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CLARIFYING ABM TREATY AMBIGUITIES: THRESHOLD LIMITS

New developments in ballistic missile defense (BMD) technology pose major challenges to the Anti-Ballistic Missile (ABM) Treaty of 1972. There is a growing need to find a way to keep the ABM Treaty current with the evolution of BMD technology. While the ABM Treaty is of indefinite duration, it needs and deserves periodic updating.

Over the past two years discussion has focused on the debate over the Reagan Administration's broad interpretation of the ABM Treaty, which holds that the Treaty does not limit the testing of exotic BMD technologies, such as lasers. But this is now a false issue. It is increasingly clear that this interpretation of the Treaty is without legal or factual merit. Congressional opposition seems likely to insure that it will not be implemented. In any case, the Administration has had considerable difficulty explaining what additional tests would be conducted should the broad interpretation be implemented.

Resolution of the broad interpretation debate does not resolve the inevitable conflict between the permissive and restrictive readings of terms of the traditional interpretation of the ABM Treaty.

The Reagan Administration espoused a permissive reading of the traditional interpretation of the ABM Treaty in its first annual Report to the Congress on the SDI in early 1985, and in each subsequent edition of this report. The Administration asserted that the SDI program was consistent with this permissive reading of the Treaty, arguing that the SDI was not developing ABM "components," and that SDI tests would not be conducted "in an ABM mode," or demonstrate "ABM capabilities," and thus the technologies tested under the SDI would not be "capable of substituting for" ABM components.

But a more restrictive reading of the Treaty's terms leads to the conclusion that many of the tests under the SDI do involve components with ABM capabilities, and thus are inconsistent with the Treaty. Unfortunately, the Treaty provides inadequate guidance for choosing the proper reading of these critical terms.

New definitions of what constitutes ABM "capabilities," and focusing on thresholds rather than categorical bans, could resolve this problem. Devices with capabilities above a certain "threshold" would be subject to the testing and deployment limits of the Treaty, while those with inferior capabilities would not. Similarly, there are questions about what is an ABM "component" or what constitutes "development," terms that are central to the ABM Treaty, but which lack sufficiently precise definition. But it should be possible to determine whether or not the mirror of a ABM component such as a laser or sensor telescope is larger than two meters in diameter, within an acceptable margin of error. Thus threshold limits would provide a less ambiguous operational definition for the "development" of an "ABM component" which

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GOALS OF THE ABM TREATY

John E. Pike

The ABM Treaty serves two mutually supporting and yet contradictory roles in banning the deployment of nationwide anti-missile systems. First, the Treaty allows sufficient research and testing by both sides to permit the design of countermeasures needed to insure that any anti-missile system that might be deployed would be ineffective. But the second role is to keep such deployments so far in the future that offensive forces are not built to discourage breakout from the Treaty.

The first role of the Treaty is to permit research in support of the Treaty regime. Research on BMD technology provides reassurance that BMD systems would not be effective, because both sides understand the technology well enough to design countermeasures. Designing a decoy requires a practical familiarity with the performance characteristics of the sensor that it's designed to fool. And when technical experts have argued that ballistic missile defense systems would be ineffective, their critique was not simply the result of idle speculation on a blackboard. It was the result of concrete, actual work that provided a practical understanding of these technologies.

The second purpose of the ABM Treaty is to establish a long leadtime for deploying an anti-missile system. Sufficient time should elapse between the point at which the treaty regime was exceeded and the time an anti-missile system was actually deployed that there would be no requirement to actually implement counter measures in existing force structures.

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has "ABM capabilities" or has been "tested in an ABM mode."

This approach was first proposed in a meeting sponsored by FAS with Soviet scientists in early 1984. Over the past year a series of private talks have confirmed the usefulness of threshold limits. At the February scientist's forum in Moscow three days of intense discussions led to agreement on a communique by Soviet and American technical experts endorsing the threshold limits approach (this document was reprinted in the March issue of the *FAS Public Interest Report*).

Formulation of the American stance at the Geneva negotiations has previously considered this approach. In September, 1985, press reports indicated that "agreement on common definitions of precisely what is permissible research" would be one of the priorities for the American delegation.

There have been a number of indications of Soviet interest in this approach. Press reports prior to the 1985 Geneva summit suggested that the Soviets wanted to ban space-based testing of kinetic kill mechanisms, set ceilings on the power levels of laser kill mechanisms to be tested in space, and regulate testing of high-energy power sources in space.

Soviet General Secretary Gorbachev has endorsed the idea of technical discussions along these lines, suggesting in April 1987 "let experts of the two countries take their time, ponder on the subject, and agree on the list of devices that would not be allowed to be put into space in the course of this research."

While senior arms control advisor Paul Nitze has publicly expressed interest in reaching an agreement of this kind, the American government remains committed officially to the broad interpretation of the Treaty.

Although the two sides did agree in January 1987 to establish a special working group at the Geneva negotiations to discuss what activities are permitted under the ABM Treaty, thus far this effort has not born fruit, because the American side is under instructions only to reiterate U.S. support for the broad interpretation of the ABM Treaty, and is prohibited from exploring Soviet proposals for a compromise.

Discussion of threshold limits to clarify the existing commitments under the ABM Treaty should be the focus for discussions in the special working group at the Geneva negotiations that was formed for this purpose early this year and in the Standing Consultative Commission (SCC). It will not be possible to resolve all of these issues at once, as this will be an ongoing process as new technologies are identified. But such negotiations limiting gray areas was precisely the role originally intended for the SCC, and it ought to be entirely feasible, if the will to agree exists.

—Reviewed and approved by the FAS Council

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The essential problem is finding a balance between the low level of research that is necessary to develop effective countermeasures and thus uphold the ABM Treaty regime, and the high level of activity that would permit a system to be deployed quickly—provoking the deployment of those countermeasures, particularly the proliferation of offensive forces, and thereby impeding negotiated limits on offensive systems.

Alternative Limitation Regimes

The ABM Treaty of 1972 is the only major bilateral arms limitation agreement in effect between the United States and the Soviet Union. The Treaty reflects their shared judgment that limitations on strategic defenses and offenses are interrelated.

Since 1972, technology has evolved considerably, as might be expected over any fifteen year period. In addition, differences in national policies relating to strategic defensive systems and the scope of the ABM Treaty have emerged, as reflected most recently at the Reykjavik Summit.

However, quite apart from these differences the issue of *the threshold between permitted and prohibited development and testing activities* would have arisen in any event, and should now be dealt with by the parties to the Treaty.

The Treaty prohibits the development, testing and deployment of ABM components that are space-based, air-based, sea-based or mobile land-based.

The Treaty provides several criteria for establishing what devices are subject to these limits:

1—the components of ABM systems at the time of the signing of the Treaty, namely interceptors, launchers, and radars;

2—devices that have been "tested in an ABM mode" (that is, tested against strategic ballistic missiles or their components in flight trajectory);

3—devices that have "ABM capabilities" or are "capable of substituting for" ABM components.

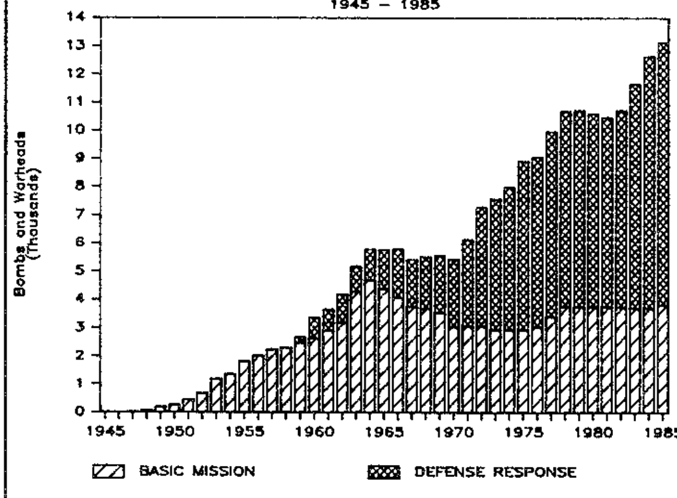
The Core Problem

The central problem is that the march of technology has complicated the interpretation of the terms of the Treaty. In 1972, verification of testing in an ABM mode was a fairly straightforward process. The operation of a radar could be monitored by electronic intelligence satellites, and the launching of an interceptor, and the flight of a target reentry vehicle could be monitored by various means. These activities provided a rather unambiguous basis for defining "tested in an ABM mode."

But the new BMD technologies pose a greater challenge for determining whether a device has been "tested in an ABM mode." Passive sensors such as telescopes which can be used to track targets do not emit signals, and thus their association with an anti-missile test can be difficult to determine. Long range interceptors can be tested against

GENESIS OF U.S. STRATEGIC FORCES

1945 – 1985



THE ABM TREATY AND OFFENSIVE ARMS CONTROL

One factor in the current high levels of strategic offensive forces are efforts to offset the other side's actual or potential strategic defenses. Deep offensive reductions may prove very difficult to achieve in the absence of greater constraints on strategic defenses. However, strategic defenses are more difficult to constrain than strategic offenses, and this may impose limits on offensive reductions.

Possibly two-thirds of the current US inventory of strategic offensive weapons were initially rationalized at least in part as a response to current or potential Soviet strategic defenses:

+ Multiple warheads (MRV's and MIRV's) which were deployed on SLBM's in the 1960's were justified in part by the need to respond to Soviet ABM systems, and later to discourage Soviet breakout from the ABM Treaty. If one regards the 656 SLBM warheads initially deployed on the Polaris A-1 as the level required for basic target coverage, over 5,500 additional SLBM MIRV's are a response to Soviet ABM systems.

+ Multiple warheads (MIRV's) were also deployed on ICBM's in the 1970's, and justified in part by the need to discourage Soviet breakout from the ABM Treaty. If the roughly 1,000 weapons on single warhead ICBM's in the 1960's were required to cover Soviet targets, about half of the 2,100 ICBM warheads currently deployed are a response to strategic defense.

+ Bomber payloads today include about 2,000 gravity bombs, which are needed to attack primary targets. But US bombers also carry 1,400 SRAM's (Short Range Attack Missile), which are used to suppress Soviet air defense, and over 1,700 ALCM's (Air Launched Cruise Missiles) which were initially justified primarily as a response to Soviet air defense.

MAJOR SDI TESTS–COMPLIANCE WITH ALTERNATIVE TREATY REGIMES

					ABM TREATY		
Test	*Lab Only*	*Ban In-Space*	*Ban Space Based*	*Restrictive*	**Narrow** *Threshold*	*Permissive*	**Broad**
1987							
PALADIN Free Electron Laser laboratory test							
Middle Note Underground Nuclear Test of SDI survival							
COBRA EYE–Optical Airborne Measurement Program	X						
AOS Airborne Optical System–first flight	X						
Queen Match–Infrared Probe tracking Soviet RVs	X	?					
JANUS sensor flight test using Maverick sensors	X	?					
Significant Technical Milestone–2 post-boost vehicle	X	X	M	?			
1988							
ALPHA Chemical Laser ground test							
Distant Drum Underground Nuclear Test of SDI Survival							
ERINT Extended Range Interceptor (ATBM) first flight	X						
HEDI High-Endostampspheric Interceptor–White Sands	X				?		
BEAR (Beam Experiment Aboard Rocket) Particle Beam	X	?					
Remote Mirror Experiment laser tracking test satellite	X	X	M	?			
AOS Airborne Optical System–Kwajelein target tests	X	X		X			
1989							
Mineral Quarry Underground Nuclear Test of SDI Survival							
Infrared Background Study Satellite German SPAS on Delta	X	X	?				
Cooperative Space System battle management satellites	X	X	?				
Braduskill–fly-along midcourse interceptor flight test	X	X			X		
MIRACL Mid-Infrared Adv Chemical Laser adaptive optics	X	?	?	?			
Starlab pointing and tracking experiment on the Shuttle	X	X	M	X			
Endgame Booster Kill Experiment–at Kwajelein	X	X	M	M	X		
1990							
Huron Forrest Underground Nuclear Test of SDI Survival							
ERIS Exo-atmospheric Reentry-vehicle Interception System	X	X			X		
GSTS (Ground-based Surveillance & Tracking System) probe	X	X					
ACE (Agile Control Experiment) laser mirror test Titan 4	X	X	M	X	X		
Pathfinder–boost-phse fire control system satellite	X	X	X				
AOS Airborne Optical System with Laser Rangefinder	X	X		X	X		
SIDE (Sensor Integrated Discrimination Experiment)	X	X	X	?	?		
LISE (Laser Integrated Space Experiment)	X	X	X	X	X		
THOR (Tiered Homing Overlay)	X	X	X	X	X		
1991							
Hunters Trophy Underground Nuclear Test of SDI Survival							
Terminal Imaging Radar ground-based radar at Kwajelein	X						
HEDI High-Endostamospheric Interceptor–Kwajelein	X				X		
10 Megawatt Free Electron Laser at White Sands					X		
Radar Lens Test of space-based radar on Shuttle	X	X	X				
DELPHI Charged Particle Beam rocket probe test	X	X	X	?			
Neutral Particle Beam Integrated Space Experiment Shuttle	X	X	M	X	?		
BSTS (Boost Surveillance & Tracking System) Titan 4	X	X	X	X			
1992							
Heavy Lift Launch vehicle first flight							
Mini Urn Underground Nuclear Test of SDI Survival							
Ground-Based Free Electron Laser low-power space mirror	X	X	M	?	X		
Space-Based Kinetic Kill Vehicle test	X	X	X	X	X		?
1993							
Space-Based Rail Gun test using Shuttle	X	X	X	X	X		
SSTS (Space Surveillance & Tracking System) satellite	X	X	X	X	X		
1994							
SP-100 nuclear reactor flight test	X	?	?		X		
1995							
Ground-Based Free Electron Laser high-power space mirror	X	X	X	X	X		

X = Banned *? = Compliance Unclear* *M = Banned Unless Modified* satellite targets which mimic the characteristics of a strategic ballistic missile.

Unfortunately, the determination of whether a device is capable of substituting for an ABM component or whether it has ABM capabilities is also very difficult, particularly if the device is based on other physical principles (such as lasers). The ABM Treaty does contain a precise threshold definition of what constitutes a radar that has ABM capabilities, but the Treaty provides no guidance on the point at which a tracking telescope is capable of substituting for an ABM radar.

Threshold definitions of ABM capabilities agreed to by the U.S. and USSR could resolve this problem. There may be questions about what is an ABM "component" or what constitutes "development," but it should be possible to determine whether or not a mirror is larger than two meters in diameter, with an acceptable margin of error. These threshold limits would provide a less ambiguous operational definition for the "development" of an "ABM component" which has "ABM capabilities" or has been "tested in an ABM mode."

Alternative Regimes

A number of possible regimes limiting anti-missile systems have been discussed in recent years, and the attitudes of the United States and Soviet Union have evolved over time. Both countries originally agreed to the traditional interpretation of the ABM Treaty in 1972. But in recent years the Reagan Administration has modified its adherence to the Treaty, moving first to the permissive reading of the Treaty in early 1985, and subsequently moving to the broad interpretation.

The Soviets called initially for a ban on all purposeful research and subsequently moved to a proposal that would ban all testing outside of laboratories. In 1985 the Soviets moved to a ban on testing that would either ban all testing in space, or all testing of space-based elements of BMD systems, and in 1987 the Soviets proposed an approach apparently based on threshold limits.

0—No Laboratory Research

The initial Soviet reaction to the Strategic Defense Initiative was to call for a complete ban on research of this type. And this continued to be their position through early 1985. Senator Gary Hart reported on 17 April 1985 that when he met with Andrei Gromyko in Moscow in January 1985 that:

> Gromyko responded that a moratorium on space weapons could not be based on testing alone, but would have to include research as well, given that "research is ninety percent" of the process of weapon development.

However, Soviet chief negotiator Victor Karpov appeared to back off from this position in October 1985 when he stated that the Soviet government had never opposed basic scientific research, although they did seek a ban on development and testing. Soviet negotiator Yuli Kvitsinsky elaborated this approach in late October 1985, noting that "what cannot be observed does not exist." Subsequent discussions in the spring of 1986 at the Geneva negotiations confirmed this position.

1—Ban of Field Testing—Laboratory Research Permitted

A less restrictive regime would prohibit all field testing of anti-missile or anti-satellite components or elements (however that might be defined), while permitting laboratory testing.

In a meeting with several U.S. Senators in Moscow in September 1985, General Secretary Gorbachev stated that "you can't verify what's going on in the brain, and that's what we refer to as fundamental or basic research. But as soon as you go beyond the laboratory, go to mock-ups, models, contracts with defense contractors, here surely verification can be done. We want a ban on that phase of research that approaches design and manufacture."

2—Prohibition of Testing Elements in Space

Although the American side gained the impression at the Iceland summit that the Soviets were still insisting on a ban on all activities outside the laboratory, following the summit the Soviets insisted that this was not their position.

Unfortunately, Soviet statements on this matter are somewhat confusing. In particular, it is unclear whether their position calls for a ban on *testing in space,* which would ban testing above the atmosphere, or whether the ban would be on *space-based testing,* which would permit testing in space of devices that were on ballistic rather than orbital trajectories.

The draft agreement submitted by Gorbachev at the Reykjavik summit on 11 October 1986, which is the clearest formulation of the Soviet positions, stated that:

> All testing of *space-based* elements of a ballistic missile defense *in outer space* will be prohibited except research and testing in laboratories.
>
> That will not require a ban on tests allowed by the ABM Treaty—of fixed land-based systems and their components. The sides must find mutually acceptable solutions in this area during negotiations in the next several years.
>
> Both sides agree to make additional efforts to reach mutually acceptable agreements to ban ASAT's (anti-satellite weapons).

3—Prohibition of Testing Space-based Elements

While it is unclear what the Soviets mean to include when they use the term "elements," another interpretation of their approach is that it would include a ban on space-based testing prohibiting testing of elements that complete one full revolution of the earth. This regime would permit unlimited activities above the atmosphere, as long as the element was on a ballistic trajectory—orbital trajectories would be prohibited.

There would be considerable difficulty in distinguishing between Regimes 2 and 3 since in most cases elements or devices or components that could be tested in a space-based mode could also be tested in space flying on a sub-orbital ballistic trajectory in which the test elements fall to Earth at the conclusion of the test.

4—Restrictive Interpretation of the ABM Treaty

The first version of the ABM Treaty is a restrictive reading of the narrow interpretation of the Treaty. The narrow interpretation of the Treaty applies the Article V prohibition on testing space-based and air-based components to all ABM *capable* components, regardless of whether they are based on traditional or exotic technologies, and applies these limits to devices with even rudimentary capabilities.

5—Threshold Limits on Performance

This regime would establish a variety of threshold limits on the performance of devices with potential anti-missile capabilities. This would clarify some of the ambiguities posed by the restrictive and permissive reading of the ABM Treaty through agreed thresholds that would define permitted and prohibited activities.

Under the ABM Treaty today categorical limits are implicitly defined by threshold limits unilaterally determined by both sides. This regime would seek bilateral agreement on these threshold limits in explicit numerical terms.

The American delegation at the Geneva negotiations has previously considered this approach. In September 1985 press reports indicated that "agreement on common definitions of precisely what is permissible research" would be one of the priorities for the American delegation.

There have been a number of indications of Soviet interest in this approach. Press reports prior to the 1985 Geneva summit suggested that the Soviets wanted to ban space-based testing of kinetic kill mechanisms, set ceilings on the power levels of laser kill mechanisms to be tested in space, and regulate testing of high-energy power sources in space.

In October 1986 Soviet Academician Roald Sagdeev stated that:

> If a powerful laser is able to produce effects needed for SDI, a demonstration of these types of devices would be quite destabilizing. But if tests are with modest instruments, they could be considered permissible under the ABM Treaty.

In April 1987 General Secretary Gorbachev suggested:

> Let experts of the two countries take their time, ponder on the subject, and agree on the list of devices that would not be allowed to be put into space in the course of this research.

Although the two sides did agree in January 1987 to establish a special working group (or mini-group) at the Geneva negotiations to discuss what activities are permitted under the ABM Treaty, thus far this effort has not borne fruit. The American side is under instructions only to reiterate U.S. support for the broad interpretation of the ABM Treaty, and is prohibited from exploring Soviet proposals for a compromise. A Presidential National Security Decision Directive has specifically prohibited the U.S. delegation from conducting detailed discussions on the meaning of the ABM Treaty's constraints on testing and development of missile defense components.

6—Permissive Reading of the Narrow Interpretation of the ABM Treaty

The permissive reading of the narrow interpretation of the Treaty recognizes that the Treaty does apply to all types of anti-missile components (including exotic systems). But it holds that the Article V's restrictions on mobile components do not constrain the SDI since none of the devices tested under the program have *all* of the characteristics of an ABM component, and that Article VI's restrictions do not constrain SDI testing since these tests would either not be conducted in an ABM mode, or would not actually and totally demonstrate ABM capabilities.

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THRESHOLD LIMITS CURRENTLY IN THE ABM TREATY

The ABM Treaty provides precedent for issues of interpretation through threshold limits. At the time the Treaty was signed, conventional rocket and radar technologies were fairly well understood, and the Treaty contains a variety of specific threshold limits on such systems.

100 Interceptors at permitted deployment areas. (Article III-a/b)

150 Kilometer radius of permitted deployment areas. (Article III-a/b)

6 ABM radar complexes at the national capital deployment area. (Article III-a) **3** Kilometer radius for each ABM complex at the national capital deployment area. (Article III-a)

2 Large phased-array radars at the ICBM deployment area. (Article III-b)

18 Small radars at the ICBM deployment area. (Article III-b).

15 ABM launchers at test ranges. (Article IV) **3,000,000** Power aperture product defining large phased array radars. (Agreed Statement B).

1300 Kilometer separation of the two permitted deployment areas. (Agreed Statement C)

1 Maximum permitted number of independently guided warheads per interceptor. (Agreed Statement E)

THE RESTRICTIVE AND PERMISSIVE READINGS OF THE ABM TREATY

The difference between the restrictive and permissive readings of the Treaty is best illustrated by the case of the Airborne Optical System (AOS), also known as the Airborne Optical Adjunct (AOA). AOS is a modified Boeing 767 aircraft that carries an infrared telescope for tracking and identifying reentry vehicles while they are still above the atmosphere for interception by mid-course and terminal defenses.

The Reagan Administration offers three lines of reasoning under its permissive reading of the ABM Treaty to support its contention that AOS is Treaty compliant.

The first rationale is that the Boeing 767 cannot stay aloft for a sufficient period of time to be an effective ABM component. This is the least compelling part of the permissive case for AOS, and resort to such a tenuous line of reasoning suggests the weakness of the permissive case as a whole. The Boeing 767 currently has a maximum airborne endurance of about 10 hours. This is comparable to the endurance of the E-3 AWACS which performs an air defense function analogous to the BMD function performed by AOS. Contractor studies have suggested that even with its current endurance, a fleet of less than forty 767 aircraft would be adequate for an operational system. And if needed, the endurance of the 767 could be extended to several days through the use of aerial refueling.

The second part of the permissive case for AOA is the assertion that AOS is compliant because of its limited signal and processing capability. But the prohibitions in Article V apply to the development of components that can be monitored by national technical means of verification. And the permissive interpretation would require a detailed understanding of the computer software and communications capabilities of AOA which is clearly beyond the capabilities of national technical means.

The third argument under the permissive interpretation assumes that a device would not be a Treaty-accountable ABM component unless it could perform the complete function of or substitute on a "stand alone" basis for an ABM component as defined in Article II of the Treaty.

Although there are some missile defense systems with a single sensor (such as the proposed Site Defense system that was under development in the United States in the 1970's) they are the exception, rather than the rule. In practice, most missile defense systems have more than one sensor component, each of which plays some role in the management of the battle.

For example, the early Nike-Zeus system had not one or two, but four separate types of radars, for target acquisition, decoy discrimination, target tracking and interceptor tracking. Under the permissive interpretation of the difference between a "component" and an "adjunct," all of these radars would be considered to be adjuncts to one another, and none of them would be considered to be a component.

The Airborne Optical System performs a role similar to that of the Perimeter Acquisition Radar (PAR) in the Sentinel /Safeguard system. Radars such as the PAR were clearly considered to be ABM components, and subjected to strict limitations in the Treaty.

The initial configuration of AOS has a passive infrared telescope sensor which can provide some target tracking data, but not the range from the sensor to the target. This limits the utility of this system, and on this basis some would argue that AOS is not a component. However, as early as 1990 AOS will be upgraded under the Airborne Laser Experiment effort with a laser rangefinder to provide target range information. This would improve the performance of the sensor, and raise more serious questions about the systems compliance with even the permissive interpretation of the Treaty.

Although the permissive interpretation case for conducting the initial tests of AOS is not compelling, it must be conceded that the plain text of the Treaty, as well as what is publicly known of the negotiating record, does not provide a clear-cut basis for choosing between the permissive and restrictive readings of the Treaty.

7—Broad Interpretations of the ABM Treaty

The third version of the ABM Treaty is the Reagan Administration's broad interpretation of the Treaty, which holds that the testing limits of Article V do not apply to exotic systems based on other physical principles, and that the only provisions of the Treaty relevant to devices other than conventional rocket and radar systems is the Agreed Statement D limit on deployment of exotic systems. A variant of the broad interpretation of the Treaty holds that even kinetic energy weapons are not subject to the Treaty's

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AGREED STATEMENT D

In order to insure fulfillment of the obligation not to deploy ABM systems and their components except as provided in Article III of the Treaty, the Parties agree that in the event ABM systems based on other physical principles and including components capable of substituting for ABM interceptor missiles, ABM launchers, or ABM radars are created in the future, specific limitations on such systems and their components would be subject to discussion in accordance with Article XIII and agreement in accordance with Article XIV of the Treaty.

testing limits, since such devices have on-board guidance systems, and thus are not totally dependent on external guidance from ABM radars or other sensors.

The recent Senate debate over this issue has made it clear that the broad interpretation is very unlikely to become the basis for the SDI program. It is increasingly clear that this interpretation of the Treaty is without legal or factual merit. Congressional opposition seems likely to insure that it will not be implemented. In any case, the Administration has had considerable difficulty explaining what additional tests would be conducted should the broad interpretation be implemented.

NEW THRESHOLD LIMITS TO CLARIFY THE ABM TREATY

A ballistic missile defense system is composed of four elements — weapons, weapon launchers, sensors and battle management. It is generally recognized that battle management poses the greatest technical challenge for perfecting an anti-missile system, and that sensors pose a greater technical challenge than do weapons and weapon launchers.

It is an unfortunate paradox that the most technically challenging aspect of a BMD system (battle management) also poses the greatest problem for verification, while the least technically challenging part of the problem (weapons) pose the least problem for verification.

The ABM Treaty places no constraints on battle management systems, since it was recognized by both parties that such limitations would be difficult if not impossible to verify.

At the time the ABM Treaty was signed, BMD sensors were very large radars that required years of construction, and thus were easy to verify, so the Treaty provided a strict regime of limitations on the deployment of such radars. But future systems using passive sensors may be much more difficult to verify. This does not mean that such future sensor technologies would be impossible to verify, or that they should be exempted from constraint. But more stringent constraints on weapons testing may be needed to compensate for the difficulties of limiting sensors.

Criteria for Threshold Limits

First, the threshold should ideally apply to a wide range of technologies. One of the challenges posed by new and emerging anti-missile technologies is their dazzling variety. The search for threshold limits should focus on a small set of parameters that cover a wide range of weapons, sensors, or both. A common limit of five square meters on the aperture of laser beam director mirrors, satellite sensor mirrors, and the windows on airborne sensor aircraft would constrain a wide variety of weapon and sensor technologies.

Second, the limits should apply to technologies that are of interest for ballistic missile defense. While limits on some systems, such as railguns, might be imagined, the low priority currently assigned such devices suggests that more immediate issues, such as lasers (particularly ground-based), rocket interceptors and passive infrared telescope sensors should be addressed as a matter of priority.

Third, the threshold limit should be related as directly as possible to the actual performance of the device in question. The power aperture product, the radar threshold limit that was agreed to in 1972 does this very well. The brightness of a laser is similarly a very good measure of the laser's military performance.

Fourth, it must be possible to distinguish permitted and prohibited activities. Ten or twenty years ago the volume of an interceptor was a fair indicator of its anti-missile potential. But the recent advent of very small terminal homing sensors has reduced the size of interceptor warheads, and thus of interceptor rockets. In the future, very capable anti-missile interceptors may be much smaller than today's anti-aircraft rockets.

Fifth, the threshold should provide adequate insurance against breakout from the Treaty limit. A typical weapon system might take about five years from the point of conception to initial field testing, another five years from initial testing to an initial operational capability, and an additional two to five or more years to reach a fully operational status. Limits on deployment provide at most five years lead-time, and may provide much less, while development and testing constraints may provide a ten year lead-time. Major reductions in offensive forces will increase the utility of limits on development and testing.

And sixth, the threshold limit clearly must be verifiable. This means that data related to the limit can be collected using national technical and other means. There are in turn several criteria that should be applied to verification.

First, the required technical collection systems and other means of verification should be available during the time frame in which the parties to the Treaty are likely to encounter the thresholds they are intended to monitor. The development and deployment of entirely new dedicated space-based sensors for monitoring limits such as laser brightness might require as much as ten years. Setting a brightness threshold limit at the level anticipated in the late 1990's, by which time a new satellite monitoring system might be in place, would permit such extensive testing of lasers at potentially very high brightness levels as to call into question the utility of the limit. In such cases, cooperative measures such as in-country monitoring stations should be considered, since they could be deployed much sooner.

The second criterion is the cost of monitoring. Since one of the canonical goals of arms control is saving money, the cost of the monitoring system should be less than the cost that would be incurred by not placing a limit on

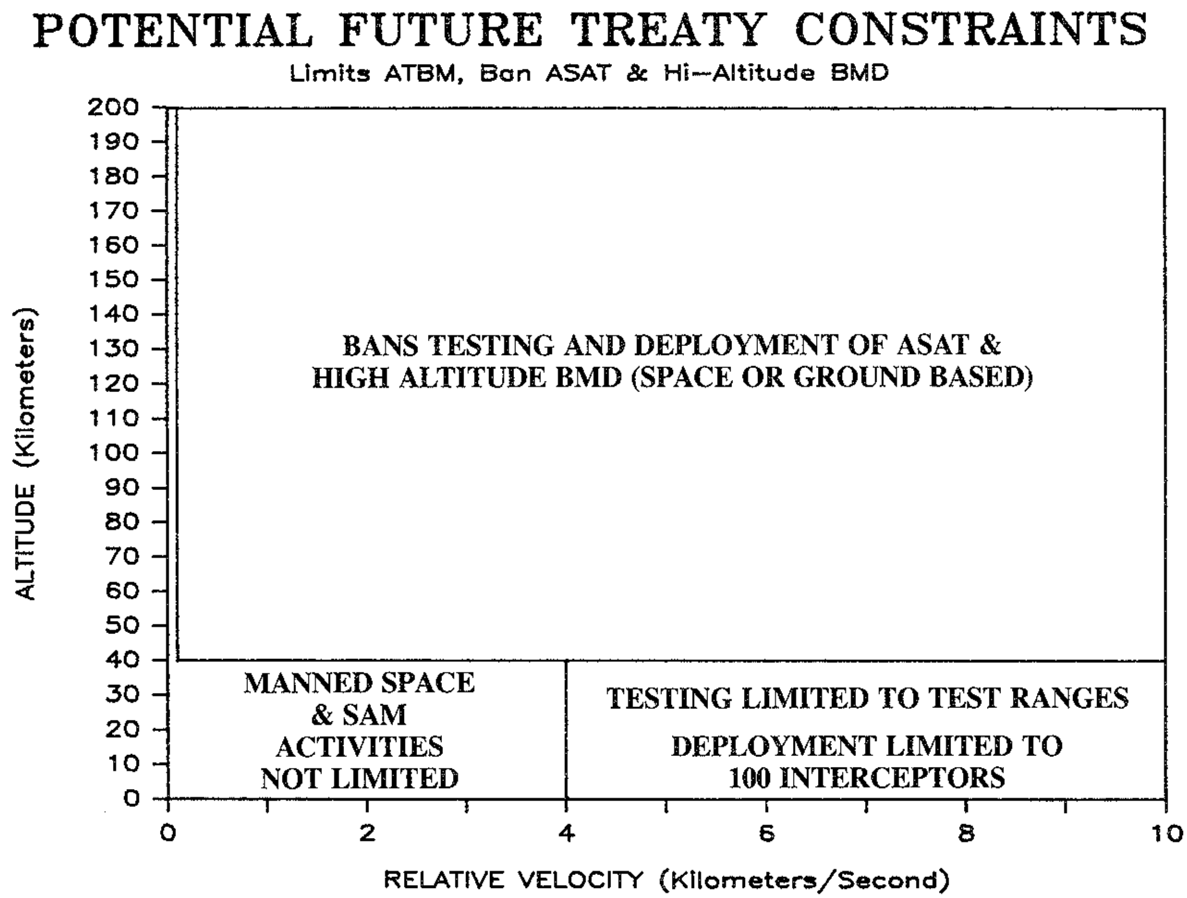
```
 PARAMETER   LASER AVERAGE BRIGHTNESS
:---------:------------------------------------------------------------:
:         :                     Joules / Steradian                     :
:  VALUE  :  10  11  12  13  14  15  16  17  18  19  20  21  22  23  24:
:         :10  10  10  10  10  10  10  10  10  10  10  10  10  10  10  :
-----------+---+---+---+---+---+---+---+---+---X---+---+---+---+---+---:
:THRESHOLD:    NOT ABM CAPABLE     : PERMITTED :     PROHIBITED        :
:---------:+---+---+---+---+---+---+---+---+---X---+---+---+---+---+---:
:LEAD TIME:                        :           :>>>>>>>> 5 YEARS       :
:---------:+---+---+---+---+---+---+---+---+---X---+---+---+---+---+---:
:         :                        :   ##      :                       :
:         :                      1986 MIRACL   :                       :
:         :                        :       ##  :                       :
:         :                        :   1987 ALPHA                      :
:  U.S.   :                        :           :   ##                  :
:   ABM   :                        :       1990'S Free Electron Laser  :
: SYSTEMS :                        :           :       ######          :
:         :                        :           :   SDI Long Term Goal  :
:         :       ###              :           :       ######          :
:         : 1984 X-Ray Laser       :         1991 X-Ray Laser Goal     :
:---------:+---+---+---+---+---+---+---+---+---X---+---+---+---+---+---:
: SOVIET  :                    ########????    :                       :
:   ABM   :                 SARY SHAGAN LASERS :                       :
: SYSTEMS :                        :           :                       :
:---------:+---+---+---+---+---+---+---+---+---X---+---+---+---+---+---:
:  U.S.   :             xx    xx   :           :                       :
:   NON   :Army Test 1975     Air Force Airborne Laser  1983           :
:   ABM   :           xxx          :       xxxxxx                      :
:MILITARY :Submarine Laser Communications  Excimer Laser ASAT 1990's   :
:---------:+---+---+---+---+---+---+---+---+---X---+---+---+---+---+---:
: SOVIET  :                 ?????? :           :                       :
:   NON   :            Airborne Laser Lab      :                       :
:   ABM   :            xxxxxxx???????????      :                       :
:MILITARY :                 Dushanbe           :                       :
:---------:+---+---+---+---+---+---+---+---+---X---+---+---+---+---+---:
:         :xxxx                    :           :                       :
:CIVILIAN :Laser Communications    :           :                       :
:  USES   :        xx              :           :                       :
:         :  Soviet Phobos probe   :           :                       :
:----------------------------------------------------------------------:
```

LIMIT 1—LASER BRIGHTNESS

Directed energy systems such as lasers should have a limit of 10 to the 19th power Watts and Joules per Steradian on their peak and average brightness, which is a function of the laser's power and energy, as well as the laser's wavelength and the diameter of the primary beam director mirror. Brightness is the most useful measure of a laser's performance. Brightness levels needed for effective ABM systems would probably be hundreds or thousands of times higher than the proposed threshold. Even though the maximum brightness of American military lasers has increased at the rate of a factor of 100 every five years since the early 1970's, the proposed threshold would provide a five to ten year lead-time protection. The minimum brightness level required for ABM purposes is about 10 to the 16th power Watts per steradian, and no other applications require lasers of this brightness, except for anti-satellite weapons. However, lasers of such brightness may be relatively small and difficult to identify. Verification of such a limit would probably require the use of non-intrusive in-country monitoring stations located near identified or suspected laser facilities.

the activity in question.

And third, technical collection systems should not be so capable that they reproduce the anti-missile systems that they are intended to limit. Large space-based infrared telescope sensors used for verification may be difficult to distinguish from sensors that would form the basis for an ABM battle management system. It would be perilously paradoxical if it were necessary to develop or deploy



LIMIT 2—INTERCEPTOR KINEMATICS

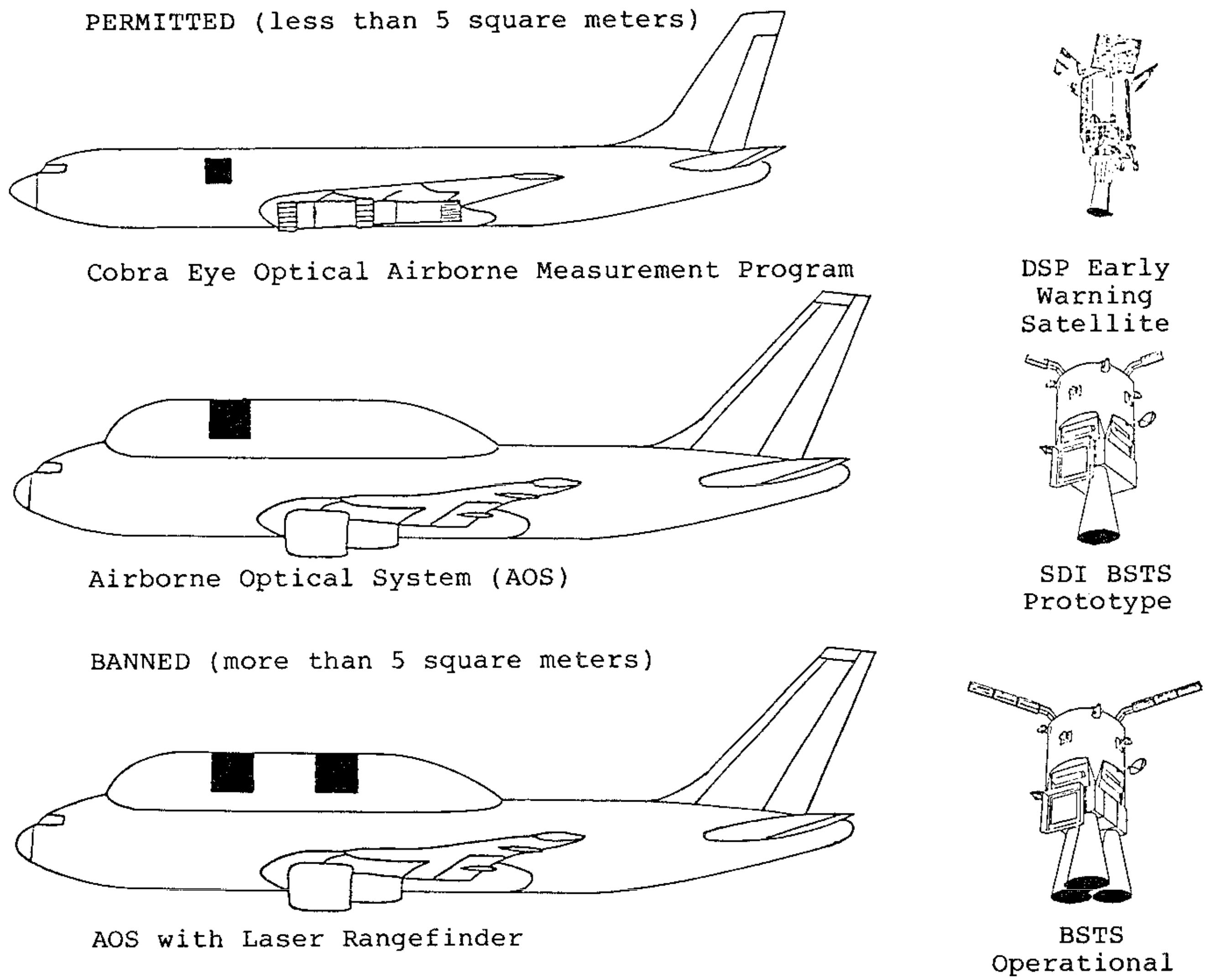
A ban on the testing of ABM interceptors (defined as the approach within 10 kilometers at a relative velocity in excess of 10 meters/second) above an altitude of 40 kilometers would preclude the further development exo-atmospheric interceptors for area defense. This would also ban effectively anti-satellite weapons. Systems tested below 40 kilometers with a relative velocity in excess of 4 kilometers/second would be subject to the deployment limits of the Treaty, thus reducing concerns about the strategic implications of anti-tactical ballistic missile systems, while permitting testing of short-range endoatmospheric ABM interceptors. The 10 meters/second threshold would permit the rendezvous and docking of manned spacecraft, since such vehicles have very low closing velocities during the final several hundred kilometers of the rendezvous. Such a threshold could be monitored by national technical means.

reasonable facsimiles of an anti-missile system to verify limits on the development or deployment of such as system.

In some cases verification may require the use of non-intrusive cooperative measures. While national technical means may be adequate to measure the aperture of the beam-director mirror of a ground-based laser, when not in use such mirrors are normally screened from the environment by a moveable cab or dome, and thus out of sight. Agreement would have to be reached that such screens would have to be temporarily removed on a periodic basis to permit monitoring by national technical means.

Some threshold limits might require more intrusive means of verification. In-country monitoring stations may be needed for the verification of limits on threshold limits on the brightness of lasers. During its passage through the atmosphere a fraction of the energy of a laser beam will interact with the atmosphere, through such mechanisms as aerosol scattering. An automated collection device, stationed a few kilometers from the laser beam director, could observe this scattering, and determine the laser's wavelength. With the addition of some small low power lasers, and other devices, this station could also assess the scattering properties of the atmosphere in the vicinity of the laser, and thus provide the basis for determining the fraction of the laser's power that would be scattered, and thus the brightness of the laser.

Pre-launch inspection of all satellite payloads could determine the presence of a reactor core. This would require placing a radiation monitoring device next to the exterior of each launcher's payload shroud shortly prior to launch. This would not require actual viewing of the satellite, and



LIMIT 3—MIRROR AND WINDOW APERTURE

A limit of 5 square meters (a diameter of about 2.5 meters) on the aperture of ground and space based laser beam director mirrors, space-based sensor satellite mirrors, and the windows on airborne telescope systems, would constrain the ABM potential of all these systems, and could be monitored by national technical means. Although the area of beam director mirrors could vary widely, calculations of the performance of space-based systems typically use areas substantially in excess of 5 square meters. This threshold would usefully constrain space-based lasers, which might pose problems for monitoring a brightness limit. Anti-missile sensor satellites require much larger optical systems than simple early warning satellites. Airborne telescopes need much larger windows on the aircraft than are required for astronomy and intelligence collection.

thus would not compromise the design characteristics of the payload.

And finally, some limits may require creative approaches to verification. It may be difficult to distinguish prohibited anti-missile technologies from benign scientific endeavors. The participation of the international scientific community in the development and execution of projects such as large space-based astronomical telescopes or nuclear powered planetary probes could provide reassurance that they were not being used as a cover for military developments.

LIMIT 4—REACTOR CORE FUEL MASS

A limit of 5 kilograms on the mass of Plutonium 239 or Uranium 235 launched into orbit on a satellite would preclude the use of reactors to power space-based ABM sensors. This could be verified by pre-launch inspection of satellites by radiation monitors. Exceptions could be made for scientific spacecraft, verified through international participation in the project.

LIMIT 5—RADAR DEPLOYMENT

A limit on the total number of permitted large-phased array radar transmitter faces (perhaps the fifteen that both Parties appear to plan) as well as specification of the distance from the national border (for instance 350 kilometers) that construction is permitted and specification of what constitutes a spacetrack radar would resolve the Krasnoyarsk and Fylingdales issues. Lowering the Treaty's power/aperture product threshold definition of an ABM radar by a factor of ten from 3,000,000 to 300,000 would lessen concerns about anti-tactical ballistic missiles.

LIMIT 6—ANNUAL MASS LAUNCHED INTO ORBIT

Agreement not to place more that 300 tons of payload into orbit each year would permit both Parties to conduct current and projected space projects, while providing reassurance that a space-based defense was not being covertly deployed.

This PIR is based on a 200 page staff study by FAS Associate Director for Space Policy John Pike. To obtain a copy of the study send $20.00 to Cely Arndt, FAS, 307 Massachusetts Ave., N.E., Washington, D.C., 20002.

FAS COUNCIL ELECTION AND CHANGES IN FAS STAFF

Six new Council members were chosen in the 1987 FAS election. These new members are: Julius Axelrod, Nobel Prize winner, currently at the National Institute of Mental Health; Deborah Bleviss, Executive Director, International Institute for Energy Conservation; Dudley R. Herschbach, Nobel Prize winner, Professor of Science, Harvard University; Art Hobson, Professor of Physics, University of Arkansas; Stephen H. Schneider, Deputy Director, Advanced Study Program, National Center for Atmospheric Research; and Robert A. Weinberg, Professor of Biology, Massachusetts Institute of Technology. They replace outgoing Council members Harrison Brown (deceased), Carl Kaysen, Jessica T. Mathews, Arthur H. Rosenfeld, Lynn Sykes, and Archie L. Wood.

Serving the second year of two-year terms, Matthew Meselson will continue in his capacity as Chairman, and Andrew Sessler will retain the post of Vice-Chairman.

The fund raising campaign designed to provide a staff member to work on biological and chemical warfare issues resulted in the addition of Gordon Burck as Staff Associate for Chemical and Biological Warfare. He will analyze issues involved in the chemical weapons procurement and biological weapons defense programs.

Bradley Cohen has been replaced by David Feltman as Legislative Liaison for the Federation. David has extensive experience working on Capitol Hill where he served on the staff of three members of Congress.

Ned Hodgman has left the Federation after working for a year on the U.S.-Soviet Exchange Project. The author of an FAS booklet on exchanges, *Raising the Rate of Exchange*, Ned was instrumental in helping stimulate renewed interest in Congressional exchanges. Cely Arndt is now the contact staff member for the project.

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