The Search for a Nuclear Sanctuary (II)

In a little noticed effort, Pentagon scientists work to create an invulnerable offense as well as an impregnable defense

Most damage-limiting strategies represent an effort by one belligerent to maximize the damage to his enemies and minimize it to himself.—Secretary of Defense Donald Rumsfeld, in the 1978 DOD annual report.

Buried inside the Defense Department's bureaucracy is a small, well-run program of enormous significance in the ongoing debate over whether or not the United States should construct a large-scale antiballistic missile system, as President Reagan proposed in his widely publicized "Star Wars" speech last March. It is known as the Advanced Strategic Missile System (ASMS) program, and almost everything that falls under its jurisdiction is considered secret. Its major function is the design, construction, and testing of sophisticated military equipment that will ensure the success of a nuclear attack on the Soviet Union.

For roughly two decades, the technical managers of ASMS and its bureaucratic antecedents have analyzed potential Soviet strategic defenses and devised the means to defeat them. During the 1960's and 1970's, the program masterminded the development of the multiple independently targetable reentry vehicle, or MIRV, for the express purpose of confusing and overwhelming the Soviet Union's fledgling antiballistic missile system. During the 1970's, the program was instrumental in the development of the highly accurate MX warhead, for the express purpose of countering an extensive Soviet effort to harden its missile silos against the effects of a nearby nuclear explosion. More recently, the program has supervised the development of a warhead that flies erratically toward its target, as well as an impressive collection of what the Pentagon calls "advanced penetration aids"—such as chaff, aerosols, and warhead decoys—each designed to defeat Soviet defenses.

Historically, the funding for ASMS has risen and fallen along with the U.S. assessment of Soviet defense capabilities. At present, its budget is just $50 million, a proverbial drop in the Pentagon bucket. The budget is expected to double next year, however, and an additional increase is scheduled for the following year. Those who are familiar with the program say that the closer that either the United States or the Soviet Union get to deploying an authentic, large-scale antiballistic missile system, the richer the ASMS program will become. "If you are working seriously on missile defense, then you'd better prepare yourself with penetration aids in anticipation of similar work by the Soviets," says one official in describing prevailing Pentagon sentiment.

ASMS, along with several newer Pentagon programs aimed specifically at countering potential Soviet space-based laser systems, will have a significant impact on the strategic balance in the event that the United States proceeds with Reagan's plan to "counter the awesome Soviet missile threat with measures that are defensive." Such a dramatic development would lead to peaceful U.S.–Soviet relations only if both nations erected equally successful missile defenses, at roughly the same time. But the United States is well ahead of the Soviet Union in missile defense technology (*Science*, 1 July, p. 30), and the technical managers of the ASMS program are confident that Soviet defenses will be useless even if they are deployed simultaneously with U.S. defenses.

If Soviet defenses indeed fail, while U.S. defenses work as planned, the United States will possess a capability to strike first against the Soviet Union without fear of significant retaliation. This possibility, in turn, sharply undercuts the President's hope that the deployment of such a system will lead to peace and not war. As noted by Victor Weisskopf, a physicist at MIT who was briefed on the President's proposal at the White House, the Soviets can hardly be expected to permit the creation of such a strategic imbalance. "They will start a war to prevent deployment of this system," he predicts.

The confidence of the Pentagon in its ability to ruin potential Soviet defenses stems in part from the development and testing of ingenious devices under the ASMS program that apparently are beyond the current capability of Soviet defense planners. The Air Force, which directs the ASMS program, does not like to crow about the program's technological successes, preferring that the Soviets, and perhaps the general public, be kept in the dark about what is obviously one of its most sensitive scientific endeavors. But questions about the program's accomplishments came up in congressional hearings several years ago on the MX missile. Senator Jake Garn (R-Utah), who sits on a defense appropriations subcommittee, wanted to know where the United States would stand if both sides deployed antiballistic missile systems in the near future. The answer, which came in writing from Antonia Chayes, who was then the Air Force under secretary, and from Lt. General Kelly Burke, who was then the top Air Force scientist, was as follows: "If the Soviet Union were to deploy an antiballistic missile system, we would still have confidence in the ability of MX to destroy hard targets through the use of chaff, decoys and other penetration aids . . . combined with such tactics as saturation." As to the chance that the Soviets would use similar tactics against a potential U.S. antiballistic missile defense, the Air Force was unconcerned. "We feel we are ahead of the Soviets in this area," the answer read.

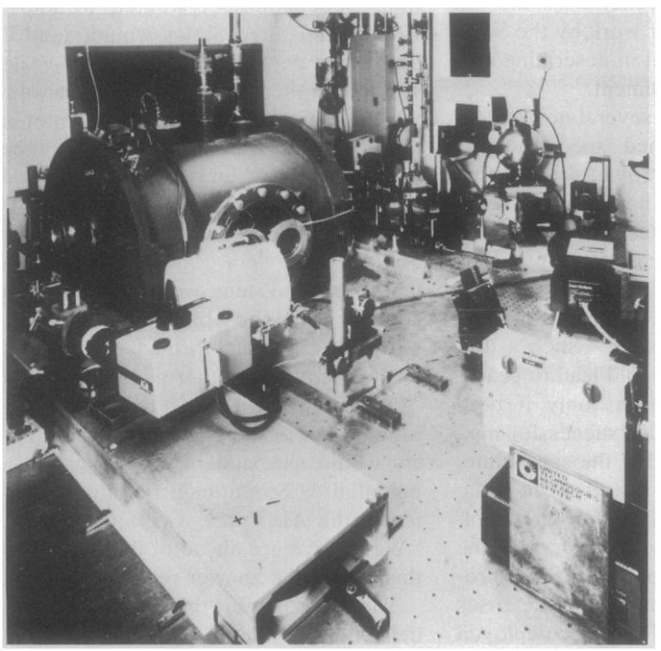
The support for this statement was deleted from the record, but bits and pieces of relevant information can be gleaned from conversations with weapons experts inside and outside Washington. One measure of the U.S. lead in devices that can ruin antiballistic missile systems is the successful development of a chaff dispenser for use with the Minuteman II and the Minuteman III intercontinental ballistic missile. The chaff consists of lightweight, knotted strands of metal, which form small clouds as they are released from a dispenser that flies alongside the warheads of the Minuteman III after they separate from the missile itself.

The purpose of chaff is to saturate defensive Soviet radar with false signals, obscuring the location of the real warhead. It is primarily suited for use outside the earth's atmosphere, where Soviet defensive missile interceptors now operate. Not all of the Minuteman missiles are equipped with chaff, but the Soviets have no way of knowing which missiles have it and which ones do not. A new form of chaff, to be used in conjunction with the warheads on the MX, will be tested next year aboard two Air Force

sounding rockets. The success of this effort to date apparently gives the United States a substantial edge in strategic competition. A top weapons expert notes that, although the intelligence data on Soviet antiballistic missile tests are not definitive, the Soviets seem to have conducted no tests of their interceptors against warheads obscured by chaff.

The United States apparently is also well ahead in the development of active and passive warhead decoys, as well as actual warheads perversely designed to look like decoys. Both the active and passive decoys are intended to defeat the latest Soviet antiballistic missile equipment, which will operate within the earth's atmosphere. The passive decoy will confuse Soviet radar by dispensing in its wake a material that ionizes, making the decoy appear to have as much drag as a real warhead (salt is one of the materials under consideration). The active decoy is a product of substantial wizardry in microelectronics and computing, engineered by MIT's Lincoln Laboratories and by the General Electric Company. Roughly the size of a half-gallon milk carton, the device operates by sensing the pulse of Soviet radar and swiftly determining its frequency and bandwidth. Next it calculates how a real warhead would appear at that particular moment on Soviet radar. And then it generates a signal that simulates the scattered radar reflection of a real warhead. All of this occurs within a microsecond or two after the initial radar contact. Development of the active and passive decoys is to be completed this year in preparation for two flight tests aboard Minuteman I test rockets in 1984. Another test aboard the Minuteman I will occur in 1985, followed by two tests aboard the MX missile in 1986 and 1987.

In addition to creating decoys that behave like warheads, ASMS contractors have created an ingenious way of making hot, heavy warheads look like cool, lightweight decoys. The transformation, which occurs in space after the warheads separate from the missiles, is intended to fool infrared optical sensors similar to those now under development by the United States. The deception is accomplished when balloons at the tails of the warheads release a carbonized foam that "erects itself forward," as one expert describes it. By creating a layer of insulation around the warhead, the foam sharply reduces its radiated heat. This device has been successfully tested on warheads dispensed by an intercontinental ballistic missile. As an alternate means of deceiving the Soviet Union's optical sensors, scientists at Lincoln Laboratories have created a special aerosol, which reflects the earth's shine, thereby creating numerous false light impressions.



The Defense Advanced Research Projects Agency is using this experimental device at the United Technologies Research Center to assess the response of ablative materials to possible Soviet lasers. The laser beam enters from an adjacent room (at top center) and strikes a sample mounted in the chamber, where upper atmospheric conditions are simulated. Various instruments measure beam quality, sample response, and ejected particles.

The U.S. grab bag of countermeasures also includes several warheads that maneuver erratically just before their impact on Soviet targets, so as to evade potential short-range Soviet missile interceptors. One such warhead, known as the Mark 500, was developed in the mid-1970's by the Navy for use aboard the Trident I submarine-launched missile. The rationale for the effort was that the Soviets might suddenly upgrade their existing air defense network, by substantially improving their interceptors, radars, and computers. The result would be an enormous antiballistic missile system, albeit one with only limited speed, range, and accuracy. The Mark 500, which maneuvers with fins according to preprogrammed instructions in its onboard computer, has been successfully flown in numerous test flights, and could be quickly produced in the event that the Soviets actually upgrade their air defense system.

A second warhead, known as the Advanced Maneuvering Reentry Vehicle, or AMARV, is designed to defeat still more sophisticated short-range missile interceptors. Intended for use aboard U.S. land-based missiles, the AMARV faces the difficult task of maintaining extreme accuracy despite its erratic, preprogrammed maneuvers immediately before impact. Each AMARV will carry its own inertial navigation system, which must be capable of withstanding enormous acceleration. Although the AMARV program was initiated in 1976, the Air Force has conducted only three flight tests,* and the program is still in its early stages. One official predicts that it could be ready by 1990 if Congress provides enough money.

Several weapons experts say there are other devices already in use that they prefer not to discuss, as well as many clever ideas for devices that might be constructed in the future. Next year, for example, ASMS scientists will begin intensive work on a reentry vehicle specifically designed to jam the radar of a Soviet antiballistic missile system. Pentagon officials justify such work by pointing to the development of a new mobile Soviet radar, as well as a new short-range missile interceptor, and a new short-range anti-aircraft missile that might be made into a missile interceptor. Richard Ruffine, a senior Pentagon analyst who specializes in antiballistic missile systems, suggests that "their ABM technology is lagging, but they could always build a much bigger system to overcome these disadvantages—perhaps within 2 or 3 years." He notes that they are much further along than the United States in the actual deployment of such a system.

It is clear, however, that the goal of the ASMS program is not to stay abreast of the Soviets but well ahead of them. Not only do the Soviets seem incapable of countering U.S. penetration aids, they also seem incapable of developing effective penetration aids of their own. "If both sides use missile defense and penetration aids—if we went all out with the technology in hand—we could eat them

*There were two flights in 1980 and one in 1981.

up," Ruffine acknowledges. "They would have enormous trouble against our defense systems"—even a system that lacked space-based lasers. To the best of our knowledge, he says, the Soviets have never even tested the deployment of chaff, much less the acutely challenging technology of a maneuvering warhead. "I would hate to be designing penetration aids for the best that we could do."

The technical accomplishments of the ASMS program are also expressed in the 1981 annual report of the U.S. Arms Control and Disarmament Agency. "The potential effectiveness of U.S. ICBMs and SLBMs [submarine-launched missiles], based on maneuvering reentry vehicle and penetration aids technology, could assure the penetration of sufficient numbers of U.S. reentry vehicles *regardless of Soviet actions with respect to ABM improvements*," the report states [emphasis added].

Although the bulk of the Pentagon's work in this area is devoted to the defeat of traditional Soviet defensive systems, a variety of newer, smaller programs have been established to anticipate and defeat a more advanced defense, such as a space-based laser system. Under one program, operated by the Defense Nuclear Agency (DNA) at a cost of about $3.5 million annually, small pieces of U.S. strategic missiles have been exposed to laser beams modeled after those used in Soviet research. The materials include warheads, electronics, fuel tanks, and coated aluminum, as well as the thick, rubberized substance that will be used to protect MX missiles from the debris of nearby nuclear explosions. Eventually, DNA wants to expose an entire assembly of warheads, decoys, and associated equipment, but this will require modifications to existing U.S. lasers. John Mansfield, the DNA deputy director for theoretical research and testing, says that the program has three principal goals: to assess Soviet vulnerabilities, to understand U.S. vulnerabilities, "and to develop countermeasures for U.S. systems."

Another program, supervised by the Defense Advanced Research Projects Agency (DARPA) is charged more specifically with the development of materials that are resistant to the effects of potential Soviet lasers. Edward van Reuth, who directed the program until his recent retirement as chief of the materials science branch at DARPA, says that "in our fondest dreams—if we are completely successful—we will have produced materials that would provide an improvement in laser resistance of 1 or 2 orders of magnitude. Then we would feel confident that no one can put up a laser of sufficient size to destroy our weapons systems." In an initial $900,000 test with a United Technologies Research Center laser in Hartford, Connecticut, DARPA exposed a handful of lightweight, nonmetallic ablative materials to a 15-kilowatt beam for 10 seconds or less. DARPA will not discuss the results, but additional tests, using a variety of lasers, will be conducted over the next 4 years. "Particle beams are considered way out," van Reuth says. "We're not all that worried about them yet."

The Air Force, with DARPA's assistance, is attempting not only to devise mechanisms that can defeat Soviet lasers but also to devise a means of ensuring that U.S. lasers cannot be defeated. Robert Sepucha, the deputy director of space defense technology at DARPA, says that $10 to 15 million a year is budgeted for an assessment of potential Soviet countermeasures. A so-called "red team," which anticipates such efforts, has been established under the direction of the Air Force Ballistic Missile Office in San Bernadino, with additional help from a group of engineers at the RAND Corporation, as well as some scientists at the Air Force Weapons Laboratory in Albuquerque.

> "The Russians know we're not going to attack them anyway."

The attempt to ensure a substantial U.S. advantage in laser countermeasures is still getting under way, and many officials are wary about predictions of complete success. "How hard can the Soviets make a booster? Is it easier for them to harden it than it is [for us] to attack? We do not really have the answer to that question at this point," says Major General Donald Lamberson, who manages the Defense Department's directed energy weapons technology program. Little is known about the Soviet laser program, he adds. "We know there is a very significant effort going on, involving several different facilities, and that the people related to it are very distinguished scientists. We are uncertain, however, about the objectives of that effort."

Nevertheless, there are signs that the United States possesses at least some advantage already. Richard DeLauer, the Pentagon's top scientist, has stated that the U.S. is superior to the Soviet Union in structural materials technology, which obviously plays a large part in laser countermeasures. Hans Bethe, a Nobel laureate at Cornell who helped devise the ablative materials now in use on U.S. warheads, says that the United States is ahead of the Soviets in this area, although it is difficult to say by how much.

Many of the officials and politicians who are pressing for construction of a large-scale antiballistic missile system acknowledge that it may impart a significant strategic advantage to the United States, but argue that this need not be feared by the Soviets. Secretary of Defense Caspar Weinberger has stated that "[one] reason the Soviets have no need to worry is that they know perfectly well that we will never launch a first strike." General John Vessey, chairman of the Joint Chiefs of Staff, has been reported as saying, "The Russians know we're not going to attack them anyway." This view is also stated by Senator Malcolm Wallop (R–Wyo.), one of the principal congressional proponents of a missile defense. "We had at [one] time the ability to annihilate the Soviet Union, bring them to heel, to do anything we chose to do to them, and did not. There is nothing historical that says when this country has great power it abuses it."

Wallop is of course technically correct, but the historical record offers only thin evidence to support a benign view of U.S. strategic intentions. The United States last enjoyed clear nuclear superiority in the 1950's, when, according to historian David Alan Rosenberg at the University of Houston, top U.S. officials, including President Eisenhower, actively considered initiating a nuclear attack on the Soviet Union. Rosenberg, writing in the spring issue of *International Security*, reports that the Pentagon was fearful that the Soviets would soon have the hydrogen bomb, which would sharply increase their retaliatory capability. Eisenhower's advisers rejected a proposal that they threaten nuclear conflict if the Soviets failed to capitulate within a specified period of time, but Eisenhower himself wondered if "our duty to future generations did not require us to initiate war at the most propitious moment we could designate." In May 1954, Rosenberg says, a special study group of the Joint Chiefs of Staff urged Eisenhower directly to consider "deliberately precipitating war with the USSR in the near future," before Soviet strategic power became "a real menace." Eisenhower apparently deliberated for several weeks before saying no.

The United States would clarify its

intentions, as well as relieve some international anxiety, by simply abandoning its plans to construct a large-scale antiballistic missile system. The only safe alternative, according to Weisskopf and Bethe, is to build the system jointly with the Soviet Union. But this is obviously more of a debating point than a realistic solution. Such a joint effort would be tantamount to mutual disarmament, which surely could be achieved more easily and less expensively in other ways. Major General Lamberson refuses even to discuss the prospect of sharing military secrets with the Soviets. Fred Ikle, the undersecretary of defense for policy, says that "we have had [previous] exchanges and cooperative ventures in the space area. If I were to structure the priorities of areas where we would cooperate, I do not think I would put space on top. . . . I would pick other areas—health, agriculture, and so on."

Three months ago, Soviet premier Yuri Andropov proposed that U.S. and Soviet "scientists, specialists in the field," conduct talks on the implications of large-scale missile defenses. Recently, the Administration rebuffed the offer. "Our position is that discussions could be mutually beneficial, that we are not opposed to talking about the issues," says a State Department spokeswoman. "But we believe that we should hold such discussions within the framework of the ongoing strategic arms reduction talks or the standing U.S.–Soviet consultative committee. These are not merely scientific subjects." President Reagan, at a press conference on 29 March, said that "I have to tell you I haven't given . . . any thought" to joint development of a missile defense. "That's something to think about and look at." Reagan's other remarks that day indicate that he favors independent U.S. research, followed by an offer to share the technology, or a directive to the Soviets that they "do away" with all of their offensive missiles, and the United States will do likewise.

The aggressive and provocative U.S. effort to develop a foolproof missile defense, and to defeat any Soviet missile defense, creates several quandaries for defense policy-makers in Washington. First, it suggests that the equilibrium publicly sought by the Administration is unlikely to be achieved. An impregnable defense in combination with an invulnerable offense—which the Pentagon openly seeks—may well give the United States a real first-strike capability. Second, it points up the fallacy of the last move in weapons invention. When Colonel Richard Rene, the ASMS program director, is asked to predict the final outcome of the U.S.–Soviet countermeasure competition, he answers by noting that "there is no such thing as a static situation for offense or defense." It seems likely that, even if both sides simultaneously deployed workable missile defenses, Rene and his counterpart in the Soviet Union will be hard at work devising mechanisms to ruin the other's defense and alter the strategic balance.

—R. JEFFREY SMITH

The Kyshtym Mystery (contd.)

The mystery of how a large area of the Soviet Urals became contaminated with radioactivity in the 1950's continues to perplex Western analysts. The latest suggestion, put forward in a report by a researcher at Vanderbilt University, is that the contamination probably resulted from a combination of many releases of radioactive waste from a nuclear weapons complex and a major explosion that occurred in 1958 in a fuel reprocessing plant.

The contamination was first brought to public attention by Zhores Medvedev, an exiled Soviet geneticist now living in England. In a 1976 article published by *New Scientist*, Medvedev wrote that a vast region near plutonium production facilities at Kyshtym had been contaminated by radioactive fallout. He reported that the fallout came from an explosion caused by heat buildup in buried wastes.

Medvedev's account was immediately denounced by several prominent members of the nuclear establishment who contended that no accident or contamination had occurred. Medvedev then conducted a painstaking search through published Soviet literature and demonstrated convincingly that the area around Kyshtym has been contaminated. Researchers at Oak Ridge National Laboratory and Los Alamos National Laboratory have independently reached the same conclusion. There is, however, considerable disagreement about the source and extent of the contamination.

Because large numbers of people living in the region were potentially exposed to radiation, Frank Parker, an environmental scientist at Vanderbilt University combed through Soviet medical literature for references to events at Kyshtym. He drew a complete blank. In a report to the Department of Energy, which funded his study, Parker noted, however, that the lack of references is not surprising because research on accident victims would have been classified.

During the course of his research, Parker interviewed several Soviet émigrés and came across one who had worked at the Kyshtym complex in the 1950's. The émigré was a construction engineer who was in charge of building a reprocessing plant at the complex. According to Parker, his description of the plant matched completely the specifications of the Purex plant at Richland, Washington. The Soviets had evidently copied a top secret U.S. weapons plant pipe-for-pipe. The Soviet engineer said that there had been many mishaps at Kyshtym that resulted in extensive contamination of the Techa River and its surroundings. The contamination was so severe that some 10,000 people had to be removed from the area. In addition, the engineer told Parker that some 6 months after he left Kyshtym, there was an accident in the reprocessing plant he had built.

This account meshes with the conclusions of others who have studied the Kyshtym mystery. John Trabalka, a researcher at Oak Ridge, for example, says "the most recent evaluation on our part is that more than one event" contributed to the contamination. He said he now believes that radioactivity was released into the environment in a series of spills, but there is also strong evidence, particularly from eyewitness accounts, of "at least one major accident." An explosion in a reprocessing plant is a plausible explanation for the major accident.

Parker says he is disappointed that Soviet studies of the medical consequences of exposure to the contamination have not turned up in the open literature. Only two other large exposed populations—those in Hiroshima and Nagasaki—have been studied, he points out, and the Kyshtym victims could provide a valuable source of information on the biological effects of low-level radiation.—COLIN NORMAN