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Testimony on Nuclear Weapons Testing
before
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Viewed from a technical perspective, continued underground testing of nuclear weapons can contribute to improving the safety of the U.S. nuclear weapons stockpile. It is my view that increased safety is the main reason and indeed the only compelling one for continuing underground testing. Viewed from a political perspective, however, continued testing of nuclear weapons may hinder efforts to counter if not prevent the proliferation of nuclear weapons in the years ahead. We therefore face a difficult challenge of weighing technical judgments about the importance of continued testing for enhanced safety against political judgments about the importance of a Comprehensive Test Ban Treaty (CTBT) for strengthening, or even preserving, the non-proliferation regime.

On the technical side, which I am more comfortable and capable to judge, I would emphasize that we can and should make important progress toward enhanced safety of the nuclear stockpile. A number of measures for improving safety do not require underground nuclear test explosions. They include:

- redirecting the weapons RDT&E program toward enhanced safety as its principal goal;
- performing laboratory experiments to develop a data base that is required for sound analyses of the risks of initiating a nuclear yield or of dispersing plutonium under a variety of abnormal circumstances for existing weapons;
- retiring older weapons from the stockpile that fail to meet modern safety design criteria;
- adapting existing warheads of compatible size that already incorporate the desired safety features to several different weapons systems that are designated to remain in the U.S. arsenal; and
- adopting operational procedures – such as limiting aerial overflights – to reduce handling and transporting risks.

However, to go further and design new warheads with safety-optimized designs, or just simply safer configurations, it will be necessary to perform underground nuclear tests.

In 1990 this Committee formed a Nuclear Weapons Safety Panel to provide Congress with a technical analysis of the safety of the U.S. nuclear weapons as

a basis for debating future policy decisions. I chaired that Panel* which did the first and only independent comprehensive review of the safety of the U.S. nuclear stockpile since World War II and its subsequent build-up to more than 20,000 warheads. This study was initiated because of concerns about the safety of several weapon systems in the U.S. arsenal. These systems have since been removed from the deployed forces.

It was a major conclusion of our study that "unintended nuclear detonations present a greater risk than previously estimated for some of the warheads in the stockpile." An important contribution to the understanding of these greater risks has come from advances in supercomputers that make it possible to carry out more realistic, three-dimensional calculations to trace the hydrodynamic and neutronic development of nuclear detonations. We now appreciate – and underground tests have confirmed – how inadequate, and in some cases misleading, were the earlier two-dimensional calculations.† Noting that, today, the uncertainties in the safety of nuclear weapons are simply too large, the Panel concluded that it is important to "identify the potential sources of the largest safety risks and push ahead with searches for new technologies that do away with them and further enhance weapons safety."

I see three questions whose answers are central to arriving at a decision whether the U.S. should continue testing or agree to a comprehensive test ban. These are:

1. *What gains in safety can reasonably be achieved by continued testing?*
2. *How extensive a test program is required and how many years will it take to fully meet appropriately conservative safety criteria for the U.S. nuclear stockpile?*
3. *Are the gains in safety that would result from continued testing more important than the political value, real or perceived, of a CTBT for strengthening or even preserving a non-proliferation regime?*

1). *What gains in safety can reasonably be achieved by continued testing?*

Important contributions to the safety of warheads result from equipping them with modern enhanced nuclear detonation safety systems (ENDS) and insensitive high explosives (IHE).‡ ENDS have been introduced into the stockpile starting

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* The other members are Drs. John S. Foster, Jr. and Charles H. Townes.

† For example we were wrong in assumptions about the location of the most sensitive point in the weapon at which a one-point detonation of the high explosive could initiate a nuclear yield. We also know very little about the risk of multi-point insults – i.e. incidence of fragments nearly simultaneously – causing a nuclear detonation. This is important for understanding risks for highly MIRV'd weapons like the Trident and MX missiles.

‡ In dealing with safety of the complete weapons system, issues of choice of missile propellant and how the systems are handled are also of importance.

in 1977 in order to enhance electrical safety of nuclear weapons against premature detonations. Currently about 70% of the weapons in the U.S. nuclear arsenal were equipped with ENDS. On the basis of current plans, it is anticipated that all weapons without ENDS will be removed from the stockpile by the end of the decade. No nuclear testing is required to complete this important stockpile improvement program for enhanced safety.§

The fact that nuclear warheads contain radioactive material, and in particular plutonium, in combination with high explosives gives rise to major safety concerns. In most bombs the nuclear primary is surrounded by a shell of high explosives which, upon detonation, initiates an implosion to generate the nuclear yield. An accident or incident causing detonation of the high explosive would result in radioactive contamination of the surrounding area, and might possibly lead to a small nuclear yield as well. IHE has been developed to reduce this danger.

In contrast to conventional high energy explosives (HE), IHE possesses a unique insensitivity to extreme abnormal environments. The consequences of a violent accident such as an airplane fire or crash, or the drop of a missile while loading it into a launching tube, may be very different depending upon whether the high explosive is IHE or conventional. In contrast to its safety advantages, IHE contains, pound for pound, only about two-thirds of the energy of conventional HE and, therefore, is needed in greater weight and volume for initiating the detonation of a nuclear warhead.

It is generally agreed that replacing warheads designed with conventional HE by new ones with IHE is a very important step for improving safety of the weapons stockpile. The understanding¶ between DOE and DoD in 1983 calls for the use of IHE in new weapons systems unless system design and operational requirements mandate use of the higher energy and, therefore, the smaller mass and volume of conventional HE. It was also "strongly recommended" by the Senate Armed

§ Limited testing would be required if we were to choose to deploy the newest and still safer implementations of ENDS that could help make the weapons more terrorist proof.

¶ This is spelled out in two memoranda. The then ATSD(AE), Richard L. Wagner, wrote on April 28, 1983: "In most of the newer nuclear weapons we are using this insensitive high explosive, and, where appropriate, plan to retrofit older nuclear warheads in the stockpile with IHE." "...the DoD policy for new nuclear weapon development is that IHE will be used unless the Military Department responsible for the nuclear weapon development requests an exception from USDRE (Under Secretary of Defense for Research and Engineering) through the ATSD(AE). Such requests will be considered favorably where the military capability of the system clearly and significantly would be degraded by the incorporation of IHE." The then Director of Military Application in DOE, Major General William Hoover, wrote: "Based on this policy, we should expect IHE to be included in the draft Military Characteristics for most new systems. It is our intention to support these requirements whenever feasible."

Services Committee* in 1978, under Chairman John Stennis, that "IHE be applied to all future nuclear weapons, be they for strategic or theatre forces."

Although IHE was first introduced into the stockpile in 1979, as of this year less than 35% of the stockpile is equipped with IHE. I know of no plans or indications to suggest that the percentage of weapons in the stockpile with IHE will exceed approximately 55% by the end of the century. Even if we proceed with reductions such as proposed in President Bush's State of the Union message on January 28, 1992, the percentage will reach no more than 65%.

A program to make an important improvement in the safety in the U.S. arsenal by removing all conventional HE and replacing it by IHE in the stockpile for the 21st century would require only a modest and limited underground test program. The details of this program would depend upon whether existing warheads such as the W88 and the W76 in the Trident system are redesigned and tested with IHE, or whether existing warheads designed with IHE, such as the W89 warhead being developed as a technology demonstration of pit reuse, are adapted for the Trident missile of the future. In either case the requirements for testing would be limited and could probably be completed by the time of the 1995 crucial 5th review conference of the Non-Proliferation Treaty (NPT), if pursued actively starting now.

A third major step to remove the risk of plutonium dispersal by a detonating warhead would be to develop the technology of a fire resistant pit (FRP). Current FRPs, which can be thought of as vaults in which the fissile material of the nuclear primary is contained, are designed to contain molten plutonium against the roughly 1000° C temperatures of an aircraft fuel fire that lasts for several hours. FRPs would fail in the event of detonation of the conventional HE and therefore should be used only in weapons equipped with IHE. It was a recommendation in the 1990 report of the Nuclear Weapons Safety Panel that all nuclear weapons loaded onto aircraft, both bombs and cruise missiles, be equipped with FRPs, together with IHE and ENDS. These are viewed as the three critical safety features for avoiding plutonium dispersal or a nuclear detonation in event of aircraft fires or crashes. Currently, no more than about 10% of the weapons in the U.S. stockpile are equipped with FRPs. This percentage will probably grow to about 20% if retirements of weapons that are anticipated, based on President Bush's initiatives, are implemented. I know of no plans to do more.

* Recommendation of the Senate Armed Services Committee presented on May 17, 1978, by Chairman John Stennis. (See Report No. 95-961; page 10)

The technology of FRPs is well known. The requirements for underground testing to develop FRPs for U.S. warheads are limited depending upon whether existing warheads with FRPs are adapted to new systems or whether, because of design constraints imposed by existing missiles and their reentry vehicles, it proves necessary to develop new warheads. The test program may or may not extend beyond the 1995 date of the NPT review to fully incorporate the benefits of fire resistant pits.

The safety effectiveness of FRPs is limited to temperatures encountered in aircraft fires. They cannot assure containment if they are also crushed in an accident leading to a fire. Nor will they provide plutonium containment against the much higher temperatures created by burning missile propellant. For enhanced safety in such circumstances it is necessary to develop new and more advanced weapons design concepts. To give a specific example, a concept familiar in the world of binary chemical weapons would separate the very hardened plutonium capsule within the warhead from the high explosive prior to arming the weapon; or similarly it might separate the high explosive itself into two non-detonable components. I do not know whether such, or other, advanced design concepts will prove practical when measured against future military requirements, availability of resources, and budget constraints. However, as recommended by the Nuclear Weapons Safety Panel, "they should be studied aggressively. R&D is not cheap but the payoff can be very valuable in terms of higher confidence in enhanced weapons safety."

2). *How extensive a test program is required and how many years will it take to fully meet the appropriately conservative safety criteria for the U.S. nuclear stockpile?*

Advanced concepts to make weapons as safe as reasonably achievable, such as the binary one discussed above, would take longer to develop and I cannot say at this time how many years it would take to develop. After initial tests it may become clearer how extensive the program should be or whether this is even a productive line to follow in search of a truly significant enhancement of safety. These and other advanced concepts have not yet been adequately explored, and their analysis and testing will certainly extend beyond the 1995 date of the NPT review. However, I believe that, with adequate resources, an underground test program directed to develop such advanced concepts that enhance safety, perhaps, as suggested, by requiring an arming action in order to physically collocate the fissile and the high-explosive components, could be accomplished within a decade. The result of such a program would be a weapons stockpile that meets desired safety criteria and that can be relied on with confidence without requiring continued testing for reliability.*

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* During the past decade most tests were planned primarily for the development of new warheads and the study of weapons effects. Current tests are emphasizing safety enhancement and pit reuse.

3). *Are the gains in safety that would result from continued testing more important than the political value, real or perceived, of a CTBT for strengthening or even preserving a non-proliferation regime?*

The safety record of the U.S. nuclear establishment is very good. There have been a number of incidents, but never an accident leading to a nuclear yield. Nor have there been any accidents leading to plutonium dispersal since SAC bombers loaded with nuclear weapons were taken off airborne alert in 1968. Nevertheless, there is still room for substantial improvements in nuclear weapons safety, as the answers to the first two questions make clear. Some of these improvements can be achieved by retiring older weapons and modifying existing ones; some can be achieved by changes in the handling procedures. However, in order to implement further improvements, continued testing is required.

It is important to recognize that there is no clear answer to a question such as "How safe is safe enough?". What is required is judgment informed by careful analyses and adequate data on how far to push, or to relax, safety standards. Informed judgments on such issues must be based on a realistic assessment of the risks and benefits, technical, military and political. It is especially important to avoid nuclear weapons accidents because of their potentially exceedingly harmful consequences, both physical and political. In particular the credibility of our entire nuclear weapons system could be severely damaged if even a minor accident were to occur involving a nuclear weapon and leading to a small detonation or the dispersal of plutonium. We have seen how accidents with civilian nuclear power reactors, and the resulting perceptions that governments were less than fully attentive to the possible health risks, have been so harmful to the debate on energy policy.

Against the importance of continuing underground tests, in order to meet the very demanding safety criteria for the U.S. arsenal, I have great difficulty in attempting to judge how important a CTBT would be at this time. I agree with Secretary of State James Baker when he said in Washington, D. C., on September 19, 1990, that "we cannot approach nuclear proliferation in a business-as-usual manner"; and further when he continued both in his name and in that of then Soviet Foreign Minister Shevardnadze, that "we both see proliferation as perhaps the greatest security challenge of 1990's... and we agree that stopping and countering proliferation must be a central part of our agenda."

If, or when, it is judged that agreeing to a comprehensive test ban would be an important aid to the non-proliferation effort, I recommend that the United States should agree to such as ban. Looking ahead to 1995 and beyond I presume that there will come a time when a CTBT will help strengthen the non-proliferation regime. Meanwhile, however, I support a testing program designed to advance the possibilities and understanding of enhanced safety, and thereby helping us prepare for the possibility of a comprehensive test ban.

In pursuing such a program I also recommend that the U.S. abandon its current

official position that we must continue to test as long as we have nuclear weapons. It should be replaced by a policy that limits underground tests to those that are required to insure that all the weapons constituting our future nuclear forces – i.e. warheads together with their delivery systems and their operational handling procedures – can be certified as meeting appropriately conservative criteria for nuclear weapons safety. This program would consist of several low yield tests per year. However, based on our 1990 review of nuclear weapons safety for this Committee, I can not say now, nor do I believe the information is yet available to say now, how many tests or how many years of testing will be required to meet this safety goal. The government can and should emphasize in public discussion what are our safety criteria and the objectives of our tests, as well as the technologies we are developing in order to enhance safety. There would be no compromise of U.S. security to share many of these technologies with the Russians – or any sophisticated nuclear power – to help improve safety. On purely military grounds I see no strong reason to avoid an exchange of general information on test goals. By now there are few real secrets to protect. It is about time for more openness and less obsessive secrecy in all matters nuclear.

Finally, I would like to add that I am disappointed at the slow response by the administration and the military to a number of the specific recommendations made by the Nuclear Weapons Safety Panel. I also regret that several important recommendations were rejected. There have been advances in safety during the past year due to force reductions – in part already accomplished, in part planned – that were initiated as a consequence of the end of the Cold War, the signing of the START Treaty on July 31, 1991, and subsequent initiatives by President Bush, former President Gorbachev, and President Yeltsin. However the response to our Panel report, which we presented to this Committee more than 15 months ago, has been largely in the form of paper statements of principle. Otherwise there has been a dearth of solid action and most of the Panel's recommendations have yet to be implemented. One that is being implemented by the two weapons laboratories, Livermore and Los Alamos, is the Panel recommendation to give higher priority in their R&D programs "to enhance safety – taking a long range view in search of big advances in technology beyond just evolutionary, incremental improvements."

The Secretaries of Defense and Energy issued a joint policy directive emphasizing the importance of surety – i.e. safety, security, and control – of nuclear weapons and initiating a review for improving the stockpile. In response a joint surety plan is still in preparation and has yet to be considered by the Nuclear Weapons Council. I understand that it considers only assessments and the collection of data bases without recommending specific safety enhancements.

Our two most important recommendations to strengthen the safety assurance process for the U.S. nuclear arsenal were to create dedicated "Red Teams" of tech-

nical people with the responsibility to scrutinize and challenge the weapons designs and operational procedures for each nuclear weapons system, and to form a Joint Advisory Committee reporting to the Secretaries of Defense and Energy with oversight responsibility for ongoing safety and security practices. Although these recommendations were accepted in principle, they have yet to be implemented. No "Red Team" or Joint Advisory Committee exists today. We also recommended that DoD/DOE "develop a joint...training program for new appointees (at the mid-levels and higher) with official responsibilities in the nuclear weapons complex, particularly for weapons safety and security." Such a program is still being prepared, and has yet to be accepted and implemented.

The Panel also recommended that the responsibilities of the two offices charged with managing nuclear weapons issues within DoD and DOE be strengthened and more tightly focused. In particular we proposed upgrading the senior Pentagon office for nuclear issues from Assistant to the Secretary of Defense for Atomic Energy [ATSD(AE)] to the same status as an Assistant Secretary of Defense with direct reporting to the Secretary. This recommendation was rejected. This is a key position and, as a presidential appointment, provides Congress with the important opportunity for input in the appointment of a successor to Dr. Robert Barker, the current ATSD(AE), who will soon be leaving this position after 5-1/2 years of service.

The retirement of older weapons, as now planned to meet announced reductions, should lead to a stockpile that is equipped entirely with ENDS by the end of the decade. However the Panel recommendation to enhance safety by requiring that all weapons loaded on bombers contain FRPs as well as ENDS and IHE has not been accepted for weapons in the existing arsenal. Instead it is proposed to include FRPs in the design of any new bomber-carried weapons, unless that requirement would interfere with other factors relating to their military characteristics. The decision to remove all SAC bombers from ready alert has reduced the dangers of plutonium dispersal due to accidents or incidents involving armed bombers of the ALFA force poised near the ends of operating runways. However, the danger still remains for operations in times of heightened alert. It would be singularly unfortunate for serious nuclear accidents or incidents to occur during a time of crisis, and I believe we should remove from the arsenals weapons that give cause for such concerns.

In response to the Panel's stated concerns about the safety of the Trident system the Navy has changed its handling procedures for the Trident II missile with the W88 warhead, and now * transports and loads the missiles into their launch tubes before they are mated to their warheads. However, no change is being considered in the current design of the Trident missile itself. This still remains a cause

* This change is in effect for the present, while the the Navy conducts a risk assessment of the new procedure.

for serious concern since the Trident's eight warheads are built without insensitive high explosives and are mounted in close proximity to the 3rd stage motor that is powered by propellant of the type more highly susceptable to detonation. Since the Trident system will be a major component of the future U.S. strategic deterrent, I want to emphasize the importance of undertaking and completing the Panel's recommended broad and in-depth examination of the safety risks of continuing to deploy the present design versus the benefits and costs of redesigning it with IHE in its warheads and with a 3rd stage motor powered by a propellant that is less susceptible to detonation.†

To summarize, I am disappointed by what I consider an inadequate response by the government to the Panel Report. I welcome the fact that nuclear safety issues are receiving more attention following our Report. I realize that enhancing safety is a difficult challenge in a rapidly changing post-Cold War world. But nuclear weapons safety is a very serious issue, one that requires much higher priority than it has received in the past, and is still receiving. The U.S. government still has to demonstrate a strong commitment to serious, sustained programs for upgrading the U.S. nuclear stockpile in order to meet the rigorous safety criteria that it has formally adopted and announced since 1968. Otherwise the argument to continue underground testing for safety can not be supported.

† Alternatively one might choose to reduce the risks in the current design by simply removing the Trident's 3rd stage motor. This modification would increase the maximum range of a Trident II if its payload were decreased from eight to no more than four W88 warheads. It could also serve as a way of verifiably downloading of the total number of deployed warheads in order to stay under potential arms control ceilings without having to reduce the Trident fleet below a size desired for operational confidence and security.