved, in the first instance, by intensive monitoring by national means (possibly facilitated by "cooperative measures") and subsequently by data exchange and "voluntary" on-site inspections along the lines worked out for the draft Comprehensive Test Ban Treaty.

**VI. Nuclear Warhead and Weapons-grade Materials Production Ban.** For perhaps a two-or three-year period, a ban on nuclear warhead production could be implemented and verified along the same lines as the ballistic missile production ban, as it would take at least that long to secretly replicate warhead production facilities. The ban would involve placing in caretaker status the principal *nuclear* component fabrication and final assembly facilities for nuclear warheads and bombs. For example, on the U.S. side this would include the unique U-235, U-238, and lithium-deuteride "secondary" component fabrication facilities at the Y-12 plant in Oak Ridge, Tenn., the Rocky Flats "primary" (fission-stage) facility outside Denver, Colorado, and the Pantex assembly plant near Amarillo, Texas. Similar Soviet facilities no doubt have been identified and are already under frequent surveillance by U.S. intelligence systems.

During this warhead production moratorium, agreements could be negotiated placing all nuclear facilities and materials stockpiles under IAEA safeguards (suitably strengthened, if necessary), creating the basis for long-term confidence that the warhead production ban would be respected. The CTB system of "voluntary" on-site inspections to resolve serious treaty-related ambiguities could be maintained to buttress the IAEA system of safeguards, leading to a verifiable cutoff in weapons grade-materials production. ☐

## CRANSTON-GAYLER PROPOSAL HAS TWO VERSIONS

**The summary of a proposal to cut off fissionable material and dismantle warheads run in the June, 1982 newsletter under the names "Senator Alan Cranston and Admiral Noel Gayler" summarized the Cranston version of this proposal.**

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