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A ONE-KILOTON TEST LIMIT INSTEAD OF A COMPREHENSIVE TEST BAN?

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Summary

A recommendation has been forwarded to the White House that President Clinton not implement the law passed by Congress and signed by President Bush on 2 October 1992, that the U.S. seek to achieve a Comprehensive Test Ban (CTB) by October 1996. Instead the weapons labs propose that the U.S. attempt to negotiate a one-kiloton threshold test ban with Russia, Britain, China and France.

In fact, while a CTB appears within reach at this time, a one-kiloton test limit would probably not be accepted by all the other four nuclear weapon states, which do not have the same capabilities as the U.S. to use results from low-yield tests to design higher-yield warheads. Since the U.S. weapons labs would fight against accepting testing restrictions that were not accepted by other countries, their proposal, if accepted, would torpedo the possibility any new testing limits. The real technical difficulties of verifying a one-kiloton test limit could also be used to indefinitely prolong the negotiations for a one-kiloton theshold test ban.

Even if a one-kiloton threshold were accepted by the other nuclear-weapon states, reneging on the U.S. commitment to seek a CTB would undermine our efforts to strengthen the nonproliferation regime. Nuclear testing at any yield communicates the attitude that nuclear weapons are useable. For that reason, the vast majority of non-nuclear weapon states are demanding a complete halt to testing by the nuclear weapon states as a price for their cooperation for an indefinite extension of the Nonproliferation Treaty in 1995. The U.S. could probably achieve an extension of the NPT for a limited period without making a commitment to a CTB but it would be unlikely to get adequate support for other nonproliferation measures, such as sanctions against proliferators. Continued U.S. testing would also tend to reduce the inhibitions of key "threshold" countries such as India against bringing their nuclear arsenals out of the closet.

U.S. testing at sub-kiloton levels could also foster the belief that we are developing "mininukes" for use in future Desert Storm-type battles in the Third World. Nothing could be more undermining of the legitimacy of the nonproliferation regime.

The weapons labs argue that continued testing at yields up to at least one kiloton is required in order to maintain the reliability of U.S. nuclear weapons. However, the most comprehensive analysis of historical data has found that nuclear tests are not necessary to test the reliability of already well-tested designs that have been in the stockpile for some years. Indeed, fielding new designs based on the results of sub-kiloton tests would probably reduce confidence in the reliability of our nuclear stockpile.

The weapons labs argue that seismic identification of an underground nuclear test below a kiloton could in theory be evaded by the "big-hole" decoupling technique. However, this technique is difficult and uncertain and susceptible to being revealed by human intelligence or other surveillance techniques. It is extremely doubtful that any sustained program of clandestine testing would remain undetected.

The arguments for the 15 tests proposed by the weapons labs prior to the testing phaseout deadline are also quite weak. Nine of these tests would be used to develop designs with safety improvements that have been rejected by the Departments of Defense and Energy as cost ineffective to implement. The three "reliability" tests would not, in fact, test the reliability of existing warheads but would instead be designed to prepare for a one-kiloton test limit by establishing that the results of such low-yield testing can reliably predict warhead performance at higher yields. The final three tests would nominally be "UK tests" at the Nevada test site. However, the UK nuclear-weapons design program is virtually fully integrated into the the U.S. program and therefore does not require additional tests any more than does the U.S. program. Finally, there is also the very troubling possibility that the weapons labs may be planning to carry many more than the maximum of 15 tests permitted by Congress by carrying out additional test explosions for unapproved purposes simultaneously with those 15. These additional tests would be undetectable by seismic means.

Rather than undermining U.S. nonproliferation policy with an indefinitely continued and provocative nuclear testing program, the U.S. government should take advantage of the current Russian-French-U.S.-U.K. testing moratorium to move quickly toward a Comprehensive Test Ban.

The Testing Phaseout Law

In the fall of 1992, after many years of debate and the end of the Cold War, Congress voted in the FY 1993 Energy and Water Development Appropriations Act (section 507) to end U.S. nuclear testing by 30 September 1996, the end of fiscal year 1996,* "unless a foreign state conducts a nuclear test after this date." President Bush reluctantly signed the bill on 2 October, apparently because it also contained funding for projects such as the Superconducting Supercollider which he considered critical to his reelection.

Presidential candidate Clinton made clear that he would sign the legislation even if President Bush did not. On 18 September 1992 he stated that his Administration would

> "finally sign off on the [approach] which would permit some testing for a few years, working toward an absolute ban, providing testing for safety in the near term.

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* The section appears as an ammendment submitted by then Representative Aspin in the *Congressional Record* on p. H9424, 24 September 1992.

"I know there is a big dispute about this but let me say that France has stopped testing; Russia has stopped testing. And I perceive the biggest threat in the future to be, as I've said earlier, the proliferation of nuclear technology...and I think to contain that, we ought to get out there and join the parade on working toward a Comprehensive Test Ban, and then focus our energies on this proliferation issue."

President Clinton's future Secretary of Defense Les Aspin had already made a similar statement on 1 June 1992 in a commencement speech at MIT:

"In the days when we relyed on nuclear weapons as the equalizer versus Soviet conventional forces, it was necessary to conduct nuclear weapons tests primarily for modernization. But no more.

"That means there is no compelling reason to do it any more. In addition, there is also an affirmative reason to stop doing it. We've been preaching nonproliferation to other nations, but we haven't been willing to give much on our own nuclear program. Here's our chance. International cooperation is at the core of nonproliferation efforts and that cooperation is going to be difficult if the United States insists on continuing nuclear testing."

The testing phase-out law and the comments by Clinton and Aspin all reflect an increased U.S. sensitivity in the wake of the Cold War to the problem of nuclear-weapons proliferation.

Nevertheless, according to recent articles in the *Washington Post*,* the Clinton Administration's subcabinet appointees in the Departments of Energy, Defense and State have supported a recommendation from the nuclear-weapons laboratories to President Clinton that he overturn the hard-fought agreement that the U.S. would seek a Comprehensive Test Ban (CTB) by October 1996. Instead the weapons labs propose that the U.S. attempt to negotiate a one-kiloton threshold test ban with Russia, Britain, China and France.

In the current context, a one-kiloton test ban does not appear to be a viable alternative to a CTB. Continued testing has come to symbolize for many key non-weapons states a continued belief by the nuclear-weapon states in the useability of nuclear weapons -- a perception that is deeply undermining to the cause of nonproliferation.

From the point of view of nonproliferation policy, there could not be a worse time for the U.S. to move backwards from its commitment to achieve a CTB by the end of 1996. The signatories to the Nonproliferation will meet in New York this month for the first preparatory meeting for the 1995 Nonproliferation Treaty extension confernce. The CTB was the central divisive issue at the 1985 and 1990 NPT review conferences and the U.S. and U.K. were quite isolated in

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* R. Jeffrey Smith, "White House Studies Nuclear Test Limits," *Washington Post*, 30 April 1993, p. A45; and "3 Senators Criticize A-Testing Proposal," *ibid*, 1 May 1993, p. A-2.

opposing the majority view.* Although the U.S. would probably be able to obtain a limited extension of the NPT without a commitment to a CTB, it would be unlikely to get either the indefinite extension that it seeks or wide acceptance of supplementary agreements such as sanctions against violators.

Permitted Testing During the Phase-out Period. The weapons laboratories are also seeking the virtual elimination of the limitations imposed by Congress on testing prior to the October 1996 CTB target date. During each of fiscal years 1994, 1995 and 1996, Congress permitted the Department of Energy up to five tests of warheads that are to remain in the active stockpile, but only after the President has submitted an annual report detailing the purposes of these tests and if Congress has not voted a resolution of disapproval within 90 days thereafter.** All five tests may be used to check warheads after installation of one or more of three key safety features in warheads that are not already so equipped.*** Alternatively, up to one of the five tests may be used to check the reliability of a U.S. nuclear warhead if "the President certifies to the Congress that it is vital to the national security" and Congress does not pass a resolution of disapproval within 60 days. Finally, up to one test each year may be offered to the United Kingdom, which carries its tests out at the U.S. Nevada test site, if the President determines that to be in the national security interests of the United States.

The weapons labs are reportedly proposing to President Clinton a plan to carry out the maximum permitted number of 5 tests a year for each of fiscal year 1994, 1995 and 1996. Of these 15 tests, nine would be safety tests committed to developing a new warhead for the Trident II missile with insensitive high explosive, and to installing fire-resistant plutonium "pits" in the B-61 bomb and the W-80 cruise missile warhead. The purpose of these changes would be to reduce the risk of a plutonium-dispersal accident.****

The testing phase-out law requires that the President submit "an analysis of the costs and benefits of installing such [safety] features in the warhead." The DoD and DoE have already concluded that the safety benefits of the proposed

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* This was reflected again in the January 1991 Partial Test Ban Treaty [PTB] Amendment Conference in which 75 countries voted to continue efforts to strengthen the nonproliferation regime by amending the PTB into a Comprehensive Test Ban [CTB], while 19 countries abstained and only the U.S. and U.K. voted against.

** The 90-day period is measured excluding periods of adjournment of either House for more than 3 days.

*** Insensitive high explosive, fire-resistant pit (the pit is the plutonium-containing component), or enhanced detonation safety.

**** The risk of an accidental nuclear explosion is already believed to be adequately low in modern designs and could, in any case, be reduced further by changes that do not require nuclear tests.

changes would not be worth the cost of producing replacement warheads.* However, the weapons labs argue that it would be useful to have the improved-safety designs "on the shelf" anyway. Congress should review this interpretation of the law.

The weapons labs also propose to carry out the three "reliability" tests permitted by Congress. However, the proposed tests would not, in fact, test the reliability of existing warheads but would instead be designed to prepare for the proposed one-kiloton test limit by establishing that the results of sub-kiloton tests could be used to reliably predict warhead performance at higher yields. Congress should reject these proposed tests because they are directly contrary to the spirit as well as the letter of the testing phaseout law.

Finally, the weapons labs propose that the final three tests out of the Congressionally permitted maximum of 15 be "UK tests." However, the UK nuclear-weapons design program is virtually fully integrated into the the U.S. program and therefore should not have any greater need of tests. The tests would be joint tests carried out for joint purposes. Congress may therefore have provided the weapons labs with a loophole for additional testing for purposes that may go beyond safety and reliability.

Finally, perhaps most troubling is the possibility that the weapons labs may be planning to carry out many more than the maximum of 15 tests permitted by Congress by carrying out additional test explosions for unapproved purposes simultaneously with the proposed 15. Technically, as far as seismic means could detect, only 15 explosions would have occurred and the summed yields of the multiple tests would comply with the 1974 Threshold (150-kiloton) Test Ban Treaty. However, this does not appear to be the definition of "test" that Congress intended. Congress should review whether it is willing to permit such circumvention of its testing phase-out law.

A One-kiloton Test Limit?

The testing phaseout law very clearly instructs the President that he should include in his first testing report to Congress

> "a plan for achieving a multilateral comprehensive ban on the testing of nuclear weapons on or before September 30, 1996."

However, the weapons laboratories are urging the President to come forward instead with a proposal to negotiate a one-kiloton threshold test ban with the other weapon states. It has even been proposed that such a limit could be used as a definition for a Comprehensive Test Ban. However, the negotiating history of the Nonproliferation Treaty [NPT] makes quite clear that a CTB would ban all nuclear

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* Testimony by Robert Barker, then Assistant to the Secretary of Defense for Atomic Energy, before the House Armed Services Committee Panel on Defense Nuclear Facilities, 21 May 1992.

explosions with yields over approximately a few hundred pounds of TNT equivalent.*

Negotiability of a One-kiloton Test Ban. Although some may see a one-kiloton test ban as a step toward a CTB, it appears easier at this time to go directly to a CTB.

Both Russia and France have undertaken testing moratoria to underline their positions that they are ready to negotiate a CTB immediately. The United Kingdom would be bound by a U.S. decision since it tests in Nevada. Although China might not join in immediately, it could no longer afford politically to be isolated for many years as the only nonadherent to a CTB, at a time when it seeks to become increasingly integrated into the world economy. For the U.S., weapons labs, with data from almost 1000 tests and the world's most advanced computer modeling capabilities, to declare that they cannot maintain a reliable nuclear deterrent without indefinitely continued testing undermines testing opponents in all these countries.

In contrast, a one-kiloton test limit is <u>not</u> likely to be negotiable. President Yeltsin might agree to a bilateral low-threshold test limit because Russian domestic politics only require that he maintain U.S.-Russian "parity." A more nationalistic Russian leadership might see a one-kiloton threshold test ban as being to the U.S. advantage, however, because of the superior U.S. capability to use computer models to scale the results of low-yield tests. The UK would, once again, be bound by any constraint on U.S. testing. However, China, which has only conducted 35 tests and has not yet developed (to my knowledge) the light-weight, high-yield warheads that would allow it to MIRV its small number of strategic ballistic missiles, could legitimately feel that it would be unfairly penalized by a one-kiloton limit. France also might disdain a threshold testing limit. After all, a nuclear explosion is a nuclear explosion is a nuclear explosion.

Verification requirements would also create an additional complication for a one-kiloton threshold test ban. It took over the Reagan and Bush Administrations a decade to negotiate a verification protocol for 1974 150-kt U.S.-Soviet Threshold Test Ban (TTB). The verification arrangements for a one-kiloton threshold would be much more difficult. Seismic techniques would be suspect because the seismic signal of a few-kiloton explosion might be reduced by partial "decoupling" (see below). The CORRTEX technique negotiated for verification of the 150-kt TTB, whereby a sensor cable is emplaced 10 meters from the test device, would become unacceptably intrusive for a 1-kt threshold because the sensor cable would have to be moved in much closer and the results would be sensitive to the details of the testing setup.

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* Below this threshold, the situation was complicated by the interest of some countries in inertial confinement fission and fusion energy systems in which a steady stream of small pellets of nuclear fuel would be imploded by laser or particle beams with a release of nuclear energy that could be contained in a thick pressure vessel with the residual heat being used to generate electicity. This does not appear a potentially competative source of electricity today and R&D on it should probably be discouraged since it is so closely related to nuclear-weapons R&D.

Under these circumstances, if the other nuclear-weapon states refused to sign onto a one-kiloton threshold test limit or a very long negotiating process was launched, the President could not hold the U.S. nuclear weapons labs to a 1-kt limit in the interim. The only result of the proposal would be the loss of what may turn out to be the last opportunity to achieve a CTB while Israel, India and Pakistan are still keeping their nuclear weapons programs in their closets.

Testing by Threshold Nuclear-weapon States. It is in fact quite striking that Israel, India and Pakistan have been so restrained about testing. Presumably this self-restraint has been because they saw testing as provocative to other countries in their regions and to the U.S. and other major powers that are concerned about nonproliferation. However, this restraint is not guaranteed to prevail indefinitely for all threshold states. If some state decided to flaunt its nuclear capability with a test, the taboo could erode quickly. We cannot sustain indefinitely the position that testing is the permanent exclusive priviledge of the five nations that tested before the NPT cutoff year of 1967. The U.S., USSR and U.K. made a clear commitment in the NPT that this discrimination would only be temporary and that they would move toward a CTB with all deliberate speed.

If, instead, it became a norm that nuclear-weapon states and threshold states alike could test up to 1 kiloton, the weaponeers in the threshold states would benefit much more those than those in the weapons states. Although testing at one kiloton might not significantly increase confidence in an existing weapon-state design that had already been well tested to full yield, it could significantly increase the confidence of a threshold weapon state in an untested design and perhaps give it the confidence to develop lighter weight, more compact, and/or boosted designs. This could mean higher yields, greater range for missiles carrying lighter payloads and perhaps even greater confidence in the possibility of igniting an untested thermonuclear secondary.

"Mininukes." The nominal purpose of a one-kiloton test limitation would be to permit the U.S. to develop new fission primaries for its nuclear warheads if, for some reason, an existing primary develops problems. However, it would be difficult to rebut allegations that the U.S. was developing a new generation of more useable "mininukes" for use in the Third World.

Indeed, a paragraph in the *Los Alamos National Laboratory Institutional Plan for FY 1992 - FY 1997* (p. 22) has been widely quoted as suggesting just such a program:

> "The changing geopolitical situation may require small numbers of special types of deterrent weapons such as earth penetrators, devices to neutralize material such as chemical-biological agents, enhanced electromagnetic pulse weapons and precisely guided small-yield weapons. We will work with the DoD and the DoE production agencies to better define the requirements for such weapon types and efficient means for producing them in small numbers."

All these weapon types are obviously motivated by challenges the U.S. encountered in Desert Storm -- although these challenges were dealt with adequately in that case by non-nuclear means. All could have yields of a few kilotons or less and

could be developed by testing at yields of less than one kiloton. Such a U.S. program -- or even the suspicion that this might be one of the purposes of continued U.S. testing at low yields -- would undermine U.S. nonproliferation efforts in the Third World by providing fuel to arguments that the U.S. can only be deterred from nuclear use by the threat of nuclear retaliation.

And what about the Russians? Already a year ago, Victor Mikhailov, the Russian Minister of Atomic Energy argued in the 7 May 1992 issue of *Rossiyskaya Gazeta*[*] that

> "the West has not yet officially renounced the right to the first nuclear strike, and is continuing to improve its nuclear forces, exploiting its advantages in technology..."

Mikhailov has made clear that, if the U.S. develops a new generation of more useable mininukes, Russia will as well.

The Need for "Reliability" Testing

As has already been noted, the weapons labs argue that the U.S. must continue to test in case doubts arise concerning the reliability of a U.S. warhead. And (the argument continues) if a problem has indeed developed with the fission trigger of a thermonuclear device,[**] it would be important to be able to develop a substitute trigger and test it.

In fact, as already noted, the "reliability" tests that are planned prior to the cutoff date of 30 September 1996 are apparently designed to establish "scaling laws" for predicting performance of fission triggers at their full yields (on the order of ten kilotons) based on the performance of a slightly modified versions at less than one kiloton.

However, the "reliability" argument for testing has been subjected to public debate and independent peer review for the past 15 years and has suffered a considerable loss of credibility as a result. A brief summary of this history may be useful to those to whom these arguments may be new.

The reliability issue first was raised to high visiblity in 1978, shortly after U.S. CTB negotiators obtained Soviet agreement in principal to the establishment of a network of remotely operated U.S. seismic stations throughout the Soviet Union, thereby largely dealing with the verification objections that had been raised to a CTB. The Directors of Los Alamos and Livermore went to President Carter to inform him that, in the absence of testing, they would not be able to certify the continuing reliability of the U.S. nuclear stockpile.

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[*] "Nuclear Weapons," translated in FBIS-SOV-92-093, 13 May 1992, pp. 2-9.

[**] There seems to be little doubt that the second thermonuclear stage of a nuclear warhead will function properly if the first stage does.

Three senior U.S. nuclear weapons experts* wrote to President Carter that stockpile confidence could be maintained without nuclear testing, by continuing to dissassemble sample warheads, inspecting them for evidence of deterioration and nonnuclear testing of the components. The nonnuclear tests include implosions of instrumented primaries after the fissile material replaced by inert material and following the progression of the implosion with fast X-ray cameras. Indeed, these procedures are the heart of the U.S. reliability program today. Because of the great costs of underground testing, very few tests have been carried out primarily because of reliablity concerns.

The CTB opponents fought back, however, citing 14 different deployed warheads for which they claimed that testing had either revealed a problem or had been required to confirm the adequacy of a fix of a problem that had been revealed by inspections. At the request of then Representative Aspin and other Members of Congress, these cases were examined in detail by a highly respected and independent Livermore weapons expert, Ray Kidder.

In his October 1987 report to Congress,** Kidder found that nine of the cited confidence problems had occurred in the early 1960s, immediately after the end of the 1958-61 testing moratorium and were of designs that had been fielded during the moratorium without adequate testing. He also found that it was a stretch to call the other five tests, which had been conducted during the 1980s, "reliability tests." In fact, these were tests conducted shortly after deployment that the Laboratories knew should have been carried out earlier.

Perhaps the most important thing to be learned from this debate was that only one U.S. warhead developed a problem more than four years after its introduction into the stockpile. This was the Poseidon W-68 warhead whose unique chemical explosive was discovered to be deteriorating. The chemical explosive was replaced with another and a test confirmed that the performance of the rebuilt warhead was to specifications. *Other than this unique case, the U.S. has experienced no significant reliability problems with warheads that have been in the arsenal for more than a few years.*

Indeed, one could easily argue that confidence in the stockpile would be reduced if well-tested primaries were replaced by primaries that had only been tested up to one kiloton.

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* Norris Bradbury, Director of Los Alamos from 1945 to 1970; Richard Garwin, a consultant to Los Alamos since 1950; and Carson Mark, Director of the Los Alamos Theoretical Division from 1947 to 1973 wrote a letter to President Carter that is reproduced as Appendix K to Ray Kidder's 1987 report, *Maintaining the U.S. Stockpile of Nuclear Weapons During a Low-Threshold or Comprehensive Test Ban.* Other experts who have made similar statements are Hans Bethe, head of the Los Alamos Theoretical Division during World War II; Andrei Sakharov; Glen Seaborg, chairman of the Atomic Energy Commission during the Kennedy and Johnson Administrations; and Herbert York, first Director of the Lawrence Livermore National Laboratory.

** *Maintaining the U.S. Stockpile of Nuclear Weapons During a Low Threshold or Comprehensive Test Ban* (Lawrence Livermore National Laboratory [LLNL]: UCRL-53820, 1987).

Competence. A closely related, almost tautological, argument that the weapons laboratories make for continued nuclear testing is that, without it, nuclear-weapons designers will loose their "competence."

The primary advantage of being able to test at one kiloton is that designers could verify that the temperature in a modified or redesigned fission primary had reached the threshold where tritium-deuterium fusion reaction used to "boost" the yield was beginning to kick in. With modern computer codes, non-nuclear testing methods, and the archived results of almost one thousand U.S. nuclear tests, however, a huge amount of relevant data would be available to educate those responsible for verifying the reliability of *existing well-tested primaries* in the U.S. nuclear arsenal. In addition, "hydro-nuclear" tests, such as those carried out by the U.S. during the 1958-61 moratorium, would make it possible to test a primary through three quarters of its exponential chain reaction while keeping the energy yield below the equivalent of one kilogram of high explosives.

A CTB might result in a marginal reduction in our ability to quickly develop new weapons designs but there would be no significant reduction in our ability to understand our existing well-tested designs well enough to continue to have confidence in their performance.

Verifiability of a CTB

For 20 years, from the mid-1950s to the mid-1970s, the road to a CTB was blocked principally by claims that the Soviet Union would be able to cheat and would derive important strategic advantages from cheating.

Indeed, it was the "big hole" theory, developed by Edward Teller and his colleagues, which derailed President Kennedy's attempt to achieve a CTB and resulted in the 1963 test-ban treaty banning tests everywhere but underground. The original claim was that the Soviets could secretly excavate a cavity deep underground large enough to "decouple" a nuclear exposion with a yield up to 300 kilotons. The claim was that the strength of the seismic signal from such an explosion would be reduced by decoupling to that of a one-kiloton explosion.

It soon became clear that it would be impractical to build a cavity large enough to decouple an explosion with a yield of over 10 kilotons and the U.S., in fact only tested the decoupling idea once with an 0.38-kiloton device with a resulting decoupling factor of 70. However, even after the Soviet government agreed to permit the establishment of a U.S. seismic monitoring system within the USSR, the debate continued as to whether it might be possible for the Soviet government to successfully conceal tests with yields on the order of <u>one</u> kiloton with the big-hole technique.

The seismic signal from a one-kiloton decoupled nuclear explosion would be reduced to approximately that from a ten-ton explosion of TNT. This seismic signal would still be detectable with the system of in-country unmanned seismic stations that has been proposed to monitor a CTB, but it would be necessary to analyze the signal and use other information about activities near the epicenter to

distinguish a potential clandestine decoupled nuclear explosion from the large number of mining explosions that occur annually within this yield range.

In the Cold War context, all sorts of potential advantages that might accrue to the USSR from a few clandestine low-yield tests were conjured up by U.S. CTB opponents. It was argued, for example, that, with one or a few low-yield tests, the USSR could confirm the reliability of its weapons for a first strike on U.S. strategic forces while we would be left in uncertainty about the reliability of our retaliatory capabilities.

Such fears seem somewhat silly now. However, in the 1980s they blocked progress and some of us therefore argued for a bilateral low-threshold test ban with a threshold in the few-kiloton range* as a compromise intermediate step toward a CTB. The House of Representatives voted for such a step three times (in 1986, 1987 and 1988).

In the post-Cold War context, the big-hole decoupling scenario, although not theoretically impossible, seems less plausible -- as it has always been regarded outside the U.S. weapons laboratories. It would take a sphererical cavity with a diameter of 115-165 feet to fully decouple a one kiloton explosion. It would be difficult to mine such a huge cavity without detection. The most favorable medium would be thick salt which occurs in a relatively limited number of locations. And there would be fears that the cavity might collapse and reveal itself as a crater on the surface, or that it would leak after the test and vent large quantities of telltale radioactive gases. Given these difficulties, the increased satellite monitoring that could be focused on locations that might be suitable for decoupling, and the ever-increasing ease of whistle-blowing in an increasingly open world, it seems implausible that any nation could conceal a sustained program of clandestine low-yield nuclear testing for long.

This is not to devalue the importance of having a good verification system for a CTB in order to deter cheating. In fact, considerable progress has already been made toward the establishment of such a system. A worldwide system of state-of-the art seismic sensors is already being put into place for whole-earth tomography as well as future verification of a CTB. The U.S. already has most of the intelligence and analytical capabilities that would be required.

The adequacy of the verification of a CTB has to be judged upon cost-benefit and risk-benefit bases. One has to weigh the risks from a few successfully concealed low-yield tests against the benefits of a CTB. We have already had to make such a balancing test for most existing arms control treaties -- including the Partial Test Ban. It is possible, for example, that Israel could, as is alleged, have concealed low-yield tests under the clouds in the South Atlantic in September 1979. To demand a guarantee of perfection for the verification of a CTB is to set zero value on its nonproliferation benefits.

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* Frank von Hippel, Harold Feiveson and Christopher Paine, "A Low-Threshold Nuclear Test Ban," *International Security*, Fall 1987, pp. 135-151. Harold Feiveson, Christopher Paine and Frank von Hippel, "A Low-Threshold Test Ban Is Feasible," *Science*, 23 October 1987, pp. 455-464.

The Need for Warhead Safety Improvements

Let us finally return to a more detailed discussion of the safety issue because it was the main argument with which the negotiation of an immediate CTB was blocked in Congress last fall.

The issue of nuclear-warhead safety became the leading argument of opponents to a CTB during 1990, as concerns about reliability were becoming less salient with the waning of the Cold War. Two groups in Congresspeople commissioned independent studies on the matter. One group of leading Senate and House CTB advocates turned again to Ray Kidder. The House Armed Services Committee decided instead to establish a Panel on Nuclear Weapons Safety, also known as the "Drell panel" after its chairman, Stanford physicist, Sidney Drell.

The Drell* and Kidder** reports differ in part because their authors were asked to address different issues: the Drell panel was asked to advise on warhead safety; Kidder was asked to advise about safety-related testing requirements. Kidder concluded that "only a modest number of nuclear tests" were needed for safety reasons. The Drell Panel report went further, as is discussed below.

As noted above, in the event, the testing phaseout mandated by Congress allows enough tests to develop a warhead containing insensitive high explosive for the Trident submarine-launched ballistic missile, the one system slated to remaining in the U.S. arsenal that does not have such a warhead. It will also permit the development of versions of the B-61 bomb and W-80 cruise missile with fire resistant plutonium "pits." These are the only aircraft carried warheads that are slated to remain in the U.S. arsenal that are not already equipped with such pits.***

The purpose of such safety changes would be to reduce the chance that the chemical explosive in a warhead would detonate and disperse some of the warhead's plutonium in an inhalable aerosol (insensitive high explosive) and to reduce the chances of plutonium contamination in case a warhead were exposed to

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* *Nuclear Weapons Safety*, Report of the Panel on Nuclear Weapons Safety of the House Committee on Armed Services (Washington, D.C.: U.S. Government Printing Office, December 1990).

** R.E. Kidder, *Report to Congress: Assessment of the Safety of U.S. Nuclear Weapons and Related Nuclear Test Requirements* (LLNL: UCRL-LR-107454, July 1991); and *Assessment of the the Safety of U.S. Nuclear Weapons and Related Nuclear Test Requirements: A Post-Bush Initiative Update* (LLNL: UCRL-LR-109503).

*** The pits would be designed to resist exposure to a prolonged jet-fuel fire. Fire-resistant pits have not been developed that could resist the much hotter fires from the burning of missile fuel.

a fire (fire resistant pits).* However, as noted above, the Departments of Defense and Energy have rejected these safety improvements as too costly to implement.

The Drell panel went beyond the proposals put forward by Kidder and endorsed by Congress and expored the possibilities of an open-ended testing program to develop still further improvements. In particular, the Drell report endorsed a weapons lab proposal for an R&D program that would, in effect, start with a blank sheet of paper to design a new generation of "inherently safe" warheads in which, for example, the plutonium core would be kept in a hardened container separated from the chemical explosive prior to the arming of the warhead. However, Drell has repeatedly and publicly qualified this endorsement with the statement that, if the time comes when a CTB is judged by the political authorities to be important to the nonproliferation effort, then that consideration should outweigh the potential additional safety margins that might be achieved by a testing program.

In fact, as indicated at the beginning of this memo, the U.S. political authorities now seem to agree with the vast preponderance of international opinion that a CTB *is* important to nonproliferation. Therefore, there should be no open-ended testing program. *Indeed, the real question now is whether, in light of the cost-ineffectiveness of any of the safety improvements that would require additional nuclear tests and, in view of the favorable conditions for the negotiating a CTB caused by the current Russian, French, U.S. and U.K. testing moratoria, the U.S. should carry out any more tests at all.*

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* See Steve Fetter and Frank von Hippel, "The Hazard from Plutonium Dispersal by Nuclear-warhead Accidents," *Science & Global Security 2* (1990), pp. 21-41.

Frank von Hippel -- Biographical Data

Frank von Hippel, a theoretical physicist, is a Professor of Public and International Affairs at Princeton University and co-principal investigator with Harold Feiveson of Princeton's Program on Nuclear Policy Alternatives. He is also chairman of the research arm of the Federation of American Scientists (FAS), directs the FAS cooperative research project on the technical basis for new arms-control initatives, and chairs the editorial boards of *Science & Global Security* and the *Bulletin of the Atomic Scientists.*

von Hippel received his B.S. degree in physics from MIT in 1959 and D.Phil. in theoretical physics in 1962 from Oxford, where he was a Rhodes Scholar. During the following ten years, while his research focus was in theoretical elementary-particle physics, he held research positions at the University of Chicago, Cornell University and Argonne National Laboratory and served on the physics faculty of Stanford University.

In 1974, von Hippel's interests shifted to "public policy physics." After spending a year as a Resident Fellow at the National Academy of Science, during which time he organized the American Physical Society's Study on Light-water Reactor Safety, he was invited to join the research and then the teaching faculty of Princeton University.

During the late 1970's, von Hippel's research focused on technical questions relating to the containment and mitigation of nuclear-reactor accidents, alternatives to recycling plutonium in nuclear-reactor fuel, and the potential for major improvements in automobile fuel economy. For the past decade, his research has focused on the possibilities of: deep cuts in the nuclear arsenals, verified nuclear-warhead elimination, a universal cutoff of the production of unsafeguarded fissile materials and a low-threshold or comprehensive nuclear-warhead test ban.

von Hippel has served on advisory panels to the Congressional Office of Technology Assessment, U.S. Department of Energy, National Science Foundation and U.S. Nuclear Regulatory Commission and on the Boards of Directors of the American Association for the Advancement of Science, Federation of American Scientists (chairman) and Bulletin of the Atomic Scientists.

In 1977, he shared with Joel Primack the American Physical Society's 1977 Forum Award for Promoting the Understanding of the Relationship of Physics and Society for their book, *Advice and Dissent: Scientists in the Political Arena.* In 1989, he was awarded the Federation of American Scientists' Public Service Award. In 1991, the American Institute of Physics published a volume of von Hippel's selected works as one of the first three books in its "Masters of Physics" series under the title, *Citizen Scientist.*