## ISSUES IN STRATEGIC DEFENSE

# SECURITY REQUIREMENTS FOR THE 1990s

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# SDI:

# Making America Secure

*On March 23, 1983, President Reagan asked American scientists to take a fresh look at the possibilities for defending America from attack by ballistic missiles, in the light of the new technologies of defense and an altered global balance of military power. SDIO—the Strategic Defense Initiative Organization—was established in response to his call.*

*On the eve of the fifth anniversary of the President's speech, the editors of* NR *put a number of key questions relating to SDI to the Technical Panel on Missile Defense of the George C. Marshall Institute. The questions begin with the basics—Do we need SDI? Is there no good alternative? Will the Soviets pre-empt if we start to deploy?—and go on from there.*

*People say the doctrine of nuclear deterrence has kept the peace since World War II. If that's true, what's so important about SDI?*

A little history is useful in answering this key question. In 1956, Khrushchev threatened to intervene in the Suez crisis. In 1973, Soviet leaders prepared to send troops into the Middle East. In both cases, the United States was able to stand off the Soviets with threats of nuclear reprisal.

But in 1979, when the Soviets invaded Afghanistan, the U.S. no longer dared to respond with a nuclear alert. President Carter withdrew from the Olympics instead. By that time, U.S. nuclear forces had been checkmated by the Soviet missile buildup. Technical advances in weapons further eroded the U.S. nuclear deterrent.

Several factors contributed to that erosion.

*First,* and most important, during the 1970s, the Soviets built up their ICBM force to massive proportions. It is now an effective first-strike force, with both the *numbers* and the *accuracy* needed to take out all key U.S. military sites, including nuclear command and control centers. If these are knocked out, our nuclear forces will be decapitated and useless, even if the nuclear weapons are still intact.

In 1973 the Soviets had only a few hundred nuclear weapons capable of destroying a hardened military site. But by 1979, the Soviets had more than three thousand such first-strike weapons, suitable for use in a surprise attack against the United States. Today they have some six thousand warheads with this capacity. The U.S. has nine hundred warheads of comparable accuracy and destructive power.

The number of Soviet first-strike warheads is still increasing rapidly. The CIA estimates that by the 1990s the USSR may have more than 12,000 accurate warheads capable of destroying U.S. forces in a surprise attack.

*Second,* nuclear warheads are getting more accurate. One of the newest warheads is accurate within 120 meters. This unprecedented accuracy means that the hundred-odd most important targets in the U.S.—the command and control centers—could be destroyed in the future with relatively small nuclear weapons.

The consequences of this development for U.S. security are potentially catastrophic. Zbigniew Brzezinski points out that while very large nuclear weapons make a first strike "messy and unpredictable," small, accurate weapons "make the dreaded first strike a viable option."

*Third,* the Soviets have assembled elements of a nationwide defense against U.S. missiles. They are nearly ready for a breakout from the ABM treaty. The main missing link is the network of nine huge battle-management radars, which should be completed around 1992.

The Soviet nationwide ABM defense will be effective enough to block a ragged U.S. nuclear response with diminished forces—all the U.S. would be able to launch after a Soviet first strike.

Once the Soviets' nationwide ABM system is completed, the U.S. will not be able to place at risk those targets on which Soviet leaders place the highest value: the Soviet military forces and the lives of the political leadership.

To be sure, the U.S. will always have a few warheads left, after a Soviet first strike, to target on Soviet cities. However, it would be foolish for the President to order a strike on Soviet cities, because that would generate a reprisal against U.S. cities. Contrary to general belief, Mutual Assured Destruction has not been U.S. policy for many years. Our strategy is not to attack Soviet cities. It is to retaliate against a Soviet attack by destroying the Soviet military as an effective fighting force, thus preventing Soviet leaders from accomplishing whatever aims of conquest motivated their attack.

*How do these changes affect U.S. security?*

The doctrine of nuclear deterrence is collapsing. In five to seven years, the U.S. will be vulnerable to nuclear blackmail—if it is not already vulnerable. When that happens—that is, when U.S. vulnerability to a massive Soviet nuclear attack becomes apparent to the world—the Soviets will be seen to have gained "an historic military advantage," according to Robert Gates, Deputy Director of the CIA.

*How widely shared is this alarming view of the Soviet threat?*

Last summer the Joint Chiefs of Staff "validated"—that is, put their stamp of approval on—an evaluation of the Soviet threat for the 1990s put together by the entire intelligence community, including the CIA, Defense Intelligence Agency, and intelligence organizations attached to the three separate armed services.

The Joint Chiefs of Staff judged the erosion of our deterrent—that is, the threat to our retaliatory capability—to be so serious as to warrant moving SDI from the research stage into the development stage. This move from research into development means that the SDI Organization can now begin to test and develop these weapons. This is "Milestone I" in the weapons-acquisition procedures of the Defense Department.

The basis for that important move by the Joint Chiefs is the intelligence community's assessment that our nuclear deterrent has been placed at risk by the Soviets.

*How about the alternatives to SDI? Would mobile missiles allow the U.S. to evade a Soviet first strike?*

Mobile missiles are less vulnerable to a first strike. The accuracy of warheads does not matter if the target has been moved a few miles down the road. The Soviets have come to this conclusion and have developed a new line of ICBMs (SS-24s and SS-25s) that can be deployed on trains and trucks.

However, even if the U.S. follows suit and deploys its own mobile missiles, that will not eliminate the vulnerability of U.S. nuclear command and control centers.

Moreover, residents of rural areas in the U.S. are certain to object violently to the idea of missiles with nuclear warheads rolling along their roads and highways. The U.S. missiles, mobile or not, will end up staying inside the fence on military reservations, where they will remain vulnerable to a Soviet barrage attack.

*What about deterring the Soviets by building a first-strike force to match theirs?*

A buildup of the MX missile force might do this. The MX has a warhead accurate enough to place at risk the Soviet command posts, bunkers for the top Soviet political leadership, and other high-value targets. However, the force of one hundred MX missiles proposed by the current Administration would not be large enough to balance the Soviet threat. With ten warheads per missile, a hundred new MX missiles would place only one thousand warheads in the field, not enough to make an appreciable dent in top-priority Soviet military targets. But five hundred MX missiles, carrying five thousand warheads, might do the job. That would be a first-strike force nearly matching the Soviet force, and as menacing a threat to the Soviets as their ICBMs are to us.

The result would be a Mexican standoff between two adversaries, each armed to the teeth, and each capable of delivering a knockout blow if it could get in the first punch. This would indeed be a balance of sorts, but it would be unstable.

*Then how can we restore American security?*

There is another way: Protect critical U.S. military sites —nuclear command centers, and the like—from a Soviet first strike by shooting down the oncoming Soviet missiles and warheads with intercepting missiles. In other words, protect key sites with an ABM defense. That preserves our capability for effective retaliation, and deters the Soviets from attacking.

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### The Technical Panel on Missile Defense Of the George C. Marshall Institute

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*Edward T. Gerry is the President of W. J. Schafer Associates, a member of the Air Force Scientific Advisory Board, and co-inventor of the gas dynamic laser.*

*Robert Jastrow is the founder and past Director of the Goddard Institute for Space Studies of NASA, first Chairman of NASA's Lunar Exploration Committee, and recipient of the NASA Medal for Exceptional Scientific Achievement.*

*William A. Nierenberg is Director Emeritus of the Scripps Institute of Oceanography of the University of California, San Diego, a member of the Defense Science Board and the National Science Board, and first Chairman of the NASA Advisory Council.*

*Frederick Seitz is President Emeritus of Rockefeller University, past President of the National Academy of Sciences and the American Physical Society, former Chairman of the Defense Science Board, and former Science Advisor to NATO.*

*The Consultant to the Panel, Lt. Col. Simon P. Worden, is Commander of the Space Defense Operations Center, U.S. Space Command, a former special assistant to the Director of SDI, and former Advisor to the Geneva Nuclear and Space Arms talks.*

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*Why didn't the U.S. build an ABM defense in the 1970s when the Soviet missile buildup began to look ominous?*

The problem is that in the 1970s, such a defense would have had to be located on the ground, shooting up at the Soviet warheads as they descended. But such a "ground-based" defense is readily overwhelmed, either by firing so many warheads at it that its inventory of interceptors is used up, or by so-called "structured attacks," such as "laddering down."

"Laddering down" means exploding a string of nuclear weapons over a target, one after the other, at progressively lower altitudes. The first explosion creates a fireball that disables our intercepting warheads and clears the way for the second warhead. That warhead descends through the fireball and explodes at a lower altitude, clearing the way for the third warhead, which is coming right behind it. By the time the third or fourth warhead explodes, the "ladder" has reached the ground, and the target is destroyed.

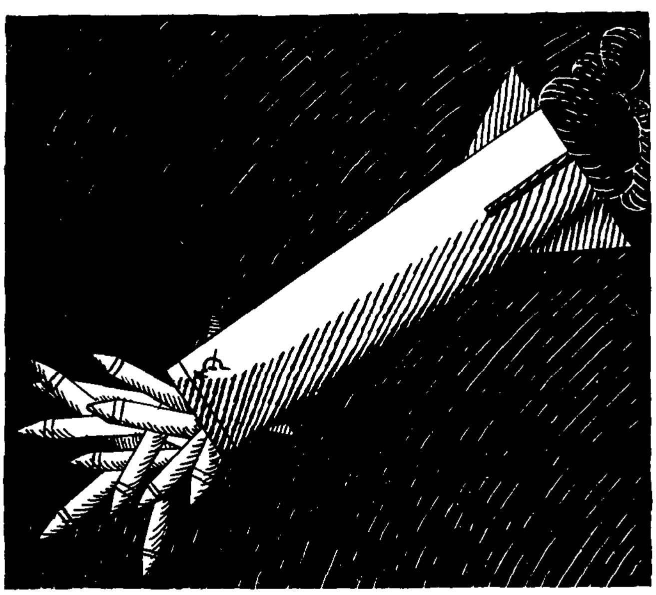
The bottom line is that by means of "laddering down," the Soviets can usually count on three or four warheads to destroy any site, no matter how many interceptors are available to defend it.

Another weak link in the 1970s defense was the network of critically important radars to track oncoming warheads. These radars would also have been located at fixed sites on the ground, easily targeted by the Soviets and vulnerable to destruction in a surprise attack.

*If ground-based defenses against a missile attack can be readily overwhelmed, why is the government pursuing SDI?*

A new technical situation has developed in the last five years, which permits us to get our defenses off the ground and up into space, in orbiting satellites. The development of these "space-based" defenses eliminates the vulnerability of U.S. defenses to "laddering down" and other kinds of structured attacks. In other words, a defense based in space cannot be readily overwhelmed. That means a new ballgame.

Space-based defenses are now possible through a marriage of the technologies of the computer, the satellite, and the heat-seeking "eye" (used so effectively in the Stinger and other air-defense missiles). Tests in space and in the atmosphere have shown that a miniaturized computer, working with a heat-seeking "eye" on a small missile, can steer the missile into the path of an oncoming warhead or ICBM. This combination of the heat-seeking eye and the computer brain produces the so-called "smart bullet."



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The new technologies also make the defense less dependent on large, vulnerable radars. A warhead can be tracked quite well without radar, by a combination of a lightweight heat detector, which finds the direction to the warhead by picking up its warmth against the cold of space, and a low-powered laser range-finder, which measures the distance to it with great accuracy. This equipment is sufficiently small and light to be flown in aircraft or on satellites, less vulnerable to attack than fixed radars on the ground.

Confronted with smart bullets based in space, the Soviets cannot count on the kind of carefully timed attack needed for "laddering down." Laddering down requires very precise timing. The warheads, after a long flight over the Pole or the ocean, must appear over the target, one by one, at just the right time, and with just the right spacing from one warhead to the next.

Even if the Soviet commander assigns special missiles to take out our key military sites by laddering down, he will be uncertain of success, because our space-based defenses may shoot down the very missiles he has assigned to these key targets. That means he cannot count on destroying critical military installations—especially the command centers for U.S. nuclear forces.

**The space-based defense breaks up the timing of the Soviet attack. Then the ground-based defense mops up the remaining warheads. This one-two punch is devastatingly effective in blocking a nuclear attack**

The key to a truly effective defense against Soviet attack turns out to be a combination of the space-based defense and the ground-based defense. The space-based defense breaks up the timing of the Soviet attack. For example, in a laddering-down attack, it takes rungs out of the "ladders"; if a "ladder" loses even one rung, its usefulness is gone.

Then the ground-based defense mops up the remaining warheads. If the U.S. has "eyes in the sky" to see what gets through the first or space-based layer, we can even pick out the warheads that are headed for the most important targets, and concentrate on stopping those. This one-two punch is devastatingly effective in blocking a nuclear attack.

*How widely accepted is the view that the Soviet threat must be countered by a* space-based *defense?*

The "architecture" of a space-based defense backed up by a ground-based defense was presented by the head of SDI to the Defense Acquisition Board, which approved the plan for a two-layer defense using smart bullets. The Defense Acquisition Board controls actual weapons purchases in the Department of Defense. Its approval constitutes recognition by the defense establishment that an urgent military requirement exists for a defense against Soviet missiles, and that this requirement can be met by space-based defenses.

*Isn't it destabilizing for the U.S. to build a defense against Soviet missiles? Won't the Soviets feel threatened?*

The Soviets might feel threatened if a situation developed in which the U.S. had an effective defense against Soviet missiles and the Soviets had no defense against U.S. missiles. But that is not the situation that will confront the Soviets in the 1990s. They have been working on missile defense for 15 years and have a larger SDI program than we do. Secretary Gorbachev said about the Soviet SDI in a television interview just before the December Summit, "The Soviet Union is doing everything the U.S. is doing."

The options available to the U.S. are: Either we go ahead full speed with SDI, in which case each side will have a defense against the other side's missiles in the 1990s; or we fail to deploy SDI, in which case the Soviet Union will have a defense against our missiles, but we will have none against theirs.

**The Soviets might feel threatened if the U.S. had an effective defense against Soviet missiles and the Soviets had no defense against U.S. missiles. But that is not the situation that will confront the Soviets in the 1990s**

*That* would be destabilizing.

*Will the Soviets launch a pre-emptive attack if we start to deploy defenses in space?*

In the near term, they won't attack for the same reason they don't attack the United States at this very moment—namely, because we have an effective deterrent in our ballistic-missile submarines. But by 1995, the Soviets will have completed deployment of their fifth-generation ICBM arsenal, and will also have completed their nationwide ABM defense. At that time, they will have clear military superiority, because they will have the ability to disarm the U.S. by destroying the command and control network for our nuclear forces, while sustaining tolerable or no damage to their own military and industrial base.

If the U.S. has not deployed a space-based defense by that time, the Soviets will be in a position to prevent us from deployment by going on a "yellow alert" and threatening a nuclear attack, as Nixon did in 1973 when Brezhnev started to move Soviet troops into the Middle East. An actual Soviet attack will be unnecessary, since its disastrous consequences for the American nation, and our inability to retaliate effectively, will be so apparent to U.S. leadership.

*Some American scientists say a space-based defense against missiles won't work. Why are you confident that these "smart-bullet" defenses will work in space?*

Smart bullets have been tested with considerable success both in space and in the atmosphere. Two tests of space-based smart bullets were carried out recently. In the first, a satellite equipped with "smart-bullet" capabilities successfully tracked a missile in space, and then homed in on it and destroyed it. This test showed that smart bullets can locate a missile even when the missile is completely enveloped and obscured by the plume of its own rocket.

The most recent test, in February 1988, showed that "smart bullets" can track a "bus" (the vital section of an ICBM that carries all the warheads) even after the missile itself has burned out and fallen away. This capability means that the U.S. defenses can catch Soviet ICBMs with many of their eggs still in one basket—i.e., with a number of warheads still on board.

That vital success in tracking a bus means an end to the era of the MIRVed missile, a particularly fearsome weapon of destruction that carries a whole cluster of nuclear warheads. If an ICBM can be caught and destroyed right after it is launched, and before it has deployed all its warheads, there is little gain from MIRVing.

*Do Soviet scientists believe SDI will work?*

The Soviets have a very large SDI program, with ten thousand scientists and engineers working on laser weapons alone — far more than the U.S. has. The CIA reports the Soviet laser-weapons effort is guided by some of the best scientists in the USSR. And President Reagan said recently that the USSR spent over $200 billion on strategic defense in the last 15 years. If the Soviets did not consider SDI to be promising, they would not be allocating major scientific and financial resources in a program that dwarfs ours.

*Aren't the computer programs for SDI impossibly complicated?*

The software requirements were originally estimated to be ten million lines of code, but they have now been worked out in detail and turn out to be four to six million lines. This is a large program, but not exceptional. For purposes of comparison, the code for a recent and very complicated SDI test in space totaled one million lines of code. That code was written in six months and worked perfectly on the first try.

*How can you test the effectiveness of the SDI software properly, short of trying it in a nuclear war?*

The one aspect of SDI that *can* be tested fully is the software. When signals are fed into the front end of the program, they look exactly the same to it regardless of whether they have been produced by a Soviet missile leaving its silo or by a piece of equipment that generates signals imitating the real thing. In fact, modern equipment can create realistic "battles" that test the program more fully than a real attack. It can hurl more "missiles," "warheads," and "decoys" at us than the Soviets could ever build. And it can "launch" them more quickly than the Soviets could ever launch their missiles in an actual attack.

*How can we guard against a catastrophic failure caused by a computer breakdown or an error in SDI software?*

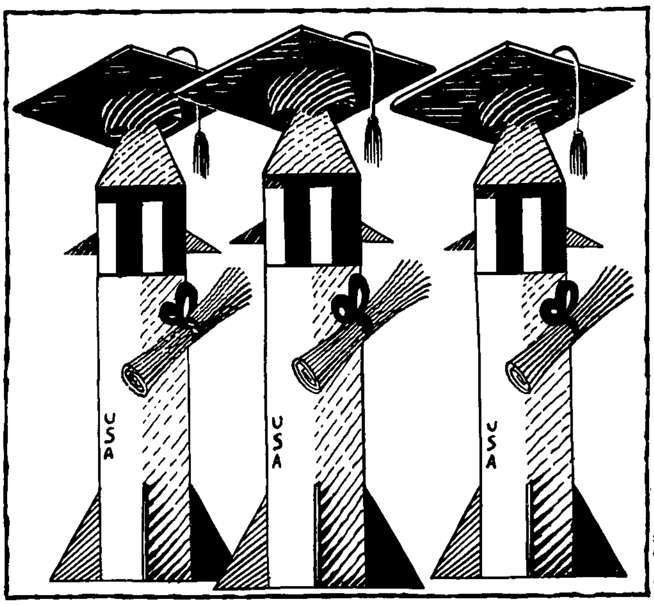
No lengthy computer program can be error-free. The approach used by SDI is to build the system so that it is heavily redundant and will perform its mission even if some computing errors are present.

Several steps are necessary for the achievement of this goal. *First*, software and hardware errors can be deliberately inserted into the program, and the system can then be tested and refined until it is "error tolerant." That is, it can be designed to carry out its tasks even with coding errors or badly damaged hardware in it, just as the brain continues to function after some damage to brain tissue. *Second*, the software is redundant; every important decision is made in several ways by independent lines of computer reasoning. *Third*, all the computer hardware is heavily redundant. That is, the electronic parts are duplicated. *Fourth*, the programs are compartmentalized—broken up into boxes. If a box fails, the program works around it; the whole system never crashes. *Finally*, the communications links that connect the different parts of the system are also heavily redundant.

This redundancy follows the pattern used by nature in the design of the human brain to minimize the chance of a catastrophic failure. Enough redundancy is being built into SDI software and hardware to reduce the probability of catastrophic failure essentially to zero.

*What about the false alarm—a computer error that activates the U.S. defense when we haven't been attacked?*

There is a vital difference in this regard between the existing policy of deterrence by the threat of retaliation, and the new policy of deterrence by defense. Under deterrence by the threat of retaliation, a false alarm could trigger the launch of ballistic missiles carrying hundreds or thousands of nuclear weapons. Once launched, these missiles cannot be recalled. Soviet retaliation is certain to follow. This is the existing U.S. policy. Under it, the consequences of a false alarm are catastrophic for both superpowers.



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But under the new system of deterrence by defense, if a computer error triggers the firing of "smart bullets" in a false alarm, the consequences are not the detonation of thousands of megatons of nuclear explosives, visiting untold destruction upon the territories and peoples of both nations. In fact, very little happens, for the smart bullets fired by the defense are non-nuclear and probably contain no explosives of any kind. A good number will escape from the earth, and the remainder will not destroy a single building, because they lack the heat shielding necessary to penetrate the earth's atmosphere without burning up.

*How effective will the smart-bullet defense be?*

The first stage of the 1990s defense, with a layer of smart bullets in space and another layer on the ground, will have an effectiveness of about 50 per cent. The fully deployed 1990s defense, with many more smart bullets in space and a total of three layers, will have an effectiveness of better than 90 per cent. That is, nine out of ten Soviet warheads will be destroyed.

*What good is a 50 per cent or 90 per cent defense when one warhead can blow up a city?*

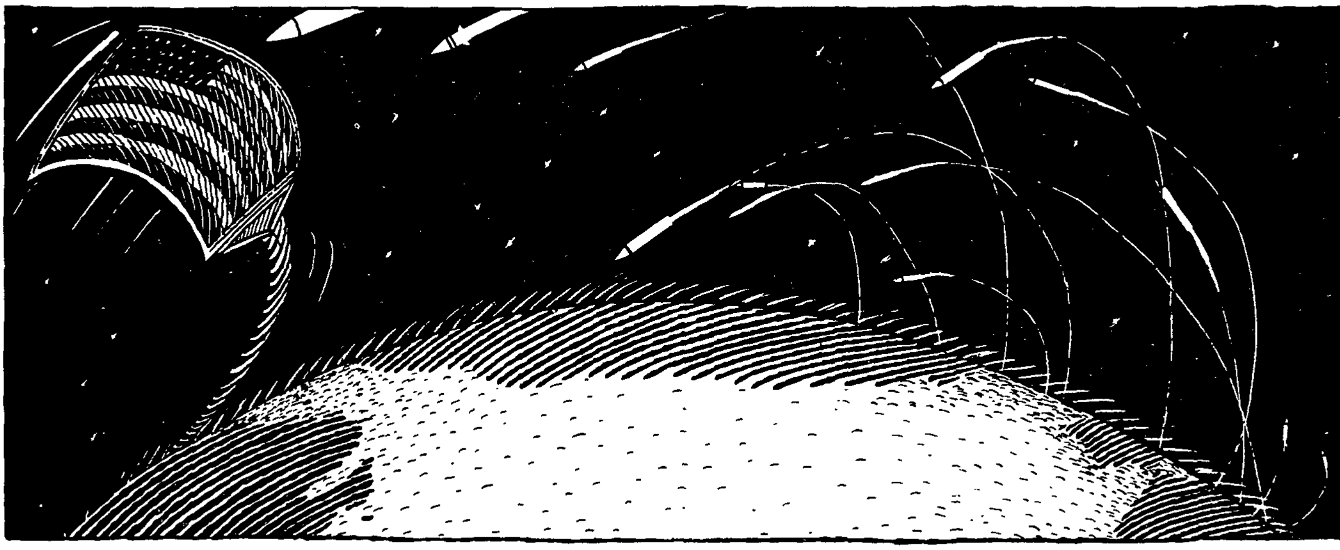
Even a 50 per cent defense is sufficient to create a paralyzing uncertainty in the mind of the would-be attacker. Soviet leaders are aware that starting a nuclear war would risk the very survival of their own state. If a Soviet commander knows only half his warheads will get through to their targets—this is what a "50 per cent defense" means—he knows he cannot hope to "ladder down" and wipe out the bulk of our retaliatory forces in a surprise attack. He knows that a large fraction of our nuclear arsenal and command and control network will remain intact after the first strike, and that, less than sixty minutes after he gives the order to launch, his own nation's military forces and industry will lie in ruins. To attack the United States under those circumstances would seem to Soviet leaders to be suicidally irrational. But the Soviet leadership is rational.

*How much will this defense cost?*

The first installment of the defense will cost between $50 and $70 billion. This is about the same as the cost of five hundred Midgetman missiles or a new type of Air Force fighter—two weapons systems the U.S. Government is already planning to buy. For the fully deployed, three-layer smart-bullet defense, independent estimates have arrived at a cost of about $120 to $130 billion.

The estimate of $130 billion comes from a rule of thumb given by former Secretary of Defense Harold Brown: to get the cost of a fully deployed weapons system, multiply the cost for research and development by ten. The R&D cost of the smart-bullet defense in SDI's five-year program totals approximately $13 billion. Applying the Brown rule gives $130 billion as the cost for the system.

This result is in close agreement with a figure of $121 billion arrived at by a different method by the Marshall Institute panel on missile defenses. The panel made a detailed examination of the costs of all the pieces in the three-layer defense—satellites, smart bullets, and so on—and added up the separate items to arrive at a total.



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There is no evidence to support the widely quoted cost estimates—frequently offered by former defense officials and Soviet spokesmen—of a trillion dollars or more for a space-based defense.

*What about the criterion proposed by Ambassador Nitze—that a missile defense should be "cost-effective at the margin"?*

Nitze's point is that it should cost the U.S. less to build our defense than it costs the Soviets to build their arsenal, and that it should cost the U.S. less to upgrade our defense than it costs the Soviets to upgrade their arsenal. How do the figures work out for SDI?

The total cost for Soviet deployment of fourth- and fifth-generation missiles through the mid-1990s is approximately $620 billion. The U.S. expenditure of $120 to $130 billion for a 1990s space-based defense that will negate the first-strike potential of this arsenal is cost-effective by a ratio of approximately five to one.

**Our satellites will not be as easily destroyed as some scientists have suggested. Satellites have been vulnerable because no one has been shooting at them, just as airplanes were vulnerable early in World War I**

With regard to incremental costs, each additional Soviet SS-24 costs approximately $200 million over the lifetime of the missile, including basing. The interceptors that can destroy the missile cost $6 million each, but only one in ten can be used during an attack. (The other nine are elsewhere in their orbits, and not within range of the Soviet missile fields at the time of the attack.) So the destruction of the Soviet ICBM effectively costs the U.S. ten times $6 million, or $60 million. The marginal-cost ratio is roughly three to one—still favorable to the defense.

*Couldn't the Soviets blow a hole in the U.S. defense planned for the 1990s by knocking out our satellites before they launch their first strike?*

U.S. satellites will not be as easily destroyed as some American scientists have suggested. Satellites have been vulnerable in the past because no one has been shooting at them, just as airplanes were vulnerable at the start of World War I. Once the enemy started to shoot at these early aircraft, they put on armor, mounted guns and cannons to shoot back, and became highly maneuverable to dodge attack. Later, military aircraft developed electronic countermeasures, metal decoys to confuse radars, heat flares to confuse heat-seeking missiles, and so on.

The satellites being developed for America's space-based defenses are using all these stratagems of defense, including armor, "shoot-back," maneuverability, heat-generating decoys, and a bag of electronic tricks. No single stratagem gives 100 per cent protection, but these stratagems together can make it very difficult and costly to kill a constellation of satellites. The secret of survivability for U.S. satellites is to make the cost of killing them so great that the Soviets are unable or unwilling to risk the attempt.

*What about missiles launched on low trajectories from submarines near our shores? Wouldn't these Soviet missiles reach their targets—say, Washington—too quickly for our defenses to work against them?*

Our ability to track and destroy "flat-trajectory" missiles will not be impaired by their short flight time. *First*, because they fly low and stay in the atmosphere, flat-trajectory missiles cannot deploy decoys. *Second*, because they fly lower and slower than ICBMs, they are easier to track, intercept, and destroy. *Finally*, some ground-based "smart bullets"—the HEDI and the FLAGE are examples—are specially designed to intercept and destroy low-flying, submarine-launched missiles. As a consequence, it doesn't matter appreciably to the effectiveness of our defenses whether the flight time is five minutes or twenty minutes.

*What about fast-burn boosters? Some critics of SDI say they could be a highly effective Soviet countermeasure.*

The fast-burn booster is a high-acceleration ICBM that burns out in one or two minutes, in contrast to three to five minutes for current Soviet missiles. (Rockets are sometimes called boosters because they boost a payload into space.)

U.S. plans for a space-based missile defense assume that the smart bullets in space will get a good shot at the Soviet ICBMs before the ICBMs burn out. But shortening the burn time of Soviet ICBMs will make it more difficult for the U.S. to destroy them in the critical early phase of their flight, because fewer "smart bullets" (with heat-sensitive detectors) will catch up to their targets while they can still see them. (The heat detector responds to the flame of the rocket; after the rocket burns out, the smart bullet may not be able to see it.)

How valuable these fast-burn boosters will be to the Soviets depends on how quickly they can build them. Time is of the essence, from the Soviet point of view, because the U.S. smart-bullet defense is planned to tide us over a period of strategic vulnerability that peaks in the 1990s. But by the turn of the century, or the first years of the next century, our government hopes to have some laser defenses in orbit to augment the smart-bullet defense. The laser beams, or "light bullets," used in these more advanced defenses travel at 186,000 miles per second—thousands of times faster than a "smart bullet." A laser beam will have no trouble catching up to an ICBM, even if the ICBM burns out quickly.

The intelligence community recently took a careful look at the question of how quickly the Soviets could build fast-burn boosters and put them into the field. The intelligence experts concluded that it would take at least 15 years to do this. That means the Soviets could not deploy a fast-burn arsenal until the beginning of the next century. But that would be too late, because the U.S. expects to have an effective laser defense by that time.

Why did the intelligence community decide the Soviet Union could not build a fast-burn booster quickly? The fast-burn booster would be an entirely new rocket, requiring a new engine, a new rocket body to counter the stresses of acceleration, and a new mechanism for keeping the ICBM from toppling over and breaking up in flight. And if the fast-burn ICBMs carried more than one warhead each, they would also need new buses to deploy their string of warheads quickly. (Existing buses take twenty to thirty seconds per warhead, or as much as five minutes for a string of ten warheads, and are vulnerable to smart bullets during this long deployment time. Furthermore, recent tests show that the buses can be seen clearly by the heat-seeking "eyes" on U.S. satellites while they are deploying their warheads, even though the rocket flame of the bus is not as bright as the flame of the booster itself.)

All these new features add up to a different ICBM. For several decades, it has taken the Soviets 12 to 15 years to design and put into the field each new generation of ICBMs. They are just now deploying their latest ICBMs —the fifth-generation SS-24s and SS-25s. Adding 12 to 15 years would bring the Soviets to the end of the century—and to the advent of U.S. laser weapons, which would negate the usefulness of their trillion-dollar investment in a new arsenal.

Faced with that prospect, Soviet leaders may rethink their policy, and stop building new ICBMs.

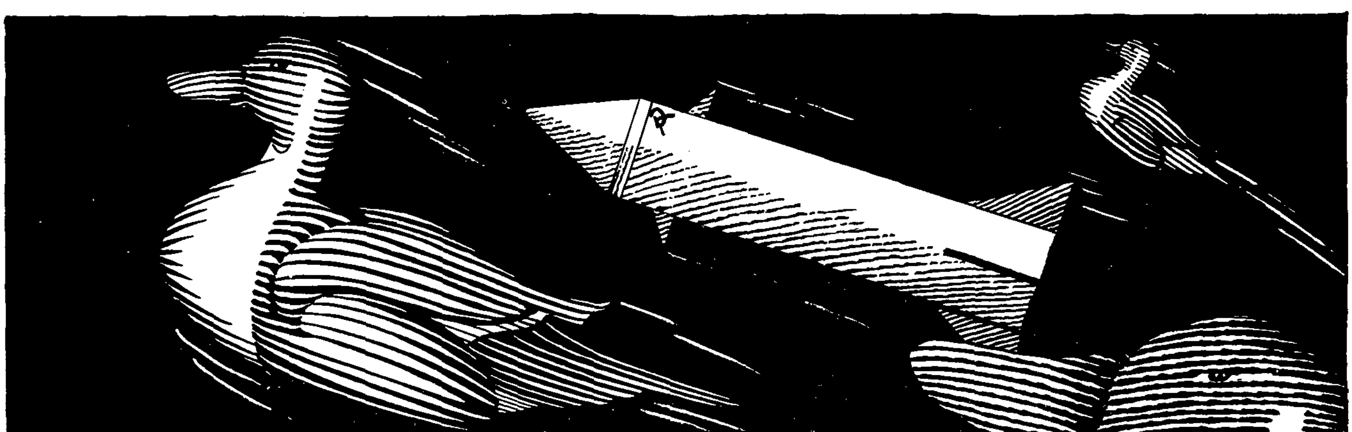
*Suppose the attacker tries to confuse the defense by launching thousands of decoys along with the real warheads. How can our defense handle that problem?*

A decoy is a lightweight object built to present the appearance of a warhead to an enemy satellite. If the decoy weighs one-twentieth as much as a real warhead, a massive attack by ten thousand Soviet warheads could be accompanied by two hundred thousand decoys. SDI critics say U.S. defenses would be swamped.

But decoys pose no problem for the space-based layer of the defense, which aims to catch and destroy the Soviet missiles shortly after they have been launched. At that time, decoys and warheads alike are still packed away in the missile. Since a space defense destroys the decoys before they can be deployed, it does not matter how many decoys the missile carries.

Decoys also pose no problem for the "terminal" layer of the defense, which catches the Soviet warheads toward the end of their flight, as they descend through the upper atmosphere and approach their targets. Since a decoy is always considerably lighter than a real warhead, the resistance of the atmosphere slows down the decoys more than it slows down the warheads. (If a decoy were as heavy as a warhead, the attacker might as well replace it with a warhead.) To tell the warheads from the decoys, the defense has only to observe which objects lag behind as the flock of apparent warheads enters the atmosphere. Ignoring the lagging objects, which are the decoys, the defense goes after the others, which are the real McCoy.

However, decoys do create potential difficulties for the



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U.S. defense in the so-called midcourse layer. This layer—which lies between the space-based layer and the terminal layer—tries to destroy the warheads as they arc through space over the Pole or the ocean.

Decoys can be a serious problem in midcourse because, when the warheads and the decoys are traveling through space, there is no appreciable atmospheric resistance to separate them. Technical opinion is divided on whether other techniques can be found for distinguishing warheads from decoys in this region. Very elegant methods have been suggested—for example, tapping each of a flock of objects with a pulse of laser light to see how they recoil; the ones that recoil the most rapidly are the lightweight decoys, and the others are the warheads—but these methods have not been tested yet.

Decoy designers are optimistic about their product. They say convincing decoys can be built, which will withstand scrutiny by the best "eyes in the sky" we can put in orbit in the mid-1990s. But no one has yet built one of these sophisticated decoys. They are a gleam in the eye of the decoy designers.

On the other side, the designers of instruments for our eye-in-the-sky satellites say their instruments will be doing a very good job of decoy discrimination by the mid-1990s—but they also have some distance to travel before they reach that goal.

**Protection against accidental launches is badly needed. However, gaining this insurance will require U.S. withdrawal from the ABM treaty. Withdrawing from the ABM treaty is a good idea**

While we wait for this technical wrangle between the decoy designers and the eye-in-the-sky instrument designers to be resolved, the value of the midcourse layer remains in doubt. The best way to handle the decoy problem for the present is to build a space-based defense that destroys the missiles before their decoys have been deployed, and cuts down the number of decoys at the outset.

*If our defense destroys Soviet nuclear warheads, won't that cause nuclear explosions in space?*

There can be nuclear explosions in space if the Soviet warheads are "salvage fused" to explode on approach of the intercepting missile or smart bullet. However, these explosions will cause no clouds of radioactive dust and no damage on the ground, provided the interception occurs above fifty thousand feet. Our interceptions will always be above that height.

*How about getting started now on deploying missile defenses, by building a limited defense against accidental launches? Senator Nunn and several others have proposed this recently. Isn't it a good idea?*

Protection against accidental launches is badly needed. However, gaining this insurance will require U.S. withdrawal from the ABM treaty. Withdrawing from the ABM treaty is a good idea, because, as matters have worked out since the treaty was signed, it now leaves America vulnerable to nuclear destruction.

Why does the modest objective of accidental-launch protection require withdrawal from the ABM treaty? *First*, even if the defense only uses ground-based smart bullets (a type of smart bullet called the ERIS, developed by Lockheed, is the most suitable), the area that can be covered by the ERIS smart bullet is limited. To get protection for the whole country (we do not want to protect the population of Los Angeles, say, and abandon New York, or vice versa), the U.S. must use the ERIS in combination with the full suite of early-warning radars spread across the North from Alaska to Greenland.

These early-warning radars were set up by the U.S. to give warning of air and missile attacks. The ABM treaty forbids using them for ABM defense.

*Second*, even with the radars, we would still not have protection against missiles launched from submarines off the coast unless ground-based smart bullets were placed in several locations near both coasts, as well as in the interior of the United States. But the ABM treaty forbids the placement of interceptors at several different locations. It allows them at one site only.

*Third*, a very large number of interceptors would be needed. An accidental launch is usually thought of as one or two missiles, but an accidental launch from one Soviet submarine could mean twenty missiles and 180 warheads headed for the United States. An accidental launch from one centrally commanded SS-18 field (SS-18s are based in clusters of fifty) could mean as many as five hundred warheads streaking toward the United States. Consequently, at least a thousand, and possibly several thousand, ground-based interceptors would have to be deployed to protect us even against "accidental" launches. The ABM treaty also forbids that. It allows only one hundred interceptors.

All these actions—using early-warning radars for an ABM purpose, putting ABM interceptors at sites around the country, and deploying at least a thousand interceptors—add up to more than a "modest amendment" to the ABM treaty, the phrase used by some advocates of accidental-launch protection.

In fact, accidental launch protection amounts to building a robust, nationwide defense against ballistic-missile attacks. Article I—the cardinal clause of the ABM treaty—forbids a nationwide defense against missile attacks. It does not distinguish between attacks launched by accident and attacks launched with intent to destroy a nation. If the U.S. wants to prevent the possibility of American cities being devastated by an accidental launch, it has to give up the ABM treaty. □