THE NEED FOR A REPORT THAT CLARIFIES AND PUTS INTO PERSPECTIVE THE TECHNICAL ARGUMENTS AGAINST THE CTBT

Presentation to the U.S. State Department's Advisory Committee on Nonproliferation and Arms Control

Frank von Hippel, Professor of Public and International Affairs
Princeton University, Dec. 2, 1999

A political explanation of the Senate's CTBT non-ratification decision is that, while only half of the Republican Senators hate arms control, all of them hate Clinton. However, there were technical arguments against the CTBT that were built on foundations laid by the testimony of the weapons-labs directors and the CIA.

Although the motivations may have been political, the debate was surprisingly substantive. The weaknesses of the CTBT were put under a magnifying glass and its benefits were put under a shrinking glass. Advocates of a CTBT have to do both a better job explaining the benefits and a better job putting into perspective the weaknesses.

There are at least four areas where the arguments of the opponents have to be put into perspective:

1) The role of the Stockpile Stewardship program in assuring warhead reliability and how and when that assurance will be provided;

2) Yield detection thresholds of the international monitoring system -- with and without supplementation by scientific and national systems and with and without decoupling;

3) What countries can do at what thresholds and how these thresholds compare to the detection thresholds; and

4) The cost/benefit ratios for specific safety improvements to the enduring stockpile that would require testing.

THE ROLE OF THE STOCKPILE STEWARDSHIP PROGRAM IN ASSURING WARHEAD RELIABILITY AND HOW AND WHEN THAT ASSURANCE WILL BE PROVIDED. The stockpile stewardship program involves the building of facilities and computational capabilities that are not yet in place. The statements of the weapons lab directors before the Senate Armed Services Committee on October 7 suggested that we therefore can't know for 10-20 years whether the program can deliver the goods in maintaining warhead reliability.

John Browne, Director of Los Alamos, said:

> "We are confident in the stockpile today. The issue is whether we have the people, the capabilities, and the national commitment to maintain this confidence in the future when we expect to see more significant changes in the weapons. The essential toolkit for stockpile stewardship will not be completed until the middle of the next decade, assuming we receive stable, sustained support from the Administration and the Congress."

Paul Robinson, Director of Sandia, said in his prepared statement that:

> "The difficulty we face is that we cannot today guarantee that Science-Based Stockpile Stewardship will be ultimately successful; nor can we guarantee that it will be possible to prove that it is successful."

The Oct. 8 *New York Times* reported that Bruce Tarter, Director of Livermore "summed up the director's overall assessment of the stewardship program: 'It is an excellent bet, but it is not a sure thing.'"

This view would certainly encourage a wait-and-see attitude toward ratification – or the ten-year opt-out clause, which the Department of Defense asked for in 1995.

I don't believe that we don't need to have on-line the full stockpile stewardship program, including the troubled National Ignition Facility, to confirm that aged or remanufactured warheads will work. If we see in hydrodynamic tests that the aged or remanufactured primaries behave as they used to and the plutonium in them behaves in subcritical tests the way it used to, then the warheads will work.

If this is right, then most of the stockpile stewardship program is about something beyond reliability. It is about our ability to make substantial changes in the designs of the warheads and have confidence that they will still work. The lab leaderships have been arguing (unconvincingly in my view) for decades that it will be impossible to remanufacture the warheads exactly: materials will become unavailable, manufacturing techniques will change, and certain changes will be desirable to make the warheads safer or more reliable. Also, the "customer," DoD, in its infamous Nuclear Posture Review, listed among its "requirements to DoE to: "maintain capability to design, fabricate, and certify new warheads" in addition to "demonstrat[ing] capability to refabricate and certify weapon types in enduring stockpile" ["Nuclear Posture Review: Press/Public Version" (Transparencies, Sept. 24, 1994), p. 27].

If we are to get a CTBT, the case must be made that, with the tools that we have now, the U.S. could maintain the existing stockpile indefinitely. This is the only fully satisfactory answer to the argument that we need to wait and see how the stockpile-stewardship program turns out.

YIELD DETECTION THRESHOLDS. The International Monitoring System seismic threshold worldwide is at about 1 kiloton coupled. In the Oct. 8 Senate debate, Senate Majority Leader Lott appeared to accept this but then brought up the issue of decoupling:

> "In a speech to the Council on Foreign Relations last year, Dr. Larry Turnbull, Chief Scientist of the Intelligence Community's Arms Control Intelligence Staff, said,
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> > "The decoupling scenario is credible for many countries for at least two reasons: First, the worldwide mining and petroleum literature indicates that construction of large cavities in both hard rock and salt is feasible, with costs that would be relatively small compared to those required for the production of materials for a nuclear device; second, literature and symposia indicate that containment of particulate and gaseous debris is feasible in both salt and hard rock.'
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> "So not only is this 'decoupling' judged to be 'credible' by the Intelligence Community, but, according to Dr. Turnbull, the technique can reduce a nuclear test's seismic signature by up to a factor of 70. This means a 70-kiloton test can be made to look like a 1-kiloton test, which the CTBT monitoring system will not be able to detect. And a 70-kiloton test, even much less than a 70-kiloton test, can be extraordinarily useful both to nations with nuclear weapons and to nations seeking nuclear weapons. Bear in mind that the first atomic bomb used in combat had a yield of only 15 kilotons."

The ability to conceal a 70-kiloton test certainly does not appear to apply to the Russian test site. On the basis of a measured upper bound of seismic magnitude 1.84, Lynn Sykes of the Lamont-Doherty Geological Observatory put an upper bound on the test that could have been conducted on Novaya Zemlya on Sept. 23, 1999 at 0.0008 kilotons coupled. This would still have been only about 0.06 kilotons with a decoupling factor of 70 – one thousandth of Senator Lott's claim.

Also, Sykes commented on a Turnbull viewgraph from an April 1995 talk to mining-company officials, where Turnbull seems to imply that decoupling is possible up to yields of 250 kilotons in salt (based on the volume of a private solution-mined cavity in Texas) and 100 kilotons in rock, based on a the volume of a cave in Sarawak, Indonesia. Sykes remarked that:

> "The top of the Sarawak cave is located at a very shallow depth as is the largest cavity in hard rock with unsupported span. Even very small explosions in them would blow out into the atmosphere. Large cavities in salt that are used commercially are filled with either water, salt brine, oil or high-pressurized gas. One of the cardinal rules in their use is never to evacuate them since about half of

the stresses in the walls of those fragile cavities are supported by materials inside them, which would have to be evacuated for a decoupled test."

So, here again, clarification is required: What will the threshold for seismic detection for underground nuclear tests be in "regions of concern," given the feasibility of decoupling in those regions and at the technical level of capability of the host nations?

WHAT COUNTRIES CAN DO AT WHAT THRESHOLDS. In his prepared testimony, Paul Robinson, Director of Sandia National Laboratories, said that:

> "I believe that nuclear testing in the subkiloton range could have utility for certain types of nuclear designs. However, it is very unlikely that the threshold for detection and yield measurement in most parts of the world will ever reach the level to identify these yields as nuclear tests, and hence as violations to the U.S. understanding of the Treaty's central obligation. This raises the question as to whether the observed definition of zero should be the international standard of detectability, rather than the supposedly absolute but unverifiable zero yield that many people infer from the treaty."

Later, in the concluding section of his statement, he said that:

> "If the United States scrupulously restricts itself to zero yield while other nations may conduct experiments up to the threshold of international detectability, we will be at an intolerable disadvantage. I would advise against accepting limitations that permit such asymmetry."

Thus Robinson appears to be arguing for a definition of zero yield similar to the definition in the Limited Test Ban Treaty that defines the underground test ban to be violated "if such explosion causes radioactive debris to be present outside the territorial limits of the state under whose jurisdiction or control such explosion is conducted."

But what would the "threshold of international detectability" be for the US? And what could be accomplished below that threshold that could mitigate the "intolerable disadvantage" that Robinson sees otherwise developing?

One threshold that was proposed by the DoD in 1995 was half a kiloton. This is in Robinson's "subkiloton range." It would apparently allow "whisper boosting" which would allow the U.S. to test whether a reduced amount of deuterium-tritium fusion would be ignited within imploding hollow plutonium "pits." Does Robinson advocate that the U.S. develop the capability to conceal such tests from international detection?

Not being able to conduct such tests would only be an "intolerable disadvantage" if the US could not maintain the reliability of our existing stockpile without such testing. Part of the answer to this question therefore depends upon the answer to question number

1: Can we confirm the reliability of warheads in the enduring stockpile without testing? If so, Robinson elsewhere in his statement points out that there are many possibilities for "adapting existing nuclear explosives for new warheads." He also notes that, although

> "the designs of primaries and secondaries are effectively frozen by a prohibition on testing [and] Los Alamos and Livermore...cannot create completely new concepts without testing, many previously tested designs could be weaponized to provide new military capabilities."

He points out, for example, that

> "Proven designs of lower yield [than the unboosted primaries in the enduring stockpile?] exist that might be adaptable for new military requirements in the future. I believe that such weapons could be deployed this way without the need for nuclear tests."

What could other countries achieve below the "threshold of international detectability"? Richard Garwin pointed out in his October 7 prepared testimony that

> "Without nuclear tests of substantial yield, it is difficult to build compact and light fission weapons and essentially impossible to have any confidence in a large-yield two-stage thermonuclear weapon or hydrogen bomb, which can readily be made in the megaton class."

To define "substantial yield," Garwin referred to the August 3, 1995 Jason report, which discusses

> "a nuclear weapon test that would involve full yield of the fission primary and some ignition of the thermonuclear secondary, and that such tests, to be useful, would 'generate nuclear yields in excess of approximately 10 kilotons.' That is clearly verifiable by the CTBT's International Monitoring System (IMS), with its seismic, hydroacoustic, and infrasound sensors, and its detectors of radioactive gases and particles."

Should we then be satisfied if we can prove an IMS threshold of 10 kilotons decoupled?

COST/BENEFIT RATIOS FOR SPECIFIC SAFETY IMPROVEMENTS TO THE ENDURING STOCKPILE THAT WOULD REQUIRE TESTING. Senators Warner, Helms and Kyl made much of the fact that not all of the warheads in the enduring stockpile contain all modern safety features. Senator Kyl put it as follows during the Oct. 8 ratification debate:

> "Safety features include items such as insensitive high explosive and fire resistant pits. Insensitive high explosive in the primary of a nuclear weapon is intended to

prevent the premature detonation of the high explosive trigger, resulting in a potential nuclear explosion should the weapon be subjected to unexpected stress, like being dropped or penetrated by shrapnel or a bullet.

"Fire resistant pits are intended to prevent the dispersal of plutonium resulting in radioactive contamination of an area should the weapon be exposed to a fire, such as an accidental blaze during loading of a weapon on an aircraft.

"Unfortunately, few people know that many of our current weapons do not contain all the safety features that already have been invented by our National Laboratories. Only one of the nine weapons in the current stockpile incorporates all six available safety features. In fact, three of the weapons in the stockpile--the W78 warhead, which is used on the Minuteman III ICBM, and the W76 and W88 warheads, which sit atop missiles carried aboard Trident submarines--incorporate only one of the six safety features. Another weapon, the W62 warhead, does not have any of the six safety features incorporated into its design."

Senator Kyl never specified which "six safety features" he had in mind. The Hatfield-Exon-Mitchell amendment to the U.S. Energy and Water Development Appropriations Act of 1993 (sec. 507) listed only three: insensitive high explosive (IHE), fire resistant pits (FRP), and an enhanced detonation safety system (ENDS) as being an adequate reason for nuclear testing between 1993 and 1996. This legislation also required "an analysis of the costs and benefits of installing such features...in the warheads" before a test could be carried out. Ultimately, the DoD decided that none of the missing safety features passed its cost-benefit test.

According to Ray Kidder's July 26, 1991 "Report to Congress: Assessment of the Safety of U.S. Nuclear Weapons and Related Nuclear Test Requirements:"

- The only U.S. nuclear warhead that does not have an ENDS is the oldest of the three ICBM warheads available for the Minuteman III, the W-62. If this makes it unsafe, it should be retired.

  The ENDS is the only one of the three safety features which has a direct bearing on the risk of a nuclear explosion. All U.S. warheads are designed to be "one-point safe" to protect against a significant nuclear yield if there is a single-point detonation of the high explosive. (For completeness, the question of the probability of multi-point detonation should be discussed as well.)

- The Trident I and II warheads (the W76 and W88) and a second Minuteman III warhead (the W78) are the only warheads that do not contain insensitive high explosive. Installation of IHE would reduce the hazard of a one-point explosion creating a plutonium-oxide aerosol cloud. Such explosions have, to my knowledge, occurred twice: during the 1960s in crashes (in Spain and on the ice off Greenland) of nuclear-armed B-52s flying airborne alert.

Steve Fetter and I estimated the consequences of a hypothetical near worst-case accident in which a cloud containing 10 kg of PuO_2 was released from an accident with a Trident missile at Bangor Naval Base and blew toward downtown Seattle 30 kilometers away ["The Hazard from Plutonium Dispersal by Nuclear-warhead Accidents," "Science & Global Security 2" (1990), pp. 21-41]. Depending upon wind speed, mixing height, and aerosol deposition velocity, we estimated from 7 to 5000 additional cancer deaths in the exposed population. The individual risk in downtown Seattle would be about one chance in one thousand. The likelihood of such an event is probably less than one chance in a thousand per year.

The Navy decided that the benefits of reducing this risk further was not worth the cost of developing and building new Trident warheads with IHE.

- Only the MX warhead (the W87, which is to be transferred to the Minuteman III after the retirement of the MX) and the B83 strategic bomb have fire-resistant pits. But here the risk is much less. In the absence of an explosion, the area of plutonium contamination would be quite limited. There have been a considerable number of fires involving nuclear warheads and apparently no significant public exposure to plutonium as a result.

In summary, I urge that a report be written which provides an authoritative clarification and puts into perspective these and the other technical objections which were brought up as arguments against the CTBT. Such a report could serve as an authoritative reference, the next time the issue comes before the Senate.