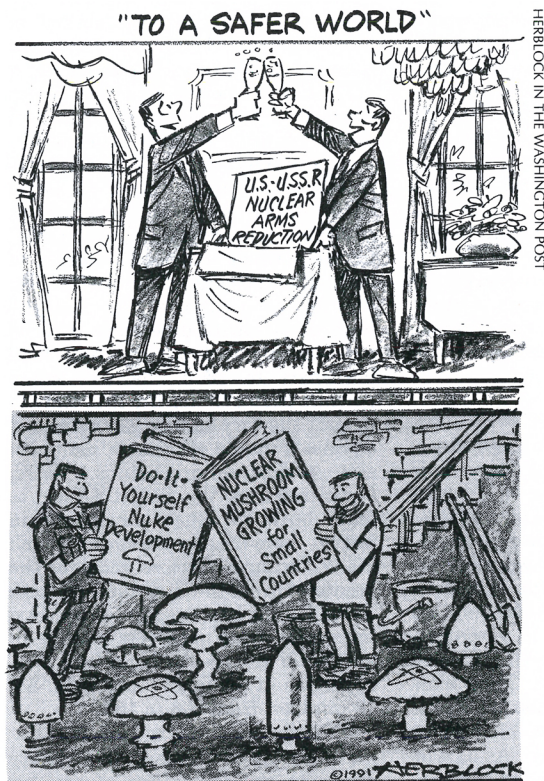


END OF AN ERA: SUPERPOWERS SIGN START, LIMITING NUCLEAR ICBMs

After nearly ten years of sporadic negotiations, the Soviet Union and US agreed on 16 July to a treaty reducing each of their strategic nuclear arsenals by about 30%—the first superpower agreement to cut back intercontinental nuclear delivery systems and their warheads. The 750-page treaty calls for extensive verification procedures that include on-site inspections of missile warheads, missile component plants and mobile missiles at their launch sites. The agreement was announced at the London economic summit of the Group of Seven industrialized democracies by President Mikhail S. Gorbachev and President Bush after days of negotiations about “breakouts” of the Anti-Ballistic Missile Treaty of 1972 and other issues. At the signing ceremony in the Kremlin on 31 July, Bush described the treaty as “the most complicated of contracts governing the most serious of concerns.”

The Strategic Arms Reduction Treaty, more familiarly known as START, limits each side to 6000 warheads, roughly half the number now in the Soviet arsenal of ballistic missiles and about one-third of those under US control. But accounting methods for warheads are not simple. Aircraft carrying gravity bombs, for instance, count as only one warhead, regardless of how many bombs are on board. Cruise missiles launched at sea are outside the treaty, although the two parties reached a binding compromise to limit the number each can deploy in the next five years.

So START is not a final farewell to nuclear arms. After the cuts are completed in long-range nuclear weapons in the late 1990s, both sides will still have huge arsenals almost the same size as when talks began just about a decade ago. What’s more, the treaty allows the US and Soviet Union to continue improving the accuracy, reliability and explosive yields of their nuclear weapons. Despite START, the principle of deterrence is certain to remain high on the policy priorities of both the US and



HERBLOCK IN THE WASHINGTON POST

Soviet Union. For 40 years they have held each other hostage with a threat that a first strike would unleash a devastating nuclear counterpunch.

The treaty covers only strategic weapons—those with ranges of more than 3000 miles. Seven years after it goes into effect, START would bring down the total of Soviet long-range nuclear warheads from nearly 11 000 to between 7000 and 8000 and the number of US warheads from 12 000 to about 10 400. Even so, when all warheads are counted—those on short-range nuclear missiles and in bombs carried by planes, ships and submarines—the US has a total of some 20 000 nuclear warheads and the Soviet Union about 30 000, according to the Natural Resources Defense Council, a private environ-

mental organization with strong concerns about limiting nuclear arms.

START, said *The Washington Post*, is “both a symbol of the past and a signpost to the future.” It reflects the thaw in cold war tensions and heralds the new uncertainties in world affairs. The disintegration of the Soviet empire and the disbandment of the Warsaw Pact reduce the threat of superpower hostilities. Nevertheless, say arms control specialists, there is a danger posed by nuclear weapons located in a Soviet republic that might secede or revolt and a fear that a “rogue” country like Iraq might acquire such weapons. These are reasons enough to make the world safer as quickly as possible.

The implications of START for US research and technology of nuclear

arms were discussed on 16 July by Energy Secretary James D. Watkins, the retired admiral who heads the department responsible for the design, production and testing of nuclear weapons. At a meeting of the Secretary of Energy Advisory Board in a windowless room of the Forrestal Building in Washington that morning, Watkins announced that the three weapons labs—Los Alamos, Lawrence Livermore and Sandia—would be given enlarged missions relating to modernization, verification, dismantling and safety of nuclear arms. Of course, the labs would continue their scientific and engineering weapons programs, he stated, and henceforth they would also be concerned with gathering information about “those rogue nations that don’t follow the Marquis of Queensbury rules on arms control.” START obligates DOE, he said, to make “the best use of the tremendous intellectual and technical resources” at the labs to keep tabs on the production of fissile material for warheads in other countries and to verify the elimination of retired warheads under the new treaty.

Verification and nonproliferation

Not surprisingly, Los Alamos, Lawrence Livermore and Brookhaven already have units dealing with verification and nonproliferation matters. Watkins intends to enlarge these. Other groups also are working on matters arising from START. The Federation of American Scientists and NRDC are organizing a workshop with Soviet scientists on the issue of warhead dismantlement. They plan a demonstration workshop in Washington in September, to be followed by a conference in November. As part of a study on nuclear weapons verification, the Office of Technology Assessment, an analytic group that provides Congress with policy options, recently examined US procedures for downloading and counting missile warheads, in keeping with provisions in START. The OTA team was permitted to count actual warheads within missile nose cones at Minuteman silos near Grand Forks, North Dakota, and at the King Bay Naval Base in Georgia, and to inspect aircraft bomb bays at the F. E. Warren Air Force Base near Cheyenne, Wyoming.

START provides for the same types of inspection procedures found in the Intermediate-Range Nuclear Forces treaty (PHYSICS TODAY, July 1988, page 47), which allows each side to inspect missile components at the factory gates of the other country and to monitor the destruction of missiles.

What’s new about START is that it enables each side to inspect MIRV nose cones. Unlike the INF treaty, though, START doesn’t deal with the disposal of nuclear warheads—an omission that could enable each side to reuse nuclear materials in reconfigured weapons.

By setting limits mainly on strategic ground-based missiles with multiple warheads, START encourages each side to improve its sea-launched weapons, gravity bombs and mobile ballistic missiles—all capable of withstanding a first strike and therefore increasing the retaliatory ability of each country. “The irony of START is if an enemy’s forces are survivable, it enhances the deterrent factor,” says Edward L. Warner, an arms control specialist at the Rand Corporation.

Accordingly, START is intended to stabilize the arms race. To begin with, START requires “substantial, equitable and verifiable reductions” in the nuclear warhead arsenals of both superpowers. The treaty also requires each country to reduce the number of warhead delivery systems for bombers, submarines and land launchers to 1600. Second, START permits each side for the first time to inspect the very same weapons aimed against it by the other side, using on-site verification procedures. Third, START requires the Soviet Union to scale back its huge advantage in heavy land-based missiles, which many Pentagon experts consider the greatest threat to US defense because those ICBMs are capable of destroying a wide swath of targets quickly. In particular the treaty requires a 50% reduction in the Soviet arsenal of SS-18 missiles, from 308 to 154.

It is this asymmetry that has angered Soviet hard-liners. The treaty works to the advantage of the US precisely because it requires the USSR to reduce far more long-range ballistic missiles and calls for fewer cuts in American long-range bombers and cruise missiles. Even so, START would allow the USSR to build up its long-range bomber squadrons.

The main sticking point in the last stage of the negotiations was the issue of “downloading”—that is, how many reentry vehicles could be offloaded from existing missiles on each side. Moscow’s attempt to download more missiles was an attempt to try to retain more of its missile force. Both the US and USSR prefer to reduce the number of warheads without building new missiles that are designed, say, for only three warheads. To do this, missiles that now carry seven warheads will be downloaded, and under the treaty these will be counted as

though they carry fewer warheads—even though they have spare capacity and, in the event one side or the other wanted to break out of the treaty, could be uploaded.

Another thorny problem was telemetry—the two-way radio link between a ground base and an intercontinental ballistic missile as it hurtles toward its target. The link enables operators on the ground not only to relay instructions to the ICBM but also to receive data from the missile’s sensors on flight performance, including the operation of its “bus”—the platform from which up to ten conical warheads are launched, one at a time, toward a test range or enemy site. For three decades, the two sides have tried to eavesdrop on each other’s missile telemetry, which is a rich source of intelligence about the capabilities and potential missions of ballistic missiles in flight.

The agreement is less ambitious than its advocates had wanted or than its initial advertisements had led many to believe. Each side will be left with thousands of strategic warheads that it is forbidden to deploy but that it need not destroy or dismantle, as well as thousands more tactical nuclear warheads. In addition, China, Britain and France together will continue to possess more than 1500 fission and thermonuclear warheads. The undeclared nuclear powers (including Israel and India, and probably Pakistan and South Africa) have a much smaller number.

Minimal deterrence

This situation creates an unacceptably dangerous nuclear world by any measure, says Roald Z. Sagdeev, director of the East-West Science and Technology Center at the University of Maryland and a former adviser to Gorbachev on strategic weapons. With Andrei Kokoshin, deputy director of the US-Canada Institute of Cultural Relations in Moscow, he wrote an article in 1987 advocating both deep cuts in US-USSR nuclear forces and minimal deterrence. “Since then, events in the Soviet Union and Eastern Europe have completely changed the nature of strategic military confrontation,” Sagdeev observes. “So now minimal deterrence is a concept whose time has come.” The idea has been taken up by Gorbachev, who published an article based on the Sagdeev-Kokoshin proposal in *Pravda* earlier this year. Gorbachev also has since named Kokoshin his principal adviser on arms control.

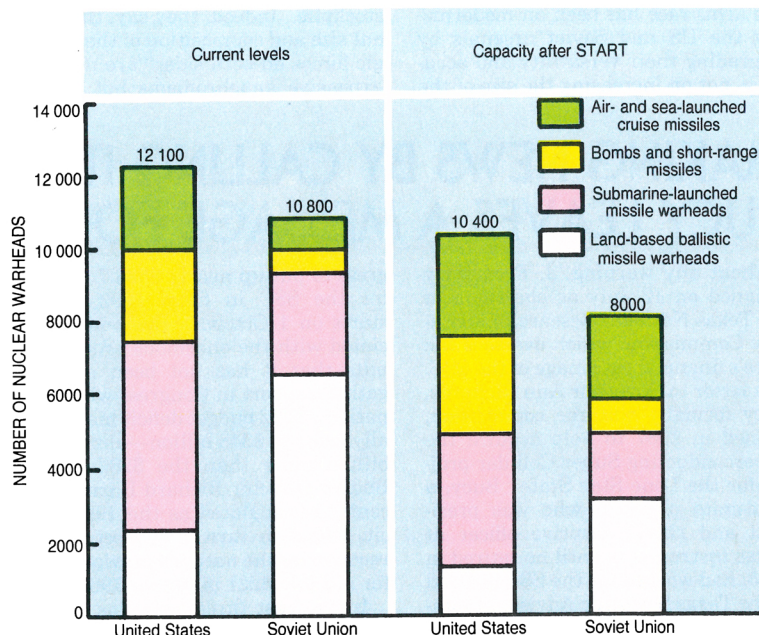
Another proposal that the superpowers make deep reductions more

rapidly appeared in the 27 June issue of *The New York Review of Books* under the coauthorship of Hans A. Bethe and Kurt Gottfried, both at Cornell University, and Robert S. McNamara, Defense Secretary in the Kennedy and Johnson Administrations. As they put it, "the crucial first step" is "a very deep and swift cut in US and Soviet nuclear forces, which should be reduced from their present total of warheads... to something on the order of 2000. To do so would, at one stroke, force the US and the USSR to adopt far less dangerous nuclear strategies and strengthen the global effort to halt the spread of nuclear weapons."

To reduce the nuclear threat, they suggest that the US and Soviet governments first recognize that their separate interests "would be best served by abandoning the strategies that have shaped their forces in the past" and adopting a strategy of minimum deterrence. In their concept of minimal deterrence, Bethe and his coauthors propose a ceiling of 5% of current levels of warheads, deployed in a combination of submarine, air and land-based delivery systems, with constraints on multiple warheads. They argue that it ought to be amply clear to all nations that any aggressor mounting a nuclear attack would suffer swift destruction "on a scale that would exceed anything known in the past."

By contrast, they write, "current strategies call for almost simultaneous attack on a vast range of military and industrial targets—some 5000 of them—while 'withholding' sufficient strategic forces to gain the upper hand in 'peace' negotiations." The authors also lay down a floor of an appropriate number of warheads that would make clandestine cheating unproductive and technical breakthroughs futile, as well as "make it difficult for either side to gain a significant advantage by a crash rearmament program should US-Soviet relations turn sour."

In addition, "tactical nuclear weapons should be eliminated from a region extending from the Atlantic to the Urals, and from naval vessels as well. There should be verifiable means of ensuring that undesirable kinds of weapons 'modernization' not take place. To that end, antisatellite weapons should be banned and ceilings imposed on missile flight tests to slow down innovation and to prevent the deployment of nuclear weapons specifically designed to attack command centers. The ABM treaty would have to remain in effect in order to give both sides confidence



Nuclear arsenals of the US and Soviet Union will be cut from the estimated current numbers of deployed and stockpiled warheads to the indicated levels in the late 1990s under the START agreement. (Source: Arms Control Association.)

that a sudden deployment of strategic defenses could not neutralize the minimum deterrent."

As for nonproliferation of nuclear weapons, Bethe, Gottfried and McNamara state that an international agreement would need to include the following measures to be effective: ceasing production of fissile materials for weapons, monitoring all nuclear weapons production facilities along the lines initiated by the INF and START accords, verification of warhead dismantling and destruction, and a sharp reduction in the number and yield of underground tests, with a commitment to ban all tests at some future date.

The test ban debate has engaged physicists for years—most recently in an exchange of articles and letters by Sidney Drell of SLAC and Frank von Hippel of Princeton in *The Bulletin of the Atomic Scientists*. In a report to the House Armed Services Committee earlier this year, Drell (and coauthors John S. Foster of TRW and Charles H. Townes of the University of California, Berkeley) concluded that tests continue to be necessary "to identify the potential sources of the largest safety risks and push ahead with searches for new technologies that... further enhance weapons safety." Von Hippel, in response, argues that the US nuclear arsenal, which al-

ready possesses an impressive safety record, "is in the process of becoming much safer." He cites a 1987 report to Congress by Ray Kidder of Livermore that stated that "nuclear weapons in the existing US stockpile are sufficiently robust to allow future replication" without further tests.

While nuclear proliferation has been less rapid than originally feared, the threat of third world nations obtaining the facilities and know-how to produce weapons and delivery systems is greater than their ability to purloin nuclear devices from countries in the nuclear club. The Nth-country problem, as proliferation was called in the 1950s and 1960s, is now more fearsome than ever. Bethe, Gottfried and McNamara argue that the superpowers must show by example that they are quitting the nuclear club. They assert that "the nuclear superpowers must demonstrate that they not only preach nuclear abstinence but are dramatically reducing their own nuclear addiction." In an unpublished paper, Sagdeev writes that moral and ideological pressures are becoming stronger for minimal deterrence at the very time that it is gaining prominence for political, economic and strategic reasons, including the proliferation danger.

In recent years, Bethe and his coauthors point out, the emphasis of

the arms race has been on modernizing the US and Soviet arsenals by upgrading their versatility and accuracy, not on increasing the size of the

stockpile. Indeed, they say, the present size and composition of the strategic forces on both sides "are not only expensive anachronisms but pose a

latent threat that can no longer be justified, even by the criteria that once led many to accept the risk of nuclear war." —IRWIN GOODWIN

MAKING NEWS BY CALLING IT QUILTS, BUCY LEAVES A MESSAGE FOR THE SSC

Without any warning, J. Fred Bucy resigned on 12 July as chairman of the Texas National Research Laboratory Commission, which oversees the state's financial patronage of the SSC. In a letter to Governor Ann Richards, Bucy formally quit the commission, formed in 1987 to help acquire the Superconducting Super Collider project for the Lone Star State. Bucy, a solid-state physicist who was president and chief executive officer at Texas Instruments until he retired in 1985, had worked for the SSC as head of the Texas Scientific Advisory Council before the Department of Energy chose a site near Waxahachie for the project in November 1988, immediately after the election of President Bush, an adopted Texan.

It was Bucy, in fact, who led the review of the 14 locations the state considered as possible sites for the giant collider before submitting its final choice to DOE. Despite his intense involvement, he turned down the offer to preside over the commission until he was pressed last October by Texas's lame-duck governor, William Clements Jr. Bucy's predecessors heading the commission were a succession of celebrated Texans: Peter T. Flawn, president emeritus of the University of Texas; Tom Luce, a wealthy lawyer prominent in state Republican politics and an associate of Ross Perot, the multimillionaire founder of Electronic Data Systems; and Morton H. Myerson, a former president of EDS and a principal backer of the resplendent new Myerson Symphony Center in Dallas.

Corralling contributors

Along with Bucy, these four were among the prominent Texans who helped lasso the SSC. They succeeded in corralling Texas voters and legislators to contribute \$1 billion. With this money, the state is buying some 16 700 acres of countryside in Ellis County, laying down roads and sewers, putting up power lines and buildings, and shelling out for pre-college education and graduate fellowships. The commission has lobbied Congress vigorously to fund the project in each of the last four years. Last February the Bush Administration asked Con-

gress to put up nearly \$533.7 million for the SSC in fiscal 1992, which starts on 1 October. Everyone associated with the enormous project admits that it has not been easy to gather support in Congress when the nation's 1992 budget deficit may actually come to \$348 billion—almost \$67 billion more than the \$282 billion Budget Director Richard Darman recently recalculated as the 1991 deficit, which in turn would set a new record over the nation's previous high for red ink, \$221 billion in 1986.

In the past three years, as budget requests for the SSC have burgeoned, opposition in Congress has increased, judging by the votes. In May, after an angry debate on the House floor, members voted 251 to 165 to continue funding the project, though they whacked \$100 million from the Administration's request. DOE and SSC officials claim that such a large cut would surely add at least six months to the project's construction schedule and run up the total cost by roughly \$210 million.

On the Senate side, Dale Bumpers, a veteran Arkansas Democrat, introduced an amendment to the 1992 energy bill on 10 July that would "zero out" the collider. The motion failed 62 to 37. The size of the opposition in this first "up or down" vote on the SSC ever cast in the Senate startled the project's proponents. Bumpers had argued against the supercollider mainly on budgetary grounds, mocking its current cost estimate of \$8.25 billion as nearly a 200% increase over the original figure of \$4.4 billion, reckoned more than four years ago. He also ridiculed the claims of advocates that the SSC would lead to many practical benefits and such commercial spinoffs as medical imaging. "You will find that the Superconducting Super Collider cures cancer and earaches and gives you an appetite if you are not hungry," he said facetiously during the floor debate. Seeking to persuade senators from Illinois, New York and California to join him in killing the project, Bumpers observed that "we cannot finance the supercollider and still finance Fermilab, Brookhaven and SLAC." When the SSC is completed

in late 1999, he noted, it is virtually certain that two of those labs will be closed. Of the senators from the three states, only Daniel Patrick Moynihan of New York, the final tally revealed, voted against the SSC.

Expecting a shortfall

Opposing Bumpers's amendment were two of the Senate's most influential Democrats—J. Bennett Johnston of Louisiana and Lloyd Bentsen of Texas, both chairmen of powerful committees and both representing states that stand to gain jobs and other economic benefits from the SSC. One surprising skeptic was Malcolm Wallop of Wyoming, who almost always accepts the Administration's line. He observed that Congress decided last year that no more than two-thirds of the total cost of the SSC should be paid out of Federal funds. Under the current estimate, said Wallop, the Federal share would be \$5.5 billion, and even with Texas's \$1 billion there is likely to be "a shortfall of about \$1.7 billion to be made up by foreign governments. . . . While I support the funding request in this year's appropriation, it will be much more difficult to support this project next year if there are no firm foreign commitments. . . . It would be prudent for the Department of Energy to present Congress with a plan on how to proceed without foreign contributions."

At the end of the debate, the Senate, by a vote of 96 to 3, passed its version of the 1992 Energy and Water Development Act, which assigned \$508.7 million for the supercollider—\$75 million more than the House. On 30 July, a subset of representatives and senators on the two Appropriations committees just about split the difference and gave the SSC \$483.7 million—exactly \$50 million less than the Administration had requested for fiscal 1992.

Bucy's resignation pointed up the SSC's funding dilemma—that without foreign contributions the project faces continued opposition in government circles as well as in science communities, where fears persist that megaprojects like the SSC and NASA's space station will siphon large sums from