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MOSCOW'S MANY PROBLEMS IN COUNTERING A U.S. STRATEGIC DEFENSE SYSTEM

INTRODUCTION

Whether the United States should change its strategic nuclear policy to incorporate ballistic missile defense (BMD) may be the critical strategic, diplomatic, and technological issue of the decade. Since Ronald Reagan announced, on March 23, 1983, the initiative to research the feasibility of rendering nuclear weapons obsolete, BMD supporters and opponents have been girding for battle. A prominent aspect of this is Moscow's ability to develop countermeasures to reduce the effectiveness of a U.S. BMD system. Opponents of the Reagan Strategic Defense Initiative (SDI) argue that an American missile defense almost surely will be foiled by Soviet systems. SDI backers disagree, maintaining that the potential effectiveness of such countermeasures is greatly exaggerated.

Countermeasures cover a broad technological spectrum and fall into three principal categories: 1) countermeasures to destroy the U.S. BMD system; 2) countermeasures to protect Soviet offensive weapons from the effects of U.S. defensive weapons; and 3) the proliferation of Soviet offensive systems to saturate the U.S. defense. Some combination of the three also could be devised. Examples include increasing the acceleration of Soviet ICBM boosters to avoid U.S. space-based lasers or direct attack on the U.S. BMD system itself.

Trends in technological development indicate that likely Soviet countermeasures are not as easy to develop or as effective as their proponents would suggest. These countermeasures, moreover, involve high risks and/or high costs. As such, the countermeasures would have such slim chances of defeating U.S. ballistic missile defenses that the Kremlin would not have a high level of confidence in their nuclear forces' ability to fulfill the military missions assigned to them. In particular, even relatively inefficient U.S. defenses could still deter or protect U.S. military sites against proliferation of Soviet missiles or warheads since Moscow could not be certain that any specific targets would be hit.

It thus seems unlikely that the Soviets would vigorously develop and deploy such countermeasures or gain any significant advantage if they did.

ELEMENTS OF A BMD SYSTEM

A U.S. BMD system might consist of many--or just a few--weapons.[1] System components could be based in space, on land, at sea, in the air, or in all four environments. A multi-layered system could utilize a number of different mechanisms to attack incoming Soviet missiles or warheads. Many kinds and combinations of Soviet countermeasures, therefore, can be imagined to destroy or overcome any part of the potential U.S. missile defense system.

While the precise shape of an effective ballistic missile defense system is unknown, certain elements are sure to be included. They are:

- <u>Sensors</u> to detect an attack, track targets, and help discriminate real targets from decoys;
- <u>Computers</u> to calculate flight trajectories, determine appropriate targets, command attacks, assess the success of an attack on a target, and perform many other tasks;
- <u>Communications links</u> to ensure that each part of a BMD system "knows" what the other parts are doing;
- <u>Weapons</u> with which to "kill" a ballistic missile, a post-boost vehicle, or warheads in their flight trajectory.

The most effective BMD system probably will use several types of weapons to intercept Soviet missiles, post-boost vehicles, and

1. Since no actual U.S. strategic defense "system" has been defined with any precision, any discussion about how to defeat any or all of the critical components of a ballistic missile defense system must of necessity be rather general.

warheads, and deploy them in ways that allow interception in all phases of flight.[2] Such types of BMD weapons include: directed energy weapons which kill through heat or pulse (such as lasers, particle beam weapons, and microwave weapons), kinetic energy weapons (so-called smart rocks) which destroy their targets through direct collision at very high velocity, and nuclear weapons which kill through blast or radiation effects (such as the old U.S. Sprint and Spartan missiles with nuclear warheads).

POSSIBLE SOVIET METHODS OF REDUCING U.S. BMD EFFECTIVENESS

A successful Soviet attack on enough of the key elements of a U.S. BMD system could prevent the entire system from intercepting and destroying approaching Soviet ballistic missiles, post-boost vehicles, and warheads.

Direct Attack on Defense

Moscow may try to develop weapons for direct attack on U.S. ground systems, either through sabotage or nonballistic missile nuclear attack. Some U.S. BMD systems might be based mainly on earth. These include terminal defenses or large short wavelength lasers used for boost phase and post-boost phase interception. Space-based BMD systems, moreover, will require an earth-based link for battle management, command, control, and communication ($BM\text{-}C^3$). Destruction of the BMD weapons or critical $BM\text{-}C^3$ assets could cripple a U.S. BMD system. U.S. BMD systems designed to destroy incoming Soviet nuclear warheads thus must possess self-defense capabilities. Soviet efforts to exhaust self-defense by saturating a BMD system with a large number of warheads could be offset by improving the U.S. system rate of fire and kills per shot or providing more interceptors.

Defense against Soviet sabotage is a problem only marginally related to BMD; base security is a problem common to all military installations. To defend against terrorist attack or nuclear attack, system components could be made mobile.

Soviet directed energy weapons (DEWs) that are space-based, ground-based, or "popped up" from the ground to space could destroy

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2. Flight phases of offensive ballistic missiles and their warheads include: boost (from take off until the missile burns out (about 5 minutes)), post boost (during which a "bus" that has been carried into space and separates from the missile distributes warheads and decoys (2 to 4 minutes)), mid-course (during which warheads and decoys coast along their trajectories(about 20 minutes)), and terminal (during which the warheads reenter the atmosphere while the lighter decoys burn up upon reentry (about 60 to 90 seconds).

space-based U.S. BMD assets such as surveillance satellites, command and control satellites, or the BMD weapon carriers themselves. These DEWs could be long or short wavelength lasers, or nuclear-pumped X-ray lasers.

Space-based BMD assets, however, can be hardened to protect against the effects of DEWs, albeit at some expense. Once under attack, BMD weapons in space would have some ability to shoot back at their space-based attackers.

Kinetic energy weapons also could destroy U.S. space-based BMD components. Such weapons include direct ascent anti-satellite (ASAT) weapons which can leave smaller signatures, accelerate faster, and have shorter boost phase periods than ICBMs. Other weapons would include clouds of fragments dispersed by Soviet satellites and space-based missiles or space mines which would orbit close to their potential U.S. targets, exploding on command.

Current Soviet ASAT weapons are so slow that a U.S. BMD weapon could shoot at them in the same way as at a Soviet ICBM booster.[3] The U.S. BMD weapon also might be able to maneuver out of the way of Soviet ASATs. Defense against future direct ascent ASAT technology would entail designing the space-based BMD system sensors to be sensitive and responsive enough to pick up the plume of the more rapidly accelerating booster and then shoot the attacking weapon.

Space mines pose a more difficult problem. The basic defense is to keep a good deal of space between the U.S. BMD component and a Soviet satellite thought to be a space mine. This can be done through maneuver or by enforcing an announced peacetime "keep out zone"--where any unauthorized satellite or other object that entered would be destroyed by the BMD weapon, or by accompanying defensive weapons.

Nuclear weapons also could destroy or degrade U.S. BMD system components. But U.S. BMD weapons could be equipped with the means to defend themselves from nuclear attack by a rocket-launched system like the current Moscow ABM system. Space-based BMD assets can also be hardened to nuclear blast and radiation effects.[4]

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3. The current Soviet ASAT system is launched atop a modified SS-9 booster to chase and catch up to a satellite in an orbit or two, whereupon an explosive device shoots thousands of high velocity pellets at its target.

4. Comments by Angelo Codevilla, at that time a staff member of the Senate Intelligence Committee, in W. Bruce Weinrod, ed., Assessing Strategic Defense: Six Roundtable Discussions (Washington, D.C.: The Heritage Foundation, 1985), p. 38.

SDI SELF-DEFENSE

To protect itself from all forms of Soviet attack on a BMD system, the U.S. could proliferate the system's components. It generally would be better for the U.S. to deploy 2,000 small carriers to "kill" attacking Soviet warheads than to deploy 50 huge ones. Similarly, many sensors are better than a few, and many smaller computer nodes are better than a couple of large, very powerful computers. Proliferation and storage of BMD components in less vulnerable locations also allows reconstitution of space assets that are destroyed.[5]

Another means by which the U.S. could defend its BMD system is deception. This includes hiding from an attacker or confusing the attacker's sensors. Soviet tracking of U.S. BMD satellites is not the easy task claimed by critics of strategic defense. Satellites can use stealth technology to reduce their radar signatures and can be placed into remote orbits, thus increasing the volume of space that must be searched and the radar power needed to find them. Until needed, they can remain "silent," sending no signals to earth. Periodic orbital maneuvers, moreover, can change the course of a satellite.

These measures are generally not available to offensive systems. During its boost phase, for instance, an offensive missile generates a massive amount of heat that cannot be hidden. The operational requirements of an attack impose serious constraints on the shape and material composition of components, which limit their ability to exploit stealth techniques. The trajectory of the buses and warheads carried by offensive missiles is also limited. None of these constraints affect the defense.

Another potential U.S. counter-countermeasure is the use of a non-Keplerian orbit--an orbit that is irregular and thus predictable only to those commanding the orbital changes. Except for minor variations due to such things as solar winds, satellite orbits are normally very predictable, allowing an attacker to plot the future location of a satellite. Periodic orbital maneuvers are useful, but use extra fuel, thereby increasing weight and expense. If BMD satellites used solar-powered ion engines, continuous but low thrust could be applied to the satellite with a varying thrust vector to make the satellite passage through space non-Keplerian. This would make it virtually impossible for a Soviet attacker to predict the path of a U.S. satellite, even though its position would be known at all times

5. Reconstitution of destroyed space assets with spares on the ground, however, must not be the primary means of ensuring the survivability of those space assets. Enough of a BMD system must survive an initial attack on its components to perform its mission effectively without relying on spares, since in most cases there would be no time to reconstitute the system before the arrival of the ballistic missiles the system is supposed to intercept.

to its operator. The result would be that Soviet countermeasures would be increased manyfold, with similar cost consequences, to make up for the increased time during the attack mode which would be devoted to searching for the SDI targets.

All of the Soviet measures against a U.S. BMD system considered above, of course, would give the U.S. advance warning of a Soviet nuclear strike. Most of the U.S. retaliatory forces thus would be either launched or placed on very high alert before the Soviet warheads arrived at their targets, and the purpose of the precursor attack would have been defeated.

SOVIET DEFENSE OF ITS OFFENSIVE SYSTEMS

There are a number of ways by which Soviet offensive systems could be made less vulnerable to the effects of a U.S. defense. All, however, suffer from important weaknesses. Among the Soviet options are:

Adjusting offensive tactics. Firing a very high number of missiles at once is the most serious option. But this is not a new problem for U.S. planners. Current Soviet doctrine for destroying U.S. ICBMs in their silos calls for high rates of fire anyway. Any U.S. BMD system design thus would have to account for this "worst case".

Concentrating offensive forces geographically. The Soviets could move all of their offensive missiles to a relatively small area rather than having them spread out over many thousands of miles as at present. This would then have the effect of diminishing the number of BMD weapons that could counter the missiles during a simultaneous launch. The U.S. could counter this with more BMD satellites. In any event, the cost to the Soviets of concentating their missiles would be prohibitive since they would have to build an almost entirely new ICBM basing scheme. The directed energy weapons can also counter missile concentration by attacking Soviet missiles in space from further than optimal range by increasing the amount of time spent attacking each missile with lasers. In addition, missiles and warheads start to disperse when they travel toward disparate targets, which in itself tends to negate the advantage of geographic launch site concentration since other satellites and ground based weapons come into play. Finally, geographically concentrated attacks could be defeated by U.S. BMD systems, such as the X-ray laser, in which a nuclear explosion provides the energy for up to 50 lasing rods at once, each of which would generate a beam of energy capable of destroying a missile.

Preferential offense. This technique would increase the number of weapons allocated to targets of the highest priority to ensure that at least one warhead would get through the defensive system for each such target. Because this would require Moscow to fire a great number of missiles at each such selected U.S. target, the total number of targets thus would be reduced. Furthermore, U.S. boost phase and post-boost phase interception systems could disrupt an attempted Soviet preferential offense attack, as these systems would shoot at all missiles and their warheads regardless of intended targets. The number of attacking warheads eliminated by the BMD system would be the same as if preferential offense were not used. However, fewer targets would be hit simply because fewer sites had been targeted.

Offensive Missile Self-Protection. The Soviets could use special ablative coatings to reduce the vulnerability of their boosters to U.S. long wave lasers that destroy missiles by heating their skin to the point of structural failure. It is not clear, however, if such coatings are very effective. U.S. laser power levels could be increased, for example, or the U.S. could reduce the "spot size" of its laser beam, thus increasing the power density at the missile's surface. Ablative coatings, moreover, would do little to reduce the effectiveness of free-electron and X-ray lasers, which destroy their targets not by heat but by a destructive shock. U.S. kinetic energy weapons also would remain unaffected by ablative shielding.

Hardening against electromagnetic impulse (EMP). While this is possible, the U.S. could generate higher EMP levels with weapons that explode and destroy Soviet weapons at close range.

Shielding. This means coating a Soviet booster with materials that would protect it against U.S. X-ray lasers. This laser, however, would destroy part of the shield, creating fragments that would strike and destroy the booster.

Lead shielding. This measure against the effects of neutral particle beams also is impractical. The shielding required to protect only the sensitive parts of the booster and warheads would weigh so much that little payload weight would be left for the warheads themselves.

Spinning. By literally spinning the booster, the area hit by a U.S. thermal kill laser would be enlarged about three times. This would then effectively triple the amount of time that U.S. laser weapons would need to destroy the same number of boosters. This spinning technique, however, would be ineffective against pulsed lasers or kinetic energy weapons. In fact, the almost random nature of hits from a pulsed laser on a spinning booster might actually enhance the prospects for a laser hitting a vulnerable part of the Soviet booster.

Shining. Soviet boosters could be designed to "shine," or reflect laser light. How effective this would be is uncertain. Passing through the atmosphere (polluted by rocket exhaust, among other things) at high temperature would reduce the Soviet booster's ability to reflect laser light. Even if the reflectivity survived passage through the atmosphere, shining still might not be effective. Short wavelength lasers, such as X-ray lasers and excimer lasers, are reflected less well by shined boosters than are chemical infrared lasers. Furthermore, high power, very bright lasers induce a phenomenon known as "enhanced coupling," which further reduces a missile skin's reflectivity. In effect, the energy "couples" with the surface more rapidly because, when such a laser beam strikes a highly reflective surface, it degrades the surface slightly, which then absorbs the laser energy more efficiently. This further degrades the surface, and so on, until the skin is deformed or punctured and the missile is destroyed. Finally, shining would not protect the Soviet booster from U.S. kinetic energy weapons, EMP, or from particle beam attack.

DEGRADING U.S. SENSORS AND COMMAND, CONTROL, COMMUNICATIONS AND INTELLIGENCE LINKS

These Soviet measures would be the primary means of countering U.S. kinetic energy weapons, since no amount of shielding can protect missiles or warheads from a very high velocity collision (up to 20,000 miles per hour).

Nuclear detonations. Moscow could detonate nuclear devices in an effort to impair the ability of U.S. sensors to detect and track Soviet missiles. Nuclear detonation in the atmosphere, however, would not affect U.S. midcourse sensors, which detect post-boost vehicles ("busses") and warheads flying through space. Soviet nuclear detonations during the terminal phase of a missile attack would have minor impact if the U.S. widely dispersed the radars used by its BMD system. Some radars, for example, could be positioned to detect warheads arriving behind a nuclear blast. Nuclear detonations shortly after the launch of Soviet missiles would disturb the upper atmosphere, thus distorting the U.S. sensor's perception of the exact location of other oncoming Soviet boosters. The U.S. could adjust to this by using sophisticated algorithms in the on-board U.S. computers when targeting Soviet boosters.

Soviet nuclear detonations in space could also be countered by hardening the U.S. BMD system's electrical components to radiation effects (as is done for many military systems) and to electromagnetic pulse effects. If the Soviets used nuclear bursts to blind BMD sensors, the U.S. could use very narrow band wavelengths to scan for the known radiation signature of the Soviet booster. It could be detected because its particular frequency band would be much stronger than the background radiation of a nuclear explosion.

Shining laser beams. Moscow could try to blind U.S. light sensitive optical sensors by directing a laser beam at the satellite from a ground, air, or space platform. The U.S. could counter this "laser blinding" in a number of ways. First, U.S. sensors could be constructed to filter incoming light into a number of narrow and widely separated frequency bands. A laser, which by its nature always operates at a single wavelength, would be able to penetrate only one of the sensor's filters. Although this portion of the sensor might be blinded, the other portions would not be.

The sensor electronics also could be constructed to limit automatically the amount of energy that could get to sensitive components. Or a companion sensor designed to detect laser light could shut down the sensor for the duration of the laser attack. Finally, the sensor could operate during discrete portions of each second, remaining on long enough to detect targets but off enough to reduce the probability of damage from pulsed lasers.

Generally, techniques aimed at confusing one particular sensor can be overcome by using combinations of sensors. Example: corner reflectors to confuse laser radars would fail if the defense used an active laser radar and correlated those images with data collected by a passive infrared sensor that detected the booster plume. Non-destructive materials (chaff) might confuse U.S. radars during the midcourse phase, but would not fool infrared sensors.

Jamming U.S. ground-to-satellite or satellite-to-satellite communications. This could be rendered ineffective if the U.S. used very high power levels and very narrow beam widths.

Spoofing. This involves the enemy sending signals to a U.S. satellite which would, in effect, give the enemy control over its actions. Spoofing, however, would be virtually impossible to achieve if the U.S. took such precautions as ensuring that the satellite command links are properly secure through the use of encryption devices.

Using decoys to fool sensors. The Soviets could launch a great number of decoys that imitated the characteristics of real warheads or boosters. The goal of the decoys would be to overwhelm the U.S. battle management capacity or the number of interceptions available to the BMD system. While it is often asserted by critics of BMD that the use of effective decoy boosters and warheads would be a simple and inexpensive measure for Moscow, in reality it would be very difficult. A warhead decoy, for example, must simulate the size, shape, flight characteristics, temperature, and the electromagnetic signature of a real warhead well enough to fool very sophisticated high-speed computers attached to a multitude of sensors viewing the decoys in all parts of the electromagnetic spectrum. During the midcourse phase of flight, the computers would have 20 minutes to make the billions of calculations needed to distinguish real warheads from decoys.

Typical decoys might use lightweight "balloons," only some of which would contain real warheads. The U.S could counter this by observing the effect of relatively low-powered laser pulses on the balloons. Those with warheads would not recover from the impulse as quickly as an empty balloon, which also would be moved more.

The Soviets also could try to use a booster decoy, a rocket with no warheads or penetration aids. But because it would have to be large enough to mimic the heat signature of ICBMs, it would cost a good deal. Since basing ICBMs in silos is very expensive because of hardening requirements, the only feasible basing for such decoys is above ground. But then, an effective defensive system would be able to identify the Soviet decoys even before launching.

Avoiding the defense. The Soviets may attempt to avoid boost-phase U.S. BMD components. Fast-burn boosters, for example, could reduce the boost time of a Soviet missile from the current three to five minutes to as little as 50 to 60 seconds. If launched on a depressed trajectory, the missile could conclude its boost phase while still in the atmosphere, thus avoiding attack by U.S. boost-phase systems that cannot penetrate the atmosphere.

What complicates this tactic is that fast-burn boosters would be somewhat less reliable than ordinary boosters, would require a heavy ablative coating to absorb the heat generated by their own ascent, and would be less accurate because of the buffeting in the atmosphere. In addition, the extra weight of the coating means that fewer warheads can be carried by the missile. However, if these problems could be resolved, fast-burn boosters could present problems for a U.S. defense.

The Soviet missiles, of course, would remain vulnerable after their fast-burn boost. The post-boost vehicle carries all the warheads and decoys. Though the bus becomes a less valuable target as it distributes its warheads, multiple warhead "kills" could still be achieved virtually up to the end of its flight.

To avoid attacks on the bus, the Soviets might seek to eliminate the post-boost phase altogether by distributing warheads in the atmosphere on ascent or by providing each warhead with its own costly small guidance system to maneuver on its own trajectory. If the warheads are released in the atmosphere, no lightweight decoys can be released because of atmospheric drag. The same atmospheric drag would tend to degrade warhead accuracy. If each warhead carried its own small guidance system, the additional weight would displace a substantial number of warheads that otherwise could be carried.

Proliferating Offensive Missiles and Warheads. Since effective decoys are expensive and difficult to build, some BMD critics have suggested that the Soviets might simply increase vastly their boosters and warheads. As with possible proliferation of decoys, the goal would be to overwhelm the battle management, command, control, and communications system of a U.S. BMD system or to force it to exhaust its interceptors. BMD critics argue that Moscow's two active ICBM production lines could expand the Soviet ICBM arsenal rapidly and that the existing Soviet ICBMs could carry more warheads than they do now. The SS-18, for example, currently carries 10 to 14 warheads; it could carry up to several dozen.

Proliferation in this manner, however, probably would not be very effective in overcoming even relatively inefficient U.S. defenses. The U.S. would be able to destroy attacking Soviet missiles and their warheads essentially at random; Moscow would have no way of predicting before an attack which of its missiles and warheads would penetrate the defense, and thus which of its targets would be destroyed. Even if the Soviets doubled or tripled their warheads in response to a 50 percent effective U.S. BMD system, Moscow still would face grave uncertainty. The Kremlin would not have the high degree of confidence it presumably seeks in Soviet ability to destroy U.S. retaliatory forces. Some targets, of course, would receive many times the number of Soviet warheads needed to destroy them. This would be a very inefficient and costly use of resources from the perspective of a Soviet military planner.

Preliminary calculations at Lawrence Livermore and Los Alamos National Laboratories reveal that the number of U.S. BMD satellites carrying weapons would have to be increased by only about the square root of the number of missiles added by the Soviets in order to continue defending against Soviet attack. According to Dartmouth physicist Robert Jastrow, a former NASA physicist and founder of the Goddard Space Flight Center, if a typical BMD system providing an 80 percent effective defense required 100 satellites to defend against the current level of 1,400 Soviet ICBMs, the system would need only 200 satellites if the Soviets deployed an additional 5,600 missiles and silos. In other words, Moscow would have to increase its missiles and silos by five times merely to maintain the relatively ineffectual level of damage capability they had against the undoubled U.S. defense.[6]

SOVIET COUNTERMEASURES TO BMD: A BALANCE SHEET

1) While some countermeasures would be more successful than others, none of them would give Moscow the certainty that would be desirable when contemplating a first strike designed to destroy U.S. nuclear forces. In the absence of such certainty, Moscow is

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6. Robert Jastrow, "The War Against Star Wars," Commentary, December 1984, p. 22.

considerably less likely to launch such an attack.

2) Virtually all the potential countermeasures would impose penalties on Soviet missile systems of significant additional cost, increased weight, and/or diminished accuracy. Cost penalties reduce the number of missiles that can be fielded economically, weight penalties reduce the number of warheads that a missile can carry, and accuracy penalties reduce the ability of the Soviets to destroy U.S. military targets.

3) A number of possible Soviet countermeasures undermine each other. Example: Shielding boosters and sensitive components with lead and ablative coatings increases their weight, requiring them to carry fewer warheads and penetration aids. This would undermine the Kremlin's option of increasing warheads and penetration aids to swamp a U.S. BMD system.

4) Many of the countermeasures might work against individual defensive technologies, but not against a sophisticated U.S. defense that used multiple technologies deployed in several layers.

5) Many of the countermeasures would require tremendous expense for Moscow in redesigning its missile force.

6) The purpose of many potential Soviet measures would be to counter a U.S. BMD system that would not be built for many years. In the absence of knowledge as to the exact direction of the U.S. program, the Soviets would not know precisely what essential technical features to incorporate in their missile force.

CONCLUSION

Critics of the Reagan Strategic Defense Initiative often assert that Soviet countermeasures easily could defeat any U.S. defensive system now conceivable. The facts, however, contradict these assertions, and dogmatic claims that strategic offense inevitably will defeat strategic defenses are clearly unjustified. Every potential Soviet countermeasure suffers either from a serious disadvantage or from the U.S. ability to develop counter-countermeasures.

A Soviet direct attack on a U.S. BMD system, moreover, is very unlikely, for it would give advance notice of a Soviet attack on the U.S. mainland. A Soviet strategy of reducing U.S. BMD system effectiveness through tactical and technical innovation in offensive

ICBMs is also unlikely unless the cost tradeoff clearly favors the offense. Early indications are that cost ratios are shifting in favor of defensive systems.[7]

In light of the difficulties in overcoming a U.S. BMD system solely through offensive technical innovation and the risks associated with forcibly preventing deployment, the Soviet leadership is likely to favor other strategies to counter U.S. BMD development. This is already evident in such current Soviet activities as:

- o Soviet BMD programs, funded at much higher levels than Reagan's SDI, have progressed so far that Moscow now has the ability to deploy rapidly a modestly effective nationwide defense against ballistic missiles,[8] and funding for research on advanced technology BMD weapons is lavish. The deployment of a Soviet BMD system, in the absence of a deployed U.S. system, could guarantee Soviet strategic superiority. It even could give Moscow enough power of intimidation to stop U.S. BMD deployment.

- o The development and deployment of Soviet "air breathing" weapons, such as bombers and cruise missiles, have put the Soviets in a good position to adopt an "end run" strategy that no longer relies on ballistic missiles that are potentially vulnerable to U.S. defenses. The U.S. might then have to deploy air defenses. However, even without such defenses, a nuclear balance based on bombers and cruise missiles would result in greater strategic stability. The relatively low speeds of these weapons make them ill-suited for a disarming first strike.

- o Soviet propaganda, coupled with complaints to U.S. allies and carefully crafted arms control positions, is an effort to generate political opposition to the U.S. SDI program. This would be a very low-cost, low-risk effort that the Soviets are likely to continue.

These approaches may be more promising to Moscow than attempts to devise technical countermeasures to a U.S. strategic defense system. To be sure, U.S. and other Western officials and analysts must

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7. The cost ratios between offense and defense have been addressed by Francis Hoeber in Heritage Foundation Backgrounder No. 442, July 5, 1985, "In the Key Battle of Comparative Costs, Strategic Defense is a Winner."

8. See David Rivkin and Manfred Hamm, "In Strategic Defense, Moscow is Far Ahead," Heritage Foundation Backgrounder No. 409, February 21, 1985, for a further description of Soviet strategic defense activities.

consider possible Soviet reactions to U.S. BMD development and deployment. These include the possibility that Moscow will attempt to expand its strategic offensive forces to overcome a U.S. strategic defense system as well as to develop technical countermeasures that exploit potential vulnerabilities of a U.S. BMD system. But today's American strategic defense systems designers are at least as aware of potential Soviet countermeasures as are SDI critics. Indeed, a number of possible U.S. counter-countermeasures already have been identified. Then, too, many Soviet countermeasures will not be effective. And virtually all Soviet attempts to evade or disable U.S. strategic defenses carry such high financial and other costs that their appeal is reduced significantly.

The technologies and economics of strategic defense have not yet been fully explored. As such, firm conclusions about the ultimate feasibility of an effective U.S. ballistic missile defense remains to be determined. Yet the technologies being spurred and investigated by Reagan's Strategic Defense Initiative show great promise of overcoming potential Soviet countermeasures and being able to provide significant levels of protection. Rather than prejudge the matter, critics of SDI should allow research and analysis to resolve objectively the technical issues of whether or by how much SDI is susceptible to Soviet countermeasures.

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