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TEST BAN

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MILITARILY SIGNIFICANT NUCLEAR EXPLOSIVE YIELDS

Ray E. Kidder

I.

The military significance of nuclear tests, particularly those at low yield, is a factor of fundamental importance in evaluating the desirability or acceptability of either a Comprehensive Test Ban Treaty (CTBT) or a Reduced Threshold Test Ban Treaty (RTTBT). If seismic detection is to be the primary means of verifying treaty compliance, we need to know the military significance of nuclear tests with yields too low to be reliably detected and identified by such means.

Although the technical details and other specifics of nuclear tests are classified, it is nevertheless possible to obtain a measure of perceived military significance versus yield by observing the frequency with which tests at different yields have been performed. This is the approach we shall follow, keeping in mind the fact that the military significance of tests at a given yield will be increased if tests at higher yield are prohibited.

II. Probability-Density Distribution and Cumulative Distribution of U.S. Nuclear Explosive Yields: *1980 through 1984*

In Figure 1 we show the distribution of explosive yields of U.S. nuclear tests conducted during the five calendar years 1980 through 1984. All of these tests were conducted for military purposes at the Nevada Test Site (NTS). No tests were conducted with yields in excess of 150 kilotons, in compliance with the Threshold Test Ban Treaty (TTBT, unratified).

In Table 1 below we list values of the cumulative distribution function P, i.e., the percentage of tests conducted with yield less than Y, versus Y.

Table 1

Percentage P of Tests Conducted with Yield Less than Y

Y(kt)	1	5	20	50	150
P(%)	5	18	62	74	100

III. Military Significance of Tests of Various Yields

If we assume that the number of tests performed in the neighborhood of a given yield constitutes a measure of the military significance of tests at that yield, at least in the eyes of those responsible for deciding what was to be tested, then we may interpret Figure 1 as a graph of (perceived) military significance versus yield, given the constraints on testing that then existed. Inspection of Figure 1 discloses that during 1980 through 1984 the military significance of tests below one kiloton was perceived to be low, whereas that of tests in the vicinity of 10 kt and 150 kt was high. The accumulation of tests near 150 kt is partly the result of testing, at reduced yield, strategic weapons whose yield would otherwise exceed the TTBT limit.

(Continued on page 2)

COMPREHENSIVE NUCLEAR TEST BAN: WHEN AND HOW

The decision by Secretary-General Gorbachev to announce a five-month moratorium on underground nuclear testing put nuclear testing back in the spotlight temporarily. But can such an agreement to end nuclear testing be achieved, and how?

The Reagan Administration, over and above its basic antipathy to arms control agreements per se, wants to continue underground nuclear testing. Even if it were totally content that its standard objections were met—that Soviet cheating was impossible and that nuclear testing of our stockpiled nuclear weapons was unnecessary—it would still want to avoid an agreement banning nuclear tests. The more obvious reasons have to do with testing "third-generation" nuclear weapons for Star Wars uses. More generally, the U.S. nuclear weapons laboratories press to stay in business testing.

This general desire to test generated charges that the Soviet Union was cheating on the best ban—charges now conceded to be false. (See pg. 4)

Accordingly, discussing ways and means of moving toward a comprehensive nuclear test ban has a certain irrelevance to it. After all, what to try for and how depends upon political circumstances. The Federation opposed ratification of the 150-kiloton-limit Threshold Test Ban Treaty when it thought the Carter Administration would and could do better, but it supported the ratification of this Treaty when the Reagan Administration came in, on the certain grounds that the Reagan Administration would do nothing more than, at most, ratify this already negotiated and signed agreement.

Looked at from this point of view, one can imagine Administrations that would negotiate, sign, and then even succeed in ratifying a comprehensive nuclear test ban treaty. Others might simply try to lower the 150-kiloton limit to 5 kilotons (or one kiloton) while still others might try to negotiate quotas on nuclear tests, perhaps of diminishing size, as way stations toward a general halt.

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Referring to Table 1, we see that had the TTBT yield limit been 5 kt instead of 150 kt, approximately 80% of the U.S. tests carried out during the 1980 through 1984 period would not have been performed. The military significance of such a yield limit was indicated in a letter dated April 19, 1977 from Dr. Harold Agnew, then director of the Los Alamos Scientific Laboratory, to Congressman Jack F. Kemp, in which he stated that:

> "I don't believe testing below say five or ten kilotons can do much to improve (as compared to maintaining) strategic posture, but clearly it can provide improvements at the theatre level, where yields of less than five kilotons are important. Being able to test up to a few kilotons allows a dynamic program for maintenance and development of theatre nuclear forces."

Alternatively, if the yield limit had been one kiloton, 95% of the tests conducted during 1980 through 1984 would not have been possible. The military significance of yields in the vicinity of one kiloton was indicated in the testimony of Dr. John S. Foster, Jr., then Director, Defense Research and Engineering, DOD, before the Subcommittee on Arms Control of the Senate Foreign Relations Committee on May 1, 1973, in which he stated:

> "In my view, Mr. Chairman, a kiloton is a very significant yield. Now, I will admit there are some cases where a half-kiloton can be very significant or a quarter of a kiloton. But certainly I know that a kiloton is a very significant yield from a military point of view. Clearly, as one raises the level above that, the number of possibilities that are included grows and so does the significance."

We note that these earlier statements of Foster (1973) and Agnew (1977) concerning the military significance of nuclear tests as a function of yield are consistent with our "military significance" interpretation of the recent test record (1980 through 1984) as presented in Figure 1.

IV. Experiments with *Potential* Military Significance: Nuclear Weapons Research

It is not necessary to conduct nuclear tests with yields as large as one kiloton in order to create energy densities and states of matter that can be achieved (on a substantial scale) only with nuclear explosives. We need only recall that a 150-ton yield in, say, 30 lbs. of fissionable material represents an energy density 10,000 times that of chemical explosives. Although relatively low yields such as this have little *direct* military significance (except for atomic demolition munitions where a low yield is necessary), they nevertheless have considerable *indirect* or potential military significance in providing a unique capability for carrying out significant nuclear weapons research and tests of nuclear weapons effects. A facility in which such low-yield tests could be safely conducted has been under consideration for some time.

For example, in 1981 a study was begun at Lawrence Livermore National Laboratory of a High Energy Density Facility (HEDF), a reusable underground facility to be located at the Nevada Test Site, in which nuclear explosions would be fully contained with yields up to 300 tons at a rate of one test per week (more than double the present U.S. testing rate). Although there are no plans to build such a facility at the pre-

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sent time, there is little doubt that it could be built at reasonable cost (a few hundred million dollars). The feasibility of such a useful, seismically quiet test facility will surely be raised as an objection to a CTBT. It would not only allow nuclear weapon research of considerable potential military significance to be done but also provide a vehicle for maintaining the skill and interest of nuclear weapon designers.

V. Conclusions

The recent test record shows that the perceived military significance of nuclear tests with yields between one kiloton and fifteen kilotons is high, 50% of all tests having been conducted within this range. On the other hand, the record shows that the significance of nuclear tests with yields less than a kiloton, relative to that of tests at higher yield, is low. So long as tests with substantially higher yield are permitted, interest in tests below a kiloton will probably continue to be modest. However, if all tests above one kiloton were forbidden, there would doubtless be a marked increase in both interest and military significance of sub-kiloton tests. Preliminary studies indicate the feasibility of conducting such tests in a seismically quiet, reusable test facility at roughly double the present U.S. testing rate.

Dr. Ray E. Kidder has been a senior physicist at the Lawrence Livermore National Laboratory for 29 years, working in the areas of nuclear weapons physics, laser fusion, and laser isotope separation. More recently he has been studying the design and applications of low-yield nuclear explosives, and the design of a reusable underground High Energy Density Facility (HEDF) capable of safely containing repeated low-yield nuclear tests.

SEISMIC METHODS WORK DOWN TO 0.1 KILOTONS

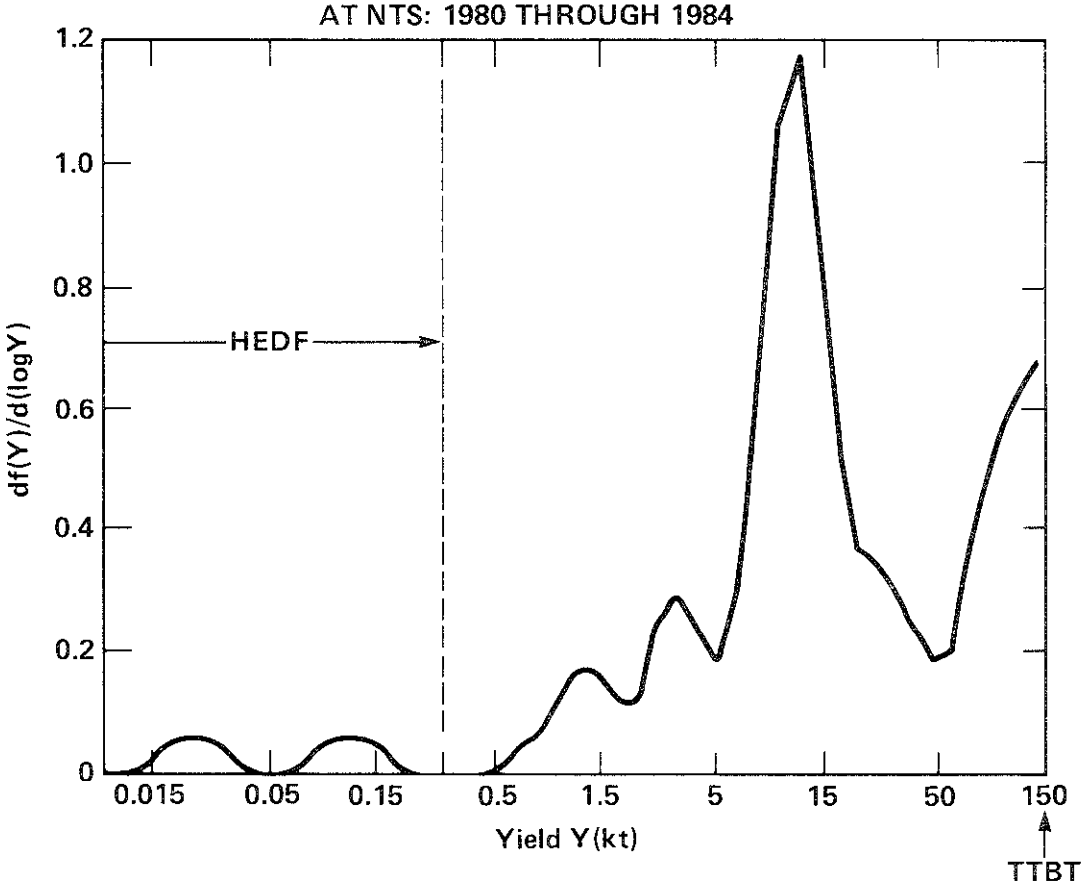
External networks provide high confidence in the detection of U.S.S.R. explosions in hard rock of about 1 kiloton and larger. The addition of stations internal to the Soviet Union [Editor's Note: which was agreed to in the test ban negotiations completed under the Carter Administration] provides a capability of about 0.1 kiloton for hard rock.

...Big Hole evasion has been seriously overrated for a number of reasons. The volume of rock that must be excavated to fully decouple an explosion of about 8 kilotons is approximately equivalent to the volume of the largest Egyptian pyramid, a fact that pessimists usually forget to tell you. Experience with the one atomic explosion that the U.S. detonated to test this idea, as well as theory, indicates that muffling is not as strong at high frequencies, i.e., there coupling is about a factor of 10 rather than 100...

With a high-frequency capability and seismic monitoring posts in the Soviet Union, it should be possible with high confidence to verify even the most strenuous attempts to cheat at a level of 1 kiloton and larger.

—Lynn R. Sykes to House Foreign Affairs Committee, May 8, 1985

DISTRIBUTION OF EXPLOSIVE YIELDS AT NTS: 1980 THROUGH 1984



The curve plotted shows the relative frequency with yield Y versus that yield for all tests at the Nevada Test Site (NTS) from 1980 through 1984. The vertical scale is designed to produce an area under the curve of one so that the relative probability of a test being of a given yield Y can be seen immediately. The dotted line shows the limit of yields that could be fully decoupled (i.e., be made seismically quiet) by a proposed High Energy Density Facility (HEDF).

f(Y) = Fraction of Tests with Yield Less Than Y

(Continued from page 1)

As a recent study of U.S.-Soviet relations reveals (Raymond L. Garthoff's brilliant "Detente and Confrontation"), the Carter Administration had a hard time deciding what exactly it was negotiating. Its desire for a permanent comprehensive nuclear test ban was shifted to a temporary ban with, and then without, any presumption of continuing. The Carter Administration negotiators were never able to define what, in fact, a total nuclear test ban would mean! What would be the "zero"? Would it include pellets detonated in the process of experiments on fusion? Presumably not. But there is a continuum of nuclear testing sizes that are available to the researchers. Indeed, as the article by Dr. Kidder reveals, these researchers are studying the possibility of fully containing nuclear explosions in a reusable underground facility that would test 300-ton explosions (⅓ of a kiloton) at a rate (one per week) that would actually double the present U.S. testing rate.

The mere possibility of such a confinement facility in the Soviet Union and a host of other considerations would lead future Administrations, sympathetic to a total test ban, to consider two alternatives:

(1) To negotiate a total test ban by assuring the American public that non-seismic means of intelligence (satellites, listening in on Soviet phones, or whatever) could reveal the existence of such facilities and, moreover, that a few tests done in secret at low explosion levels would have little strategic significance; or

(2) Limiting the Treaty to explosions above a very low threshold normally taken to be one kiloton or five kilotons and using seismic means of verification as the main publicly advanced method of verification.

The first alternative would require an Administration even more committed, and much more unified, than the Carter Administration in which the CIA Director and NSA officials, among others, took a strong pro-test ban position. The Joint Chiefs of Staff and the Secretary of Defense would have to sit on the weapons laboratories and argue that continued testing was not of much use. Above all, there would have to be no imminent need for testing felt by the Administration, as is the case with Star Wars weapons.

The second alternative would vent pressures at the labs by permitting some tests, and finesse political pressures in Washington by claiming less for verification. At five kilotons, especially, the laboratories would feel more comfortable. And, no doubt, as time went on, they would find that they could do more and more under whatever threshold they were given. (This is, of course, exactly what happened when the Partial Test Ban Treaty stopped testing everywhere except underground and the previously difficult below-surface tests became the only possibility; the overall rate of testing actually increased.)

In any case, the Reagan Administration is not interested in either one. And the real significance of the Gorbachev proposal lies, perhaps, in the fact that it suggests a readiness to go for a total test ban (or some approach to it) if and when a future Administration wants to try.

—Jeremy J. Stone

SOVIET COMPLIANCE WITH THRESHOLD TREATY NOW GENERALLY CONFIRMED

The Reagan Administration broke off talks on the Comprehensive Test Ban in 1982 in part because it believed the Soviet Union was cheating on the 150-kiloton limit mandated by the signed, but unratified (by the U.S.), Threshold Test Ban Treaty of March 31, 1976. (The other reasons given were that seismic methods were inadequate to verify a Comprehensive Treaty and that U.S. security was best enhanced by testing new weapons.)

The charges were based on what now is generally admitted to be a misreading of seismic signals. Using data from the Nevada test site, which has had recent tectonic activity, to interpret explosions at the Soviet test sites, which have had no tectonic activity in the last several hundred million years, led some seismologists to overestimate the size of Soviet explosions.

The confusion was compounded by the fact that before the Threshold Test Ban Treaty was signed, the Soviets were doing tests of 150 kilotons at their high-yield testing site at the Arctic-Novaya Zemlya, whereas after the signing, they moved explosions near that limit to their less remote Semipalatinsk site (STS) which had, until 1977, been confined to 50-kiloton explosions or less.

Jack Evernden of the U.S. Geological Survey writes about what then transpired inside our bureaucracy:

> "It is obvious from seismological observations that yields at STS have increased by a large factor since the (150-kiloton limit) Treaty went into force. After the Treaty went into force, the Soviets either were soon testing far above permitted yields or the U.S. had badly overestimated yields of Soviet explosions for many years. As a matter of long-demonstrated seismological fact, the latter was the case. The open seismological literature contained all the relevant quantitative data proving this point. After elaborate discussion in the U.S. government, it was concluded that the old analyses were indeed proof of magnitude bias. However, for some obscure reason, it was decided to adopt a bias value one-half of that implied by the seismological data."

Elaborate arguments for what the Soviets were doing then went forward, even including the charge that they had diabolically learned the degree of bias we were using and were exploiting it. When these and other hypotheses were proven false, it became obvious that the answer was to accept the full bias suggested by the seismic evidence, after which all became quite clear. The largest tests from 1976 and thereafter were found to have yields close to the permitted 150 kilotons estimated either from short- or long-period seismic waves.

FAS Council Member Lynn Sykes of Columbia has played a leading role in the interagency and public wars to rectify this misuse of science to charge Soviet cheating.—*JJS*

MILITARY ADVANTAGE OF THE COMPREHENSIVE TEST BAN

The Comprehensive Test Ban Treaty (CTBT) would provide one military advantage for the United States that has been generally overlooked in the CTBT debate. The CTBT would preserve the continuing American lead over the Soviet Union in light-weight, efficient warheads. In the absence of a CTBT, the Soviets could significantly improve the yield-to-weight ratios (the maximum yield that can be obtained from a warhead of a given weight) of their warheads.

If the Soviets were to achieve the yield-to-weight ratios of American warheads, this could result in an effective doubling or tripling of the number of warheads on their missiles, without adding a single missile to their arsenal.

The United States had traditionally concentrated on small, solid-fueled missiles with limited payloads. Thus American weapons designers have had the incentives to improve yield-to-weight ratios in order to increase the number of warheads that each missile can carry, and to reduce the weight and cost of each missile. The Soviets until recently were content with large liquid-fueled missiles, and their warhead designers were not compelled to seek significant improvements in yield-to-weight ratios.

Why Yield-to-Weight Ratios Matter

Some Administration officials, including Paul Nitze and Richard Perle, have sought to make limitations on total missile payload (or throw weight) the principal objective of the current arms control talks (the total throw weight of American ballistic missiles today is about 2,000,000 kilograms; the Soviet figure is several times larger). They argue that payload is the best measure of the lethality of a missile. This might be true if Soviet and American yield-to-weight ratios were the same, but they are not.

Advocates of throw-weight limitations argue that if the Soviets were to take advantage of their substantial lead in throw weight they could achieve militarily significant advantages. Substantial increases in the number of Soviet warheads could improve their prospects for the destruction of fixed land-based missiles. Perhaps even more important, additional warheads could also be used to barrage bombers, mobile missiles, and submarines, raising the spectre of new "windows of vulnerability." They could also be used to overwhelm an American anti-missile system designed to protect missile silos or cities.

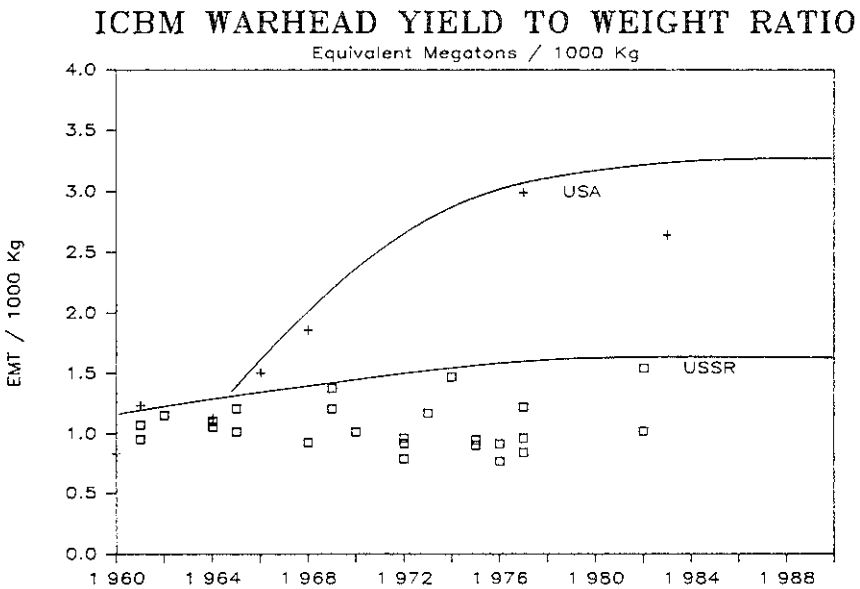
The CBTB and the Preservation of the American Lead

In the absence of negotiated deep reductions in Soviet ballistic missile throw weight, the most direct means of preventing the Soviets from taking advantage of their current lead in missile throw weight would be by preventing them from improving the yield-to-weight ratio of their missile warheads. The Comprehensive Test Ban Treaty is the best, if not the only, way of achieving this.

Improving the yield-to-weight ratio of a warhead is a difficult task, requiring the use of novel components and materials fitted together with very exacting tolerances. These improvements require extensive testing to verify that the design innovations work together as planned. Unlike stockpile confidence testing, which typically involves only the low-yield fission primary of a weapon, testing of an improved design requires testing at full yield, or at some significant fraction (perhaps 25% to 33%) of the full yield.

Limitations in Soviet warhead fabrication and manufacturing capabilities seem to have discouraged them from attempting the sophisticated and exacting designs that characterize American nuclear weapons. However, in the absence of a CTBT, there is nothing to preclude them from doing so in the future.

—John E. Pike



Yield-to-weight ratio is usually expressed in terms of "equivalent megatons" (which is the yield to the two-thirds power) per 1,000 kilograms of warhead weight. This graph plots the yield-to-weight ratios of Soviet (squares) and American (crosses) ICBM warheads over time. Each data point corresponds to the first year of deployment for various missiles of the two countries. The United States has significantly improved the yield-to-weight ratio of both its ICBM and SLBM warheads over the past several decades, although a limit seems to have been reached recently. While the Soviets have also made some improvements, they have not progressed as rapidly as the U.S. As a result, the Soviets have continued to lag behind the United States, and this gap widened in the 1970s.

UNIVERSITY DEBATE ON STAR WARS RESEARCH

"...I call upon the scientific community who gave us nuclear weapons to turn their great talents to the cause of mankind and world peace: to give us the means of rendering nuclear weapons impotent and obsolete."

—President Reagan, March 23, 1983

With these words, President Reagan invited the nation's scientists to make the "Star Wars" dream of an impenetrable shield against incoming missiles possible. Some scientists have in fact rushed for their share of the more than $600 million over the next five years in Strategic Defense Initiative (SDI) funding for university-based research. Administration official James A. Ionson was recently quoted as saying that "virtually everyone, on every campus, wants to get involved."

Despite the Administration's enthusiasm and a reported 1,000 research proposals received at the Washington office of the Strategic Defense Initiative Organization (SDIO), there is growing opposition among university scientists throughout the U.S. to participation in SDI. At the University of Illinois at Champaign-Urbana, 57 of 72 physics professors have signed a pledge not to apply for or accept funding from SDIO. Cornell University, one of four national supercomputer facilities (as is Illinois), has a similar petition circulating among its science and engineering departments, with over 150 faculty signatures so far. Additional petitions are flourishing at the University of California at Santa Barbara, at Berkeley, and at MIT. A combined petition from the Illinois and Cornell versions is being distributed nationally (see box).

Some of the points raised by scientists reluctant to accept SDI research funding include the following:

- Technical feasibility—Many scientists disagree with the Star Wars proposal because it simply will not work. David Parnas, Professor of Computer Science at the University of Victoria in British Columbia, resigned from an advisory panel on battle management on the grounds that the software to control a leakproof missile defense system could not be achieved. According to Parnas, "It is our duty, as scientists and engineers, to reply that we have no technological magic that will accomplish that."
- Risk of war—In the 18 months since the program was announced, there has been little indication that Star Wars will, in fact, render nuclear weapons obsolete. Nor, as was originally promised, is the system designed to protect individuals. According to Professor Michael Weissman of the University of Illinois, the SDI is "a step toward nuclear war," which is one of that university's main arguments against accepting any SDI research money.
- Academic freedom—As voiced in the Cornell-Illinois petition, "it is likely that SDI funding would restrict academic freedom and blur the distinction between classified and unclassified research." Moreover, unclassified research, if successful, may be declared classified. The rights of scientists to publish their results may accordingly be at risk. Other implications of university research conducted under SDIO include the possibilities of security clearances for researchers, restrictions on foreign staff and visitors, and, ultimately, the

PETITION FROM ILLINOIS-CORNELL ON SDI RESEARCH

We, the undersigned science and engineering faculty, believe that the Strategic Defense Initiative (SDI) program (commonly known as Star Wars) is ill-conceived and dangerous. Anti-ballistic missile defense of sufficient reliability to defend the population of the United States against a Soviet attack is not technically feasible. A system of more limited capability will only serve to escalate the nuclear arms race by encouraging the development of both additional offensive overkill and an all-out competition in anti-ballistic missile weapons. The program will jeopardize existing arms control agreements and make arms control negotiation even more difficult than it is at present. The program is a step toward the type of weapons and strategy likely to trigger a nuclear holocaust. For these reasons, we believe that the SDI program represents, not an advance toward genuine security, but rather a major step backwards.

The likelihood that SDI funding will restrict academic freedom and blur the distinction between classified and unclassified research is greater than for other sources of funding. The structure of SDI research programs makes it likely that groups doing only unclassified research will be part of a Research Consortium and will therefore work closely with other universities and industries doing *classified* research. SDI officials openly concede that any successful unclassified project may *become* classified. Moreover, the potentially sensitive nature of the research may invoke legal restrictions required by the Export Administration Act.

Participation in SDI by individual researchers would lend their institution's name to a program of dubious scientific validity, and give legitimacy to this program at a time when the involvement of prestigious research institutions is being sought to increase Congressional support. Researchers who oppose the SDI program yet choose to participate in it should therefore recognize that their participation would contribute to the political acceptance of SDI.

Accordingly, as working scientists and engineers, we pledge neither to solicit nor accept SDI funds, and encourage others to join us in this refusal. We hope together to persuade the public and Congress not to support this deeply misguided and dangerous program.

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termination of academic participation in the project.

• Effects on other research—The lure of readily-available SDI funds may divert university resources from other projects, leading to the neglect of non-SDI areas of research. Another concern is that universities which commit heavily to SDI research may later find themselves without support as the appropriations debate intensifies between Congress and the Administration.

In summary, if scientists are being asked to provide the technological breakthroughs for the SDI, then the scientific community must consider carefully the ramifications of soliciting and accepting Star Wars funding. The Federation of American Scientists is currently formulating its official policy on SDI university research funding and is seeking an observer at each university to report to FAS by our December Council Meeting on the reactions at that university.

Accordingly, members in a position to do so are encouraged to send the Federation a memorandum on their university's debate on this issue. (Unless otherwise restricted, the editor of the FAS Public Interest Report will feel free to excerpt such material in a subsequent newsletter.) For further information, contact the undersigned at our office.

—*Vanessa Lide*

Book Review
STRATEGIC COMMAND AND CONTROL

Few books in the defense community library have as much to recommend them as Bruce Blair's *Strategic Command and Control* (Bookings Institution, 1985).

In the first place, this book is enormously well-informed about details of strategic interactions rarely commented upon. In effect, it explains what would have happened to our strategic forces in the event of a full-scale attack on them in several previous periods. Each of these chapters would have been, if prepared in the time period at issue, so highly classified that only a handful of people could have been given access to them. Even the best-informed specialists will learn much from this book.

In the second place, this volume reveals the strategic absurdity of matching the Soviets missile for missile because it shows, dramatically, how much weaker is the command and control of both sides' forces than the forces themselves. Blair believes that any Soviet decision-maker who got sufficiently desperate to attack in some future crisis would go for the command and control and try to "decapitate" the U.S. ability to respond. In this argument, he makes a good case that money would be better spent protecting command and control than increasing forces.

Not least important, this volume weaves together the disparate strands of force capability and bureaucratic controls over those forces. Written by a former Minuteman missile launch control officer who later worked on the SAC Airborne Command Post, the book shows a wealth of detail that no outsider could ever accumulate.

Blair's conclusion is that, since the 1960s, a Soviet attack could "isolate almost all U.S. forces and sharply reduce coordination among those remaining." Even if U.S. forces were already alerted, such an attack could still "isolate most forces and severely reduce the effectiveness of the rest." Soviet planners, he believes, could hardly fail to appreciate that "their only chance to block retaliation would be to paralyze U.S. command and control and intelligence."

Bruce Blair

As a consequence, the overall strategic balance over time has been "relatively unaffected" by changes in the size and composition of the technical arsenals. Thus where the doves see the balance as irrelevant due to "overkill," Blair sees the balance, as normally measured, as irrelevant for quite another reason—the weakness of command and control.

One casualty of this analysis is, for example, the theory of Paul Nitze that the Soviets might attack our forces and then bargain. An attack on our forces, Blair argues, would "create almost irresistible pressure on the U.S. command system to commit all its forces before greater command and control disruption could take place."

In Blair's analysis, neither side would strike first under normal circumstances. But if either found itself expecting an attack from the other, it would have an incentive to attack first in an effort to pre-empt such a threat.

In his view it is symptomatic of this instability that "the programmed emergency operation of nuclear organizations are geared for launch on warning."

One conclusion is to avoid raising the alert level of strategic forces: "To flex military muscle as part of crisis diplomacy is to transform a latent instability into a salient one."

But the long-term goal would be to avoid policies requiring "immediate second use." We would want to return to the period when we could ride out attacks and respond deliberately thereafter. Blair even wants consideration of "undersea command posts" using Trident or retired Polaris submarines.

Whether the world in general will ever stop measuring the strategic force balance in terms of missiles and warheads is hard to say. But there is little doubt but that Blair's approach is far more accurate in measuring the strategic outcome of nuclear war than the customary assessments. And since the only time in which deterrence is likely to fail is in crises when war is expected, Blair's volume is required reading for those who want to strengthen deterrence at the point where it is weakest.—*JJS*

HERBERT SCOVILLE, JR., DIES

Herbert (Pete) Scoville, Jr., one of the arms control community's leading spirits, died of cancer at 70 years of age on July 30.

Scoville had worked for the Central Intelligence Agency (CIA) from 1955 through 1963, rising to the rank of Deputy Director for Science and Technology. While little is publicly known of his work there, which included examining U-2 photographs and such, it is clear from his arguing for a comprehensive test ban as early as 1954, and from his later career, that he was, throughout, an opponent of the arms race.

This became more evident to the public in the subsequent six years at the Arms Control and Disarmament Agency where he functioned as Assistant Director for Science and Technology.

It was, however, in 1969, in his mid-fifties, that he began a final and most public phase of his life: public advocacy of arms control.

In the earliest part of this career, he worked closely with the Federation, testifying frequently for it, serving as its Secretary from 1970-75, and as Chairman of the FAS Strategic Weapons Committee, and even standing for election as Vice-Chairman.

In 1971, he became the catalytic force behind the founding of the Arms Control Association (ACA). Serving as its President, he saw ACA become a respected spokesman for arms control positions and a center for arms control educational work.

Along the way, he was indefatigable in providing advice to organizations of all kinds and served on the Boards of such organizations as Council for a Livable World, Union of Concerned Scientists, Center for Defense Information, and others.

Scoville used two canes to get around following a bout with arthritis but was never slowed down. He was tireless in attending conferences and very productive in commentary on the arms race. A frequent contributor to the New York Times op-ed page, the author of two relevant books, and the frequent organizer of petitions and appeals, he was everywhere seen and heard.

Even while engaged in a struggle with cancer, Scoville produced the lead article in the June, 1985 issue ofArms Control Today, entitled "Reciprocal National Restraint: An Alternative Path." Both as a force for such restraint and as an example of public service, he will be badly missed.

The deaths of Scoville, Adrian Fisher (1983) and George Kistiakowsky (1982) reduce significantly the pool of former Government officials who saw the arms race from virtually the beginning and opposed it throughout. The senior statesmen of our community are passing on even while the groups proliferate.

ARCHIE L. WOOD JOINS FAS

Mr. Archie L. Wood, former Vice President of TRW for Information Resources, has joined FAS as Associate Director for Strategic Weapon Policy. Mr. Wood, an engineer by training, was Deputy Assistant Secretary of Defense (Strategic Programs) under President Nixon and later, while at the Brookings Institution, wrote (with Alton H. Quanbeck) an influential book on the limitations of the B-1 Bomber. Mr. Wood's initial emphasis at FAS will be on problems of sea-based counterforce.

A box in the June FAS report entitled "Bethe on Teller" was excerpted from the text of a conference. The context of the excerpt supports this communication from H.A. Bethe:

"I was asked who could write a good article in favor of Star Wars for the Bulletin of the Atomic Scientists in which, of course, technical arguments should be emphasized. I believe Teller's strength lies in different directions; he would not be the best person to write such an article."

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Zip
PRIMARY PROFESSIONAL DISCIPLINE _____