TESTIMONY OF

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TO

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MAINTAINING AMERICA'S NUCLEAR DETERRENT
VIA STOCKPILE STEWARDSHIP

Introduction

Mr. Chairman, I am pleased to have the opportunity to testify before the Senate Armed Services Committee today regarding our responsibility to certify the safety and reliability of the US nuclear stockpile without nuclear testing. There are five key points that I would like to make:

- Nuclear deterrence remains key to the nation's defense and will for the foreseeable future. The safety and reliability of the nuclear weapons in our stockpile, regardless of its size, cannot be taken for granted.
- Maintaining the safety and reliability of our nuclear weapons without nuclear testing is an unprecedented technical challenge.
- The Stockpile Stewardship Program is working successfully toward this goal, but it is a work in progress. Los Alamos has been able to certify the safety and reliability of its nuclear weapons since the cessation of testing. On the basis of our experience over the last four years, I am confident that a fully supported and sustained program will enable us to continue to maintain America's nuclear deterrent without nuclear testing. However, I am concerned about several trends that are reducing my confidence level each year. These include annual shortfalls in the planned budgets, increased numbers of findings in the stockpile that need resolution, an augmented workload beyond our original plans, and unfunded mandates that cut into the program. We must have a national commitment if we are to succeed in certifying the stockpile without nuclear testing.
- All the Safeguards in the Comprehensive Test Ban Treaty are critical to maintain the US nuclear deterrent if this treaty is ratified. In particular, Safeguard F provides an essential hedge against unanticipated serious problems in the stockpile that cannot be resolved by the stewardship program.
- I am concerned about other significant disturbances this year in the stability of the support from the government, partially in response to concerns about espionage. This

has sent a mixed message to the Laboratory that will make it more difficult to carry out this essential program. I repeat my earlier statement. *With or without nuclear testing, we must have a sustained national commitment if we are to succeed in certifying the stockpile.*

The Stockpile Stewardship Program

The United States has the safest, most reliable, and most capable nuclear arsenal in the world. However, even after the end of the Cold War_with the threat of a massive nuclear exchange greatly diminished_the world remains a dangerous place. Two countries, India and Pakistan, conducted nuclear tests in the past year, and there are other countries in addition to the declared nuclear states that we suspect harbor nuclear weapons programs in various stages of development. There is concern that some countries may have obtained vital nuclear weapons data via espionage or other means that could mitigate to some degree their inability to do a nuclear test. Given these and other emerging threats, the U.S. nuclear deterrent is a vital component of our nation's security today and will be for many years to come. It is essential that we maintain effective means of ensuring its safety and reliability.

America's nuclear deterrent is being maintained without nuclear tests through a comprehensive program of calculations, experiments, and manufacturing known as the Stockpile Stewardship Program. Each year the directors of the Department of Energy's weapons laboratories certify the safety, reliability and performance of the stockpile. The DOE, the DoD, the United States Strategic Command, and others rigorously review this certification process. We are confident that our nuclear weapons at present are safe, reliable, and will perform as designed if required. We are engaged in an unprecedented program to ensure their credibility as the ultimate deterrent for decades to come.

The job of DOE's nuclear weapons complex is to make sure that no one in the world doubts that the United States has the technical capability to project overwhelming nuclear force in the defense of our national interest. Accomplishing this task involves two parallel efforts. First, we must take care of the actual weapons themselves, including actions made necessary by aging, manufacturing defects, and new military requirements.

Second, the nuclear deterrent must remain credible to our government officials and to the governments of allies and potential adversaries.

Each year, through a comprehensive program of surveillance of the stockpile, we find one or more problems in each weapon system that may require attention. Some of these problems are related to the aging of weapons components. We are requiring that our weapons last much longer than their original design lifetime, and therefore we will need to monitor weapon components closely in order to identify and fix problems in a timely manner. We also continue to find problems that were introduced during the original manufacturing of some specific weapons. We have identified several issues that, if they had occurred when testing was active, most likely would have been resolved by nuclear testing. However, to date we have been able to resolve these issues without testing by using the methods of stockpile stewardship.

The United States developed its nuclear arsenal using the same methods applied to most other complex systems: a sequence of design_test_produce. We designed weapons to meet stringent military requirements. We tested them to validate our designs and to ensure that our weapons would perform over the full range of hostile environments After the design was validated by nuclear testing we produced as many as were required for'our nation's security.

Today, we are employing a new method: a sequence of surveillance_evaluation_response. In this new paradigm, we are using a fundamentally different set of tools to ensure the safety, reliability, and performance of nuclear weapons: the Stockpile Stewardship Program. We need many program elements to perform our responsibilities. Five of the key elements to do our job are:

- **Large scale computing.** Without nuclear testing, numerical simulations must serve as the integrating method to confirm the safety and reliability of stockpiled weapons. Historically, we have always used the most advanced supercomputers to guide our designs. However, these machines were unable to do more than link past tests with incremental changes in design. There are simply too many processes in a nuclear explosion involving too much physics detail to perform a complete calculation. At present, with the most powerful supercomputers on Earth, we know that we are not doing calculations with sufficient accuracy and with sufficient detail to provide maximum confidence in the stockpile. The DOE's Accelerated Strategic Computing Initiative (ASCI) is intended to provide the needed technology to validate new computational models before our most experienced nuclear designers and engineers have retired or left the complex. We are now using our new supercomputers and new weapons codes provided by this program in important but limited ways. With adequate support and with good progress in ASCI, we expect that a suite of detailed weapons calculations will begin to be possible in 2004.

- **Hydrodynamics Testing.** The most sensitive element of a nuclear weapon is the "primary," the component containing high explosives and plutonium. We know that we do not adequately understand instabilities that occur during the implosion process and we are concerned about the aging of high explosives and plutonium that could necessitate expensive remanufacture of the stockpile. The Dual Axis Radiographic Hydrodynamics Test (DARHT) facility now in initial operation at Los Alamos is a step toward providing the high resolution images that we need to validate aging weapons behavior. The Advanced Hydrodynamics Facility (AHF), for which we are still developing technologies, will provide greater confidence in weapons primaries. Subcritical tests at the Nevada Test Site provide vital information on the behavior of plutonium under shock conditions and essential data required to re-certify remanufactured weapons components. These experiments are essential to validate the results of our calculations.

- **Materials Science.** We are being asked to maintain our nuclear weapons well beyond their intended design lifetime. Since weapons are made of complex materials, we must greatly advance our understanding of such materials and how they age over decades in the stockpile. The ability to characterize aging effects in weapons and predict when materials should be replaced will be crucial to extend the life of stockpiled weapons. Two examples may help elucidate the complexity of this problem. High explosives are a combination of explosives molecules and plastic binders that provide mechanical strength and enable precision machining. Over time, the plastic in high explosives migrates, much as the plasticizer in the dashboard of an automobile. This drying can lead to cracks and gaps in the explosive charge. One might suggest that we simply remanufacture the high explosive when needed. Unless this is done in conjunction with scheduled stockpile refurbishment, it would be prohibitively costly by requiring the disassembly and reassembly of thousands of weapons with the attendant risks of error or accident. Second, we are requiring that the plutonium pits in our weapons endure in the stockpile for longer than this element has existed on Earth. We do not know the details of how this complex, artificially produced metal ages, including whether pits fail gradually, giving us time to replace them with newly manufactured ones, or whether they fail catastrophically in a short time interval that would render many of our weapons unreliable at once. Advanced materials facilities, including neutron and x-ray scattering facilities, and the continuation of subcritical experiments at the Nevada Test Site, are essential to provide information on material aging before it is too late to remedy the problem without taking one or more weapons systems out of the stockpile.

- **High Energy Density Facilities.** When detonated, nuclear weapons are the hottest and densest objects in the solar system. We know that we do not understand enough about the behavior of materials at temperatures and densities that exceed those at the center of the Sun. Facilities such as the National Ignition Facility will not duplicate weapons conditions exactly, but they will enable us to study key parameters more accurately than any other technique short of nuclear testing. Pulsed power facilities such as the "Z" machine at Sandia National Laboratories and the Atlas machine developed at Los Alamos National Laboratory for siting in Nevada will provide additional capabilities to do experiments at high pressures and temperatures on large engineering samples.

- **Manufacturing Capability.** The average age of the nuclear stockpile is older now than at any time in history, and nuclear weapons involve materials and technologies found nowhere else on earth. Maintaining an adequate specialized manufacturing base is crucial to maintaining the nuclear deterrent. Every component in a nuclear weapon should be considered as a limited life component. Having the capability to reproduce these components is essential for us to maintain our deterrent indefinitely. Right now, the United States has a very limited weapons production capability. The infrastructure that was required in the Cold War era is being downsized and reconfigured. Los Alamos is in the process of demonstrating the ability to produce a small number of plutonium pits per year. The Y12 plant produces uranium components, but again at limited production rates. The Kansas City Plant produces non-nuclear components to replace out of date electronic systems and other auxiliary weapons parts. The Pantex Plant is responsible for weapons disassembly, refurbishment, and assembly. Finally, Savannah River Site does the replacement of tritium, a radioactive gas that is essential to weapons performance but has a half-life of twelve years. We must have the appropriate level of stockpile support and manufacturing capability in all these areas to maintain our deterrent.

Progress in Stockpile Stewardship

The Stockpile Stewardship Program is working and has already had a number of noteworthy successes. The DOE and the labs are developing advanced computer simulations using our new powerful supercomputers that allow us to understand complex weapons phenomena better than ever before. We are beginning the operation of the world's most powerful radiographic machine that will allow to investigate key primary issues better than in the past. Los Alamos is developing a new technology, called proton radiography that will provide high-resolution three-dimensional motion pictures of (noncritical) implosions of weapons assemblies. We have conducted a number of subcritical experiments underground at the Nevada Test Site that are key to comparing newly manufactured weapons pits to those manufactured at the Rocky Flats facility and to understanding important weapons physics features that can only be approximated in computer simulations. DOE's production plants are providing replacement components for out of date parts.

Most important, over the past four years we have been able to certify, without nuclear testing, that all of our weapons systems are safe and reliable and that that they will perform as designed if called upon to do so. We are confident in the stockpile today.

The issue is whether we will 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.

It is important to note that even with a complete set of tools we will not be able to confirm all aspects of weapons safety and performance. Nuclear explosions produce pressures and temperatures that cannot be duplicated in any current or anticipated laboratory facility. Some processes simply cannot be experimentally studied on a small scale because they depend on the specific configuration of material at the time of the explosion. While we can and will perform small-scale experiments, and in so doing confirm our understanding of basic physics and the accuracy of our computational methods, we must still utilize significant extrapolations to relate these data to actual weapons conditions.

Having raised these caveats, it is equally important to note that all of the weapons in our nuclear stockpile have been extensively tested. In over one thousand tests we have demonstrated both our understanding of the phenomenology of nuclear explosives and the validity of our specific stockpile designs. While we never did measure some key weapons processes, either due to a lack of measurement technology or schedule pressures due to weapons development timeliness we have a great deal of valuable data that will help us to validate our computer simulations. A stewardship challenge will be to understand how these data can help resolve future issues that arise from component aging or materials substitution.

A ready stockpile is but one component of nuclear deterrence. Also important is *confidence* in the weapons. Such confidence has three aspects. First, the stockpile stewards must have confidence in their ability to do their job. In this respect confidence should be balanced. Too little confidence could erode the utility of our nuclear deterrent, while over-confidence could lead to a false sense of security that could prove catastrophic if our weapons were called upon to defend our country. A second aspect of confidence is that of our govermnent-the President must have confidence in our nuclear forces in order to negotiate from a position of strength. Third, to serve as an effective deterrent, our nuclear weapons must be seen as credible by any opponent.

The end of nuclear testing introduces a new challenge into this third aspect of confidence. While we were testing weapons it was possible for any interested party to verify our ability to produce nuclear explosions in the 100 kiloton class or more. Without such tests, how will the readiness of our nuclear deterrent be apparent to other countries? This issue is not so critical now as it will be in twenty or thirty years, when no one in the nuclear weapons program will have had any nuclear test experience. Through the Stockpile Stewardship program we intend to demonstrate a technical excellence in weapons relevant science and engineering that will project confidence in our nuclear capability. This technical excellence will be evident in our unclassified publications and presentations at scientific conferences. Other countries will see these accomplishments and will understand their connection to the quality of our weapons program. Nothing could be more detrimental to strategic security than a lack of confidence in our nuclear forces, a confidence that is grounded in the recognized excellence of our scientists and engineers.

On the basis of our experience in the last four years, we continue to be optimistic that we can maintain our nuclear weapons without testing. However, we have identified many issues that increase the risk and lower our level of confidence. We are working on methods that will enable us to provide quantitative estimates of the uncertainties in weapon safety and performance, but these methods are not yet mature. The principal tools of stockpile stewardship, including supercomputers, advanced computer simulations, hydrodynamics facilities, lasers, and other facilities, will be fully operational in the middle of the next decade. We are in the process of attracting and training the next generation of stockpile stewards, a task made more difficult by the current security climate at the weapon laboratories.

We believe that all Safeguards in the Comprehensive Test Ban Treaty are critical to effectively maintaining the treaty regime and could be strengthened by an annual assessment process that evaluates the status of the Safeguards. In particular, Safeguard F provides a necessary hedge against discovery of a critical flaw in the stockpile that cannot be addressed by the Stewardship Program. We must ensure that there is a well-defined, carefully protected process that allows the government to evaluate the overall national security situation if one of the laboratories determines there is a problem in the stockpile that they believe cannot be resolved without nuclear testing.

We must be able to quantify our uncertainties about the stockpile in the future. What is the "tripwire" that would cause us to recommend a test? How will we know that an issue is beyond the ability of our computational and experimental tools to resolve? While we do not have definitive answers to these questions as yet, the Stockpile Stewardship program is focused on providing them.

Concluding Remarks

Nuclear deterrence will remain key to the nation's defense for the foreseeable future. To ensure the viability of our deterrent we must be able to certify the safety and reliability of the stockpile. Can we maintain the safety and reliability of our stockpile indefinitely without nuclear testing? We believe that we can, but to succeed we must have a sustained national commitment. The Stockpile Stewardship program has undertaken this unprecedented technical challenge, and to date it is working. Safeguard F in the Comprehensive Test Ban Treaty is an essential hedge to ensure that the country has the option to respond if we find that our stockpile has a problem that cannot be solved without nuclear testing.

Thank you for your past support of our laboratory and the nuclear weapons program. I trust that you will continue to provide us with your strong support in the future.