

NATIONAL DEFENSE UNIVERSITY

NATIONAL WAR COLLEGE

**ASSURING THE SAFETY AND RELIABILITY OF AMERICA'S NUCLEAR
WEAPONS: THE ANNUAL CERTIFICATION PROCESS**

**Course 5603
National Security Process**

**Richard H. Perkins
Course Instructor: Captain Michael Dunaway, USN
Faculty Advisor: Dr. Mel Goodman**

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Introduction and Background

The last nuclear weapon test conducted by the United States occurred in September 1992, underground, at Department of Energy's Nevada Test Site approximately 65 miles north of Las Vegas. It was the last of a busy era of U.S. underground nuclear testing. In fact, between 1951 and 1992, the United States government conducted 806 underground nuclear tests¹. Tests were conducted for number of reasons, the most obvious being to determine whether a nuclear device would work and if so, how well, yielding irrefutable proof of the device's performance. In October 1992, one month after the last U.S. underground test, President Bush signed the FY 1993 Energy and Water Appropriations Bill, which instituted a nine-month moratorium on nuclear testing and required the President to take steps toward achieving a multilateral ban on all underground nuclear weapons tests by September 30, 1996.²

In July 1993, President Clinton announced that he would continue the moratorium, while seeking agreement on a "zero-yield" international treaty to ban the testing of nuclear weapons. A unilateral U.S. test moratorium has remained in effect since October 1992. Two years later, on August 11, 1995, President Clinton declared support for negotiation of the Comprehensive Test Ban Treaty (CTBT). On September 24, 1996 President Clinton signed the CTBT and forwarded it to the Senate for advice and consent on September 22, 1997. By unanimous consent, the CTBT was brought to

¹ 24 additional underground tests were conducted as joint US-UK operations. This number does not include 9 underground tests conducted by the United States that were intended to produce craters; the explosions were not contained and could be considered atmospheric. Altogether, between 1945 and 1992, the U.S. conducted 1054 nuclear tests, both above and below ground, with yields ranging from 0 to 15 Megatons.

U.S. Department of Energy, Nevada Operations Office. "A Chronology of United States Nuclear Tests, July 1945 Through September 1992," (1999).

the floor of the Senate for debate and vote on October 8th, 12th, and 13th, 1999. Requiring a two-thirds majority for ratification, the Treaty failed to be ratified on October 13th.³

The administration has stated, however, that it intends to continue to seek ratification for the CTBT, and that it will abide by the Treaty's provisions. This means the moratorium on underground testing is likely to continue for some time along with the process of evaluating how much confidence we should continue to have in the nuclear stockpile in the absence of underground testing. In order to assure continued confidence in the reliability of the nuclear stockpile, the President released a prepared statement at the time of his initial declaration of support for the CTBT that called for the establishment of a process which would later be called simply *Annual Certification*. The President's statement read, "As part of this arrangement, I am today directing the establishment of a new annual reporting and certification requirement that will ensure our nuclear weapons remain safe and reliable under a comprehensive test ban."⁴

Annual Certification Goals and Issues

The current Annual Certification process is a series of formalized reviews, conducted each year with multiple participants from various government and contractor organizations, culminating in a written certification letter from the Secretaries of Defense and Energy to the President that the nuclear weapons stockpile is safe and reliable in the absence of underground testing. The process serves to provide the President, and also the

² John Foster, Harold Agnew, Sydeell Gold, Stephen Guidice, James Schlesinger. "FY 1999 Report to Congress of the Panel to Assess the Reliability, Safety, and Security of the United States Nuclear Stockpile - Appendix A." (November 8, 1999): pg. A-1.

³ John Foster, et al. "FY 1999 Report to Congress of the Panel to Assess the Reliability, Safety, and Security of the United States Nuclear Stockpile - Appendix A." (November 8, 1999): pg. A-1.

⁴ Jim Kapsalas, "Annual Certification." (November 1999).

Secretary of Defense through Department of Defense participation, a measure of confidence that the nuclear deterrent is still safe and militarily effective.

Over the years, however, the potential for conflicts of interest among the players have caused some government entities to question whether the President should have confidence in the process itself. It was, in part, for this reason that Congress recently established a temporary five-member panel chaired by Dr. John Foster “to assess the reliability, safety, and security of the U.S. nuclear deterrent.” This “second-look” panel will provide annual reports for three consecutive years and will then be disbanded. The first of these three reports was submitted on November 8, 1999.

The 1999 Foster-panel report to Congress describes “confidence in the stockpile” as having two dimensions. The first, being quantitative, derives from scientific assessments and surveillance of the systems. It is based largely on a sufficient degree of thoroughness and probabilities calculated as a result of a wide array of tests. The second dimension of confidence centers on judgment; it is based on trust in the ability of the people, methods, and tools available to find, assess, and fix potential problems in the stockpile.⁵ Because of its qualitative nature and heavy reliance on judgment, it is this second facet which can be most perplexing. In fact, as we look closer at the overall process, we will find that once all the caveats and assumptions are accounted for in “quantitative testing,” here too, a great deal of faith is placed in judgment. This creates more than a little tension among military leaders who would prefer more concrete proof because judgment is hard to audit and scientists, especially physicists, are certainly capable of routine disagreement. Worse yet is the notion that non-scientific

⁵ John Foster, et al. “FY 1999 Report to Congress of the Panel to Assess the Reliability, Safety, and Security of the United States Nuclear Stockpile.” (November 8, 1999): pg. 2.

considerations could influence the judgment process. We will see that there are many such issues that warrant this concern and consideration.

Underground Nuclear Testing

In the past, the U.S. has placed a great deal of value on the ability to test weapons. The obvious benefits come from the ability to detonate an actual nuclear device and measure the results. Numerous diagnostics can be placed with the test device to take measurements and relay them away from the explosion right up until the very moment the instrument is destroyed. To prevent radiation and radioactive contaminants from spreading, hundreds of feet of earth and sand contain the nuclear detonations, although the shock waves produced by the detonations are so powerful they could break the legs of anyone standing on the surface directly above the test. The explosion itself does not reach far beyond the initial placement of the test device. The heavy mass of earth resting on top of the device effectively captures the nuclear detonation, preventing it from reaching the surface. Instead, the explosion simply creates a gaseous cavern, measured in yards, that is temporarily filled with vaporized earth and strains under the immense pressure and heat created from nuclear yields often well in excess of those which destroyed Hiroshima and Nagasaki in 1945. The blinding-white light, the powerful radiation, and the heat of a thousand suns are all contained just below the surface of the earth. Just several miles to the west, in Mercury, a government-owned town just outside the test site's main gate, the residents would be unable to feel, hear, or see any evidence of the detonation.

After about an hour of cooling, the gasses in the cavity created by the detonation begin to condense back into solids and the pressure begins to subside. At a certain point,

the weight of the earth above the cavity overcomes the decreasing pressure and begins to cave in on the underground cavern. This begins a chain reaction as a column of earth and sand falls into the void like sand running into the bottom of an hourglass, creating successive voids above it which in turn cave in. As the open space steps toward the surface, it emits a rumble that can be picked up by seismographs. The whole process may take a minute to complete, culminating in a sudden appearance of a depression on the surface. This forms the familiar evidence of an underground test called a subsidence crater. Many people associate the appearance of a subsidence crater with the moment of detonation, but it is really the sign of an underground test cooling down some time after the explosion.

Since 1963, all but five tests were conducted at the Nevada Test Site.⁶ The advantage the site offers is the infrastructure necessary to repeatedly place diagnostics with the detonations. Most underground tests are “shaft” tests, where a deep vertical shaft is drilled. The test assembly rack (consisting of the test device, diagnostics, and other experiments) is placed at the bottom of the shaft with control and communication cables running back up to the surface. The shaft is then filled in, or stemmed, with carefully selected layers of earthen material. Each aggregate layer has a specific thickness that is optimized to keep the earth sealed and the explosion plugged tight. In another kind of test, called a “tunnel shot,” long horizontal tunnels are dug into hillsides in order to place the test device under a mountain of earth. The tunnel shots allow diagnostic equipment to look down the tunnel directly at the test device as it is detonated. Moments after the detonation, a series of explosives fire to close doors and seal off access

⁶ U.S. Department of Energy, Nevada Operations Office. “A Chronology of United States Nuclear Tests, July 1945 Through September 1992,” (1999).

pipes, protecting the diagnostic equipment from the emissions of the explosion. The bulk of the weapon's energy is delivered into the earth inside the mountain, pushing out a pocket of earth which helps to seal off the tunnel exits, further preventing the radioactive material and blast from reaching the atmosphere.

Non-nuclear Testing

Outside of underground tests, weapon reliability is assessed through the application of scientific theory, relevant experimentation, and a surveillance program where random war-reserve⁷ nuclear weapons are recalled from military deployment, dissected, inspected, functioned as components, and/or flight tested. Historically, all of these tools were also used in the process of *certification*, the process through which the responsible national laboratories⁸ ensures that any weapon that has been designed and produced to enter the nuclear stockpile is safe, secure, and reliable in meeting its designed military characteristics and stockpile-to-target sequence.⁹ It is arguable that more has been learned through the application of theory, experimentation, and surveillance than from nuclear testing. However, nuclear tests provide the only opportunity to function the weapon in its actual, unperturbed configuration.

Experiments called “hydro tests” function weapons after replacing the fissile material parts with surrogate materials that will not produce a nuclear detonation. X-ray photographs are taken at the moment of detonation to observe the mechanics of the

⁷ A war-reserve nuclear weapon is a weapon that has passed a comprehensive quality control evaluation. War-reserve weapons and weapon parts receive a “diamond stamp” indicating they are acceptable to transfer to Department of Defense custody for use as war fighting tools.

⁸ The responsible national laboratories consist of the laboratory which designed the nuclear physics package and Sandia National Laboratories, which is responsible for additional non-nuclear components.

⁹ Stockpile-to-target sequence is a set described of environments for which the weapon is certified.

detonation. These experiments are extremely valuable and yield a great deal of useful information. However, the use of surrogate materials introduces corruption into the experiment since the molecular weights and material properties of the surrogate materials will not exactly match those of the fissile materials. Corrections to the calculations can be made based on known differences, but how closely the results correlate to an actual weapon design is left to judgment.

Surveillance tests are performed as either laboratory tests or flight tests. In laboratory tests, war-reserve weapons are withdrawn from military service, inspected, and partially disassembled. The separated components are then operated individually under conditions that may or may not mimic the flight environment. Laboratory surveillance identifies numerous issues related to the stockpile, allowing repairs to be made before a problem becomes widespread. However, the acts of disassembly and inspection may destroy or remove evidence of certain problems. In flight tests, the components are rebuilt into *joint test assemblies* (a simulated nuclear weapon with telemetry devices that radio information about the performance of weapon to remote recorders on the ground) that can be delivered to a test target using the designated military platform. Flight tests excel as an accurate confidence test in that the flight environment is precisely duplicated and the original equipment is used whenever possible, but the correlation to the original weapon can be vague since the weapon has been completely disassembled and reassembled just months prior to the test and the nuclear fissile materials have been removed and replaced with surrogate materials.

Maintaining Confidence in the Status Quo

Since 1992, the random surveillance of weapons coupled with the above mentioned experimentation has continued to identify and correct problems within the stockpile. Based on the number of problems discovered and the estimated impact and spread through the stockpile, statisticians have been able to calculate weapon reliabilities which meet or exceed requirements stated in the military specification for the weapon systems. The unanswerable questions, however, pertain to whether the theory is correct and whether an important issue is simply being overlooked.

To help minimize these concerns as much as possible a new mindset of operation quickly took root once the 1992 test moratorium was imposed; don't change anything. This popular approach centers on maintaining the exact same *baseline designs* that were originally tested with underground tests in hopes that if nothing changes, we will be able to maintain a high confidence in the system. As weapons age, however, many of the parts must be replaced. For the longer-lived components, extra parts were never made since it was expected that the system would be retired and replaced with a new design before the main body of the weapon ever aged enough to warrant concern.

Unfortunately, many of the commercial technologies used to make the original parts no longer exist and would be cost prohibitive to reestablish. Additionally, newer safety requirements have driven the need to change or add components. Where possible, weapon designers have created new component designs that minimize the physical changes to the system. Additionally, advanced computer simulations have been used to model the new configurations, but as changes from the baseline designs accumulate, the

confidence in the simulation results decrease. Of the most significant questions concerning the Annual Certification process – will we know when we’ve gone too far?

The Annual Certification Process

The overall Annual Certification process is shown in figure 1.¹⁰ The foundation of the process is a report that is generated for each weapon system. The evaluation begins with a written *design lab technical certification report* prepared by the national laboratories responsible for the weapon system. That report is then edited and expanded within a project officers group¹¹ (POG) responsible for the system in order to create a POG report which considers input from DoD, DOE, and several contractors having responsibilities associated with the system. The POG reports constitute the largest and most comprehensive written assessments within the process. The members of the weapon system POGs are among those most familiar with issues surrounding the individual systems at any given time. This familiarity results in a very thorough scrubbing of the report. Nothing in the report should be a surprise to the POG, however, since any new issues would have been negotiated and addressed by the POG already. Any member of the POG can raise a question about the safety or reliability of the system, but the most influential member by far (because of their sheer exposure to the science and data surrounding the evaluation) is the national laboratory member. Discussions may call into question the opinions of the laboratories, and those opinions may be influenced to change, but in the end it is almost always the laboratory opinion that is the foundation of the technical assessment.

¹⁰ Jim Kapsalas, “Annual Certification.” (November 1999).

¹¹ A group of government and contractor representatives with shared responsibility for a weapon system.

Once the POG report is completed, it is briefed to the Air Force or Navy (depending on the system), Joint Chiefs of Staff, Office of the Secretary of Defense, Strategic Command, the Nuclear Weapons Council Standing and Safety Committee, and the Nuclear Weapons Council. Once each of these organizations sign off on the report, it is passed to the Secretaries of Defense and Energy with a recommendation and a letter to sign out to the President. Before the Annual Certification letter goes to the President, Strategic Command (the war-fighter customer using the weapons) and the National Laboratory Directors have the opportunity to communicate directly with the Secretaries of Defense and Energy presumably so that a negative opinion or concern could be delivered by bypassing the formal review chain. The process is deliberately set up to give multiple players a fair and reasonable chance to raise questions and concerns and minimize the chances that institutional or political agendas could railroad the process.

The National Laboratories and Their Roles

There are three nuclear weapon design laboratories in the United States: Los Alamos National Laboratory in Los Alamos, New Mexico; Lawrence Livermore National Laboratory in Livermore, California; and Sandia National Laboratories which has facilities in both Albuquerque, New Mexico and Livermore, California. Two of the laboratories, Los Alamos and Lawrence Livermore, focus primarily on issues related to the nuclear cores (or physics packages) of the weapons, while the focus of Sandia is the non-nuclear aspects of the weapons such as radars, parachutes, neutron generators, arming/fusing/firing systems, etc. While Sandia has a large and significant role with all weapon systems, ownership of physics package design will belong to just one of the other

two “nuclear” labs. Only 9 different designs remain in the current active stockpile; 4 belong to Lawrence Livermore and 5 belong to Los Alamos. Decreasing budgets have lead to continued discussion about eliminating more of the designs in order to save money. Not surprisingly, this leads to more than a subtle degree of design protectionism on the part of the laboratories to ensure the justification of their budgets.

Competition between the two nuclear laboratories goes all the way back to their creation. Los Alamos grew out of the Manhattan Project and the effort lead by Robert Oppenheimer, who is commonly referred to as the father of the fission bomb. The Lawrence Livermore Laboratory served to support the ideas of another physicist, Edward Teller, who is commonly referred to as the father of the H-bomb or fusion weapon. Between the two physicists, tensions existed that were significantly exacerbated by professional differences of opinion and accusations that Oppenheimer was spying for the Soviet Union government. These circumstances are likely to have fueled the intense (bordering on bitter) rivalry that continues today between the two laboratories. Another representative example of the friction between the labs are the cultural differences of their physical locations. Los Alamos is a quiet, rather isolated, mountain town full of gun-toting hunters and outdoorsmen. In Los Alamos, it’s hard to find an open restaurant after 8:30 p.m. Livermore, on the other hand, is a high-brow city suburb of metropolitan San Francisco and in the heart of wine country. While the two laboratory cultures share mutual professional respect, each looks at the other with a healthy degree of skepticism.

What the two nuclear laboratories fight over is money, scientific dominance and notoriety, and (most importantly) a continued mission. All three laboratories engage in numerous non-weapons related pursuits, but as pressures mount to privatize government

programs, maintaining a nuclear weapons-related responsibility is the one sure bet for improving their chances of staying around. The national laboratories are well aware that the loss of a nuclear responsibility is not desirable. For this reason, laboratories must balance between asking for increased funds in order to maintain their systems while not drawing too much negative attention on a system, giving it the appearance of being weak or troublesome and making it a candidate for retirement. Major factors that affect repair/retire decisions include the military importance of the weapon system, the safety and reliability of the system, the perceived potential to make safety and reliability improvements within the systems, cost, and where, how, and when the money would be spent. Both the Department of Energy and the laboratories know how these factors stack up for any given system. In fact, the Annual Certification assessments are reviewed by the very organizations that would be most influential in making repair/retire decisions. Since the laboratories themselves contribute significantly to the reports, the opportunity exists for the report input to be influenced for reasons other than the objective assessment of the weapon. The multiple and parallel reviews that are part of the process attempt to prevent any such occurrence. The establishment of the Foster Panel, however, shows that Congress may question the results of the Annual Certification process at least enough to have asked for a second opinion. Given the complex nature of nuclear testing and analysis and the immense infrastructure and significant lead time required to conduct an underground nuclear test, there can be little room for error in the present day evaluation of nuclear weapon safety and reliability.

Conclusion

Scientific objectivity within the laboratory and weapons community is still very strong. The process is packed with motivated, mission-oriented individual players who have dedicated their lives to maintaining the strength of the nuclear deterrent. Many of the individuals live a lifestyle that is motivated much more by the purpose of their job than by their paycheck. While subtle judgment decisions will always continue to be debated behind the scenes, it seems unlikely that the appearance of any consensus for concern would go un-debated in a greater forum. Additionally, strong technical staffing within the DOD organizations, and from the Navy's Strategic Systems Programs in particular, has helped to provide a highly significant check and balance in the assessment process as these organizations hold major roles in the project officers groups that develop the written assessments. Maintaining effective and capable organizations with the scientific and technical ability to audit the Annual Certification process serves two great purposes: first, to assure institutional and political influences do not affect the outcome without a valid basis and, secondly, to provide continued confidence to national security leaders that the Annual Certification outcome reflects the true nature of the United States nuclear deterrent forces. The potential institutional and political conflicts that can exist within the Annual Certification process, coupled with the seriousness of the nuclear deterrent mission, mandate that very close watch be kept over the Annual Certification process as long as the underground nuclear test moratorium remains in effect.

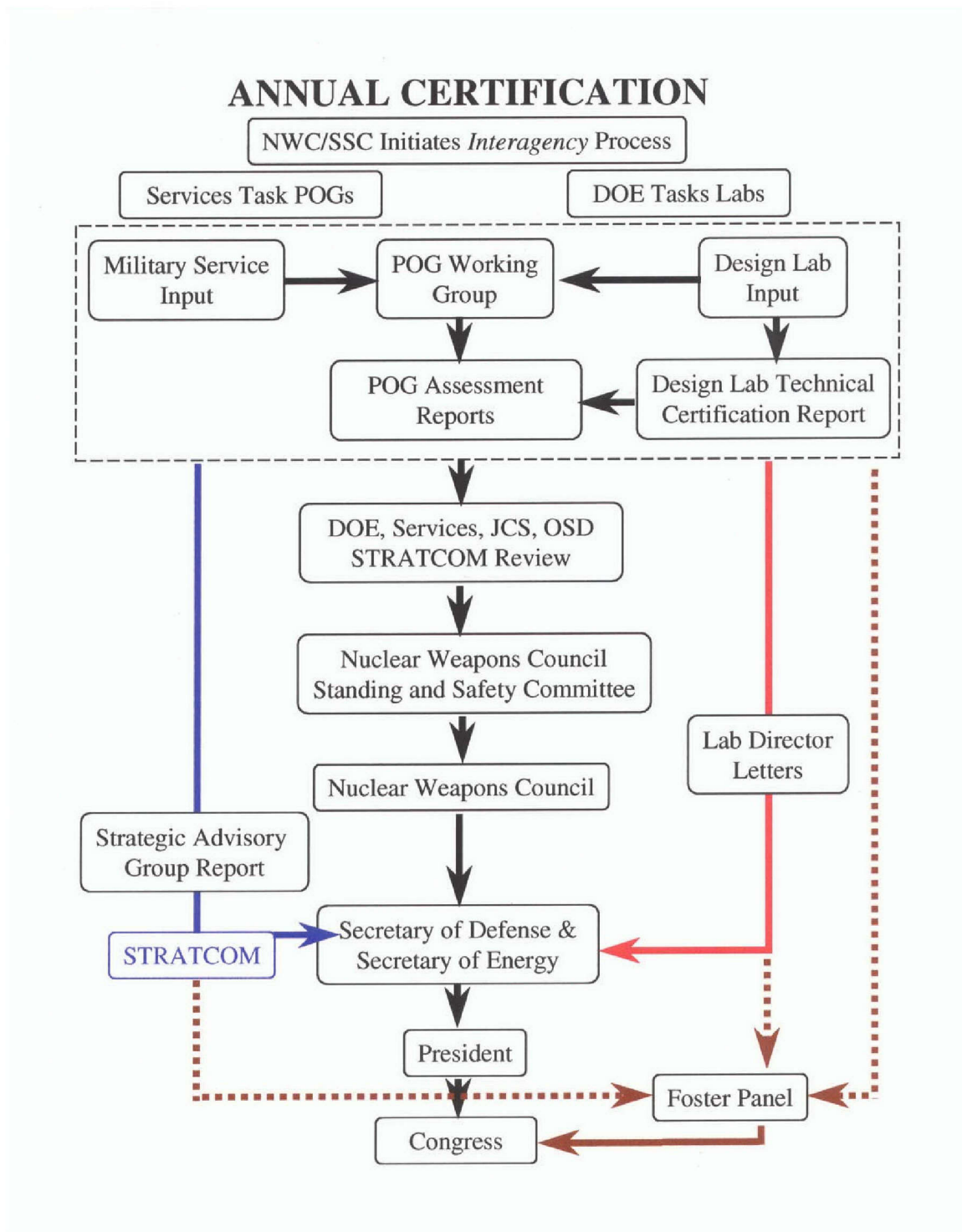


Figure 1