envisioned, the diameter of the aiming mirror could be 6 times smaller. (Optical tolerances, however, have to be more precise.) Also, a shorter wavelength means the power of the laser is focused into a smaller space, increasing its lethality. With a wavelength 6 times shorter, the diameter of a beam hitting a target will be 6 times smaller, the area 36 times smaller, and thus the overall flux per unit of target area 36 times greater. The alternative, generating 36 times more radiation from the laser device itself, is a prodigious undertaking that taxes the imagination. In addition, shorter wavelengths put more energy into targets. For a missile body struck by a long wavelength laser, about 99 percent of the energy is reflected. With shorter wavelengths, the figure is about 90 percent.

The push for short wavelength lasers is not confined to the House. Last year, the Defense Science Board recommended that the Pentagon switch its emphasis to shorter wavelengths. The director of DARPA, Robert Cooper, after conducting a review of all the agency's laser programs, told the House Armed Services Committee in March that shorter wavelengths are more efficient. Air Force Deputy Chief of Staff for Research Kelly Burke also agreed that program emphasis should be on shorter wavelengths.

In its April report, the House Armed Services Committee took the bold step of calling for a cut of $121 million from the Administration's fiscal 1983 budget request for space lasers, including the termination of two of the three principal long wavelength laser demonstration programs, Alpha and Lode. In place of these projects, the committee called for a $50-million program to explore short wavelength lasers.

In particular, the House committee encouraged the exploration of the free-electron laser (FEL), which is based on technology similar to that of particle accelerators.

Critics of the move have one main objection. The short wavelength idea has not been seriously explored amid the rush to exploit lasers, and the technology is in a rudimentary state. Senator Malcolm Wallop (R–Wyo.), an advocate of space lasers, asked from the Senate floor, should we wait "to build the infrared lasers we know how to build, and instead put our money on the short wavelength lasers we do not yet know how to build? We have heard this sort of thing before. . . . Because we have listened, we have slipped behind in quantity and quality of strategic weapons. . . . We are faced with two sharply contrasting sets of claims in this field. The bureaucracy's claims which are reflected in the [House] Armed Services Committee's report, and my claims, backed by the only source of facts in the field: the aerospace industry."

After Wallop's pitch, the Senate passed an amendment to the defense authorization bill calling for a demonstration space laser, preferably within the decade.

Despite the Senate's disdain for the short wavelength option, work on the idea has forged ahead under conditions of less than lavish funding. A working FEL has been built at Stanford University in California, and state-of-the-art data are being collected at the Los Alamos National Laboratory in New Mexico. A good test-bed for a large FEL, according to short wavelength advocates, would be the huge Advanced Technology Accelerator now under construction at Lawrence Livermore National Laboratory in California.

The battle over how to build a proper laser for fighting a war in space offers an interesting window into the process of government. A new idea and an impressive consensus on how to go about the job have emerged, yet the great momentum behind existing laser projects, on which defense contractors have already spent millions, threatens to thwart a more rational approach. The result could well be laser battle stations that cost billions and look impressive but offer little by way of a credible threat.

—WILLIAM J. BROAD

Reagan Proposes to Restructure Soviet Forces

Ironically, both sides might be more vulnerable under Reagan's arms control plan

President Reagan achieved political success with his recent proposal to negotiate reductions in U.S. and Soviet nuclear weapons, even if his formula for reductions fell flat. A week after Reagan's announcement, Soviet President Leonid Brezhnev indirectly rejected the formula by faulting it as prejudicial to the security of the Soviet Union and a cover for a continued U.S. military buildup. A group of congressmen and arms control experts within the United States claimed that it might endanger the security of both countries, and worsen international tensions. But the President received high praise nonetheless, simply for agreeing at long last to talk with the Soviets about nuclear weapons and to listen to any Soviet counterproposals.

Although a date has not yet been set, negotiations are now expected to begin in late summer at the Soviet mission and the Botanic Building in Geneva, the historic location of previous negotiations and the ongoing U.S.–Soviet talks about weapons in Europe. These talks have bogged down in large part because of U.S. insistence on its opening proposal, but this tactic will not be used during the discussions about strategic nuclear weapons. Administration officials admit that Reagan's formula is merely an opening gambit, and that it will inevitably be amended as negotiations proceed.

In hearings before the Senate Foreign Relations Committee, Secretary of State Alexander Haig acknowledged that the proposal imposes the heaviest burden on the Soviet Union, because it focuses on the weapons that form the bulk of the Soviet arsenal: land-based missiles. The proposal asks that the Soviets eliminate—over a period of years—the majority of its land-based missiles, destroying in the process about 3000 warheads. In compensation, the Soviets could increase the number of warheads on submarines by about one-third. The United States, in contrast, could increase the total number of warheads atop land-based missiles by 500, although it would have to cut the number of warheads aboard submarines in half.

The overall purpose of these cuts, Reagan says, is to reduce the total number of nuclear weapons in the world, as well as to restructure the Soviet's arse-

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nal, so that more of their force is based at sea. Ostensibly, this would make it more difficult for the Soviets to threaten U.S. land-based missiles, a matter that causes sleepless nights at the Pentagon. Soviet submarine missiles are less threatening to U.S. land-based missiles because they are less accurate.

Reagan's proposal is mute on the subject of what missiles and which submarines will carry the warheads permitted in the two arsenals, meaning that each side is free to modernize its forces however and whenever it wishes. The proposal is also mute on the topic of warheads transported by bombers or cruise missiles, where the United States maintains both a quantitative and a qualitative advantage. Haig says that these weapons were deliberately excluded because they would be used for retaliation, whereas land- and sea-based missiles can be used in a first strike. This distinction was lost on Brezhnev, who complained in a speech to a conference of the Young Communist League that the "American position is absolutely unilateral in nature—above all, because the United States would like, in general, to exclude from the talks the strategic arms it is now most intensively developing."

Similar objections have been raised by several members of Congress despite the assurances of Haig and Eugene Rostow, director of the Arms Control and Disarmament Agency, that bombers and cruise missiles could be included in the forthcoming talks. Haig even went so far as to state that the MX, a controversial new land-based missile, "will certainly be [up] for negotiation." But this did not go far enough for Senator Edward Kennedy (D–Mass.) and others who support a prompt freeze on the development, testing, and production of nuclear weapons. They wanted Reagan to say outright that new weapons would be forsworn.

More substantive criticism came from leaders of the Arms Control Association (ACA), a Washington lobbying group, and from a handful of congressmen, who are concerned about the balance of U.S. and Soviet forces after the reductions have been completed. The problem, according to Representative Albert Gore, Jr. (D–Tenn.), "is that not all reductions are benign and not all forms of parity lead to stability."

Under the Reagan plan, for example, the United States would have fewer submarines. Herbert Scoville, the ACA president and a former deputy director of the Central Intelligence Agency, believes this would permit the Soviets to concentrate their resources on fewer targets, leading to swifter submarine attrition during a nuclear war. The United States would also have its other warheads concentrated in a smaller group of land-based missiles, a factor that would enhance the value of a preemptive Soviet strike. "Quite frankly," says Senator Joseph Biden, Jr. (D–Del.), "we are more vulnerable under the President's proposal to a first strike than we are under SALT II."

The rebuttal offered by Administration officials is that U.S. land-based missiles will somehow be made invulnerable to attack, thus negating the increased Soviet advantage from striking first. But no one yet knows how this will be done.

That is one problem. A second is that, by the peculiar math of the Reagan proposal, the Soviets might be more vulnerable to a preemptive attack by the United States. Their land-based missiles could contain more warheads, making them more attractive targets. They might want to make their missiles mobile, so as to prevent a successful American attack, but the United States is thinking about banning mobile missile systems in the new agreement. More of the Soviet missiles would be based at sea, but their invulnerability might not be assured. Soviet subs are noisy and unreliable, and the United States possesses geographical and technical advantages in antisubmarine warfare.

These are admittedly worst-case estimates of the balance of power that could result from the Reagan proposal. A lot depends on exactly how each side elects to structure its forces and to react to decisions taken by the other. The conclusive estimate of comparative vulnerabilities will not be possible until the agreement is complete, which Reagan says is probably "many years" away.

Some of this uncertainty would be eliminated under a proposal advanced by Representative Gore. He has suggested that the only new missiles that would be permitted on either side should be those that carry a single warhead. If each side had equivalent arsenals of single-warhead weapons, a first strike would eliminate both arsenals simultaneously. This would substantially limit the existing incentive for such strikes.

Although the idea has reportedly been favorably mentioned by some Soviet officials, the Reagan Administration has expressed skepticism, pointing out that such an agreement would reverse at least a decade of nuclear weapons development, and require the design of a new missile to replace the MX.

—R. JEFFREY SMITH

Revised Animal Bill Under Scrutiny

A bill introduced into the House last year would have diverted up to 50 percent of federal funds for biomedical research into attempts to reduce or eliminate the use of laboratory animals. The bill was finally shelved after vociferous objections from researchers. Now, two House committees are looking at a modified bill, H.R. 6245, whose chief thrust is to raise the standards of laboratory animal care. But even this version is causing concern.

H.R. 6245, introduced by Representative Doug Walgren (D–Penn.) would authorize $45 million over the next 3 years for proposals to develop alternatives to animal use. It would mandate that institutional animal care committees contain at least one veterinarian and at least one outside member.

It would also establish a "private agency," probably the American Association for Accreditation of Laboratory Animal Care (AAALAC), as the accrediting body for all entities that accept federal funds for animal-related research. Currently, AAALAC accreditation is voluntary. The National Institutes of Health (NIH), for example, encourages AAALAC accreditation to demonstrate compliance with its animal care guidelines.

But researchers are not happy with making this accreditation mandatory. The Association of American Medical Colleges (AAMC) claims that, based on figures developed by the National Academy of Sciences, it would cost NIH-funded laboratories about $500 million to bring their labs up to AAALAC standards. (The bill would appropriate $30 million for this purpose.) Although 59 of 123 medical schools are already AAALAC-accredited, an AAMC spokeswoman says "the standards are regarded by many as ideal rather than realistic," and with research funding as tight as it is, now is not the time to reach for the ideal.

Criticism from NIH has been more guarded. William Raub, director of extramural research and training, testified at subcommittee hearings in May that existing mechanisms are adequate "if they are utilized fully." NIH is currently reviewing the structure and

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