THE NATIONAL NUCLEAR SECURITY ADMINISTRATION'S BUDGET REQUEST FOR FY 2003

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OPENING REMARKS

Mr. Chairman and members of the committee, thank you for the opportunity to provide a statement on the budget request for FY 2003 for the National Nuclear Security Administration (NNSA). I am the Director of the Lawrence Livermore National Laboratory (LLNL). Livermore is committed to maintaining confidence in the U.S. nuclear weapons stockpile as a principal participant in the nation's Stockpile Stewardship Program. The Laboratory is also engaged in vital national programs to reduce the threat posed by the proliferation of weapons of mass destruction and to provide for homeland security.

My statement discusses Livermore's accomplishments in NNSA programs as well as the technical and programmatic challenges we face. But first, I want to thank the Congress for your continuing support of the Stockpile Stewardship Program and our nonproliferation and threat reduction activities. The Stockpile Stewardship Program continues to make excellent technical progress in the face of many challenges, some of the toughest of which likely lie ahead as weapons continue to age. A strongly supported and sustained Stockpile Stewardship Program is clearly needed to ensure that this nation can maintain the safety, security, and reliability of its nuclear deterrent over the long term. The five-year plan of the National Nuclear Security Administration details the need for a strong program, and I support NNSA's plan and the budget request for FY 2003.

Strong and sustained support is likewise needed for programs aimed at providing technologies to reduce the threat posed by weapons of mass destruction (WMD) through nonproliferation, counterproliferation, and counterterrorism activities. Because Livermore and our sister NNSA laboratories had been working for the past decade to develop technical capabilities to detect, counter, and mitigate WMD proliferation and terrorism, we were able to respond rapidly and effectively to the events of September 11 and its aftermath. Although those investments are paying great dividends in the newly declared war on terrorism, substantial investment is needed to develop vastly improved warning and responsive capabilities to protect the U.S. against these threats, now and in the future. We are fully committed to this long-term national security endeavor.

INTRODUCTION

Exactly one year ago, NNSA administrator General John Gordon, head of the NNSA, and Admiral Richard Mies, commander in-chief of U.S. Strategic Command, were at Livermore to commemorate the certification of the refurbished W87 ICBM warhead. Speaking as the "customer," Admiral Mies called the occasion an "historic event" and "the first real test of stockpile stewardship." The W87 life-extension program challenged all elements of the Stockpile Stewardship Program. Devising the engineering improvements to the warhead, going into production in a less than fully functional weapons complex, and certifying the performance of the refurbished warheads without nuclear testing were all major accomplishments. It is an important success story, but in the words of General Gordon, "we still have a long way to go." More challenging technical issues are on the horizon as the weapons continue to age, as other weapon systems are refurbished, and as new needs emerge.

Weapon-refurbishment decisions and actions bring into play the full spectrum of capabilities that we are striving to attain through the Stockpile Stewardship Program. First, to recognize and evaluate aging problems (and other defects) in weapons and devise remedies, we must understand in detail the science and technology that govern all aspects of nuclear weapons. We are making progress here, but we need even better investigative tools. Second, the nuclear weapons production complex must be able to remanufacture parts and refurbish weapons as needed. Currently the complex is far from fully functional. Third, we must be able to certify with confidence the performance of both the refurbished warheads and the other weapons in the stockpile. This task requires the application of expert judgment, together with the advanced experimental and computational tools we are using to improve our fundamental understanding of nuclear weapons. Finally, acquisition of this spectrum of capabilities is time urgent to meet existing requirements for weapon refurbishment and to deal with other weapon performance issues as they arise.

Thus a principal goal of the Stockpile Stewardship Program has been to expeditiously put into place a set of vastly improved scientific tools and modern manufacturing capabilities, including 100-teraops supercomputers, advanced radiography capabilities to take three-dimensional images of imploding mock primaries, a high-energy-density research facility (the National Ignition Facility) to study the thermonuclear physics of primaries and secondaries, and efficient and flexible manufacturing facilities. These investments are very demanding of resources, as is the need to meet requirements imposed by the Department of Defense (DoD). The 2002 Nuclear Posture Review provides a high-level policy perspective of what will be demanded from the NNSA laboratories to sustain the nation's nuclear posture. Concurrently, NNSA has developed a five-year plan for its Defense Program activities. The proposed budget for FY 2003 and succeeding years is larger than recent budgets, but there is much to be done and we must manage to achieve our critical milestones with the resources provided.

Livermore has major responsibilities within the Stockpile Stewardship Program, and our successes in 2001—as well as the challenges that lie ahead—provide a snapshot of the overall program. I already mentioned the successful certification of the W87 warhead, refurbished through a life-extension program (LEP). In addition, Lawrence Livermore and Sandia/California are starting the LEP for the W80 cruise missile warhead, designed by Los Alamos. This program will implement refurbishment options defined in a formal DOD/DOE study completed in 2000. It builds upon a modern baseline understanding of the W80 and its performance, which was developed cooperatively by the New Mexico and California laboratories during the DOD/DOE study and through significant additional work performed during 2001. At this time, there is a Congressional hold on NNSA work for the LEP while the Air Force defines its plans for life-extension work on the cruise missiles themselves. Prompt agreement on the path forward is needed if we are to be able to meet the directed date for the W80 first production unit (FY 2006). Also in FY 2001, we completed a pilot project to demonstrate the capability to conduct warhead pit surveillance operations, and we are now performing full surveillance on two warhead pits. Transfer of certain pit surveillance responsibility for LLNL-designed warheads to Livermore makes the work load at the TA-55 facility at Los Alamos more manageable.

Lawrence Livermore is also responsible for a number of state-of-the-art experimental and computer facilities—in operation and in development—that are essential for stockpile stewardship. Construction of the Contained Firing Facility for hydrodynamic testing at Site 300 is now finished. Qualification testing has been completed to assure the facility's ability to contain debris from experiments that use up to 60 kilograms of high explosives. The first stockpile-related experiment was executed last month, and an active testing schedule is now under way.

Construction of the National Ignition Facility (NIF) at Livermore is now more than 60% complete. I am extremely pleased to report that NIF remains on track and is meeting its baseline cost and schedule as provided to Congress in September 2000. We expect to have NIF's first laser beams delivered to the target chamber within the next year. Over the past two years, regular reviews of the NIF Project have been held every six months. Among other positive findings, the most recent review concluded that "The project has made impressive progress and has been responsive to previous review team recommendations." NIF remains a funding-constrained project that could be completed earlier and at significantly less total cost if more of its total project funding were to be made available in FY 2003 and FY 2004 rather than in later years.

The Advanced Simulation and Computing (ASCI) program is central to many of the success stories of the Stockpile Stewardship Program. Last summer, we took delivery from IBM of ASCI White, the world's most powerful computer, capable of 12.3 teraops (trillion operations per second). This machine has been used intensively by all three weapons laboratories to support stockpile stewardship through a variety of applications. For example, in the fall of 2001 both Livermore and Los Alamos used this machine to complete the first-ever fully three-dimensional simulations of a complete warhead explosion. We are earmarked to take delivery of our next ASCI computer in FY 2004, a machine that will be capable of 60 to 100 teraops. The groundbreaking ceremony for construction of the Terascale Simulation Facility (TSF) to house this computer was held just last week.

The events of September 11 highlighted the immense value of the NNSA laboratories' technical capabilities and their activities to reduce the threats posed by the proliferation or terrorist acquisition of weapons of mass destruction. These efforts are part of a comprehensive set of activities aimed at proliferation prevention (e.g., through cooperative programs with Russia), detection and reversal, response, and avoiding surprise (including support to the U.S. Intelligence Community).

Post-September 11, Lawrence Livermore provided analysis and assessments as well as information-operations tools and expert personnel to the Intelligence Community. Our Nuclear Threat Assessment Center operated seven days a week to evaluate numerous smuggling incidents and nuclear-related threats. Miniaturized DNA analysis technology pioneered by Livermore made possible several biodetectors with vastly improved capabilities which are being commercialized and are at the core of the nation's biodefense capabilities. In addition, our Counterproliferation Analysis and Planning System (CAPS), extensively used by the DoD, supported U.S. military efforts with evaluations focused on sites of concern in and around Afghanistan. Later in my statement, I provide many other examples of the capabilities and expert assistance we are providing to help government entities defend against WMD terrorism.

In short, Livermore's assessment capabilities and technologies are contributing to homeland defense in manifold ways. We were able to respond immediately because we had begun to address the threat of WMD terrorism long before September 11. We take a comprehensive approach to the problem, developing technologies and tools to counter threats and working closely with federal, state, and local response agencies to ensure that our technological solutions meet real-world operational needs. In several key areas, the research programs benefited greatly from the use of Laboratory-Directed Research and Development (LDRD) funding for exploratory efforts that led to technologies that are now being deployed; for example, without the head start provided by LDRD, the advanced biodetection systems that are now being fielded would still be in development. We are poised to contribute to homeland defense in the long-run through the development of more advanced technologies to defend against both current and future threats. The nation would greatly benefit from sustained funding for long-range research and development activities at the NNSA laboratories to improve homeland security.

One area of concern is the proposed FY 2003 budget for environmental management efforts at the Laboratory, which constitutes a reduction of about 27 percent from the FY 2002 allocation of $40.9 million. The Laboratory requires an additional $17.5 million above the budget request to maintain its existing environmental management program, which consists of two parts. The first is Environmental Restoration—the clean up of groundwater and soil contaminated from past operations. Considerable work has been done in remediating contamination at the Laboratory's two sites. However, with the proposed cuts, Livermore will miss critical cleanup milestones that have been negotiated by DOE with the State of California and the U.S. Environmental Protection Agency. In contrast, the Laboratory strongly believes that we should accelerate our cleaup activities, and we are again proposing this initiative to DOE as we have in past years. The second part of the program, Waste Management, involves the treatment, handling, and disposal of hazardous and radioactive waste from ongoing and past operations. Under the current proposed budget, it will be impossible to support the Laboratory's programmatic needs with a safe, compliant waste management program. This will have severe impacts on the national security mission and will cause certain programmatic activities to be deferred and/or cancelled.

On a positive note, from Livermore's perspective, I am very pleased with the progress that General Gordon is making at NNSA and with changes at the University of California in its role as manager of the Livermore and Los Alamos national laboratories. Preparation of the five-year plan for NNSA's Defense Program activities is the first of what I expect to be many tangible benefits from NNSA organizational changes. General Gordon's plan to eliminate a layer of field management and to reengineer operations at NNSA sites are other important steps. We at Livermore are working with NNSA to find ways to significantly reduce the administrative workload. As part of the University of California's management and operations contract extension, the position of Vice President for Laboratory Management was created and John McTague was selected to serve. Dr. McTague is providing outstanding leadership in efforts to strengthen management accountability, institute more uniform best practices in operations at Lawrence Livermore and Los Alamos, and foster even greater cooperation between the laboratories.

As you may be aware, I will be leaving my position as laboratory director soon, when my successor has been selected. I appreciate the support that this committee has provided to Lawrence Livermore and to me during my tenure. I also appreciate having had the opportunity to serve our nation in this manner. I look forward to the very positive future that I believe Lawrence Livermore will have with your continued support.

THE STOCKPILE STEWARDSHIP PROGRAM

The Stockpile Stewardship Program is designed to ensure the safety and reliability of the U.S. nuclear weapons stockpile required to meet national security needs of the 21st century. Confidence in the safety and reliability of the weapons is to be maintained through an ongoing and integrated process of stockpile surveillance, assessment and certification, and refurbishment. Stockpile stewardship is a principal mission of the National Nuclear Security Administration (NNSA). NNSA began operation in March 2000.

Earlier this year General John Gordon, Administrator of NNSA, announced organizational changes to enhance NNSA's performance in core mission areas. The changes realign and separate programmatic and operational functions within the agency. The organizational and other positive changes adopted by General Gordon will clarify lines of communication and authority, which should improve overall efficiency and performance. Execution of the Stockpile Stewardship Program remains the primary responsibility of the NNSA Deputy Administrator for Defense Programs (NNSA/DP).

The changes being made at NNSA will facilitate long-range planning and the preparation of a comprehensive five-year budget, which are critically important. The Stockpile Stewardship Program faces many competing demands for available resources. Difficult trade-off decisions will have to be made. NNSA must balance evolving requirements for directed stockpile work, the need for vigorous campaigns to prepare stockpile stewards for the more challenging issues that will arise as weapons continue to age, and required investments in research and production facilities and people.

We will greatly benefit from enhanced five-year planning because it will establish reliable future program bases at each of the laboratories and production facilities, which greatly helps in resource, workforce, and facility planning. Completion of the Nuclear Posture Review has also been an important step in defining future program policy direction. Livermore's expertise in many nuclear-weapons issues is a national resource that has contributed to these deliberations. Enhanced five-year budget planning and the outcome of high-level reviews are also important for the future of our Laboratory's nonproliferation and arms control programs.

Integrated Program Management and Execution

Integrated program management and execution is critical to the success of the Stockpile Stewardship Program. The three major program elements—surveillance, assessment and certification, and refurbishment—are tightly interconnected. So are the activities of the three laboratories, the production plants, and the Nevada Test Site. Livermore has many close partnerships and working relationships with other sites in the weapons complex. As one of the two nuclear design laboratories, we have particularly important formal certification responsibilities. The Laboratory also operates a number of unique, state-of-the-art experimental and computer facilities that are essential for both assessment of stockpile performance and certification of refurbishment actions.

The Stockpile Stewardship Program is formally managed by NNSA/DP through three overarching sets of activities: Directed Stockpile Work, Campaigns, and Readiness in Technical Base and Facilities. NNSA/DP uses this breakout to make evident program integration, establish more clearly program goals and budget priorities, and help to identify program risks if there are budget shortfalls. The integrated program activities include:

- **Directed Stockpile Work.** Directed Stockpile Work supports the readiness of weapons and includes activities to meet current stockpile requirements. The effort includes weapon maintenance, comprehensive surveillance, weapon baselining, assessment and certification, supporting research and development, and scheduled weapon refurbishments. It also includes other stockpile commitments, such as dismantlement and information archiving.

- **Campaigns.** Campaigns are directed at making the scientific and technological advances necessary to assess and certify weapon performance now and over the long-term. They develop and maintain specific critical capabilities that are needed to sustain a viable nuclear deterrent. Each campaign has milestones and specific end-dates designed to focus advanced basic and applied science, computing, and engineering efforts on well-defined deliverables related to the stockpile. The current set of seventeen campaigns provides a planning framework for the program's research and development activities.

- **Readiness in Technical Base and Facilities.** "Readiness in Technical Base and Facilities" ensures that necessary investments are made in people and their supporting infrastructure. Readiness includes the fixed costs and the investments of the Stockpile Stewardship Program, and it aims to ensure the presence of: (1) high-quality, motivated people in the program with the needed skills and training; (2) a well-maintained, modern infrastructure—to support the activities of these people—that is operated in a safe, secure, and environmentally responsible manner; and (3) special experimental and computational facilities that must be developed and brought on line for stewardship to be successful in the long term.

A rigorous planning process has been established to clearly define programmatic milestones to be achieved within each of these program areas. The Stockpile Stewardship Program is now defined by a series of five-year plans, one for each program element, describing goals and objectives. The five-year plans, which were developed with participation by the laboratories, plants, and the test site, are accompanied by annual implementation plans with detailed milestones.

ACCOMPLISHMENTS AND CHALLENGES IN DIRECTED STOCKPILE WORK

Livermore is the design laboratory for four weapon systems in the stockpile: the W87 and W62 ICBM warheads, the B83 bomb, and the W84 cruise missile warhead. They are expected to remain in the stockpile well past their originally anticipated lifetimes; the W62 already has. Significant effort is being expended on weapons surveillance and baselining, on assessing the weapons' performance, and on maintenance and selective refurbishment. We have just completed a major effort to extend the stockpile life of the W87 warhead, and Livermore and Sandia/California have been assigned the responsibility for the engineering development work to refurbish the W80, a Los Alamos-designed weapon.

Stockpile Surveillance and Baselining

Our stockpile surveillance efforts focus on assessing the condition of Livermore designs in the stockpile and on understanding the effect of aging on weapons in the stockpile. Aging is important because it affects the physical characteristics of materials, and we must determine how these changes impact weapon safety and performance. With a better understanding of aging, our stockpile surveillance can be more predictive, making possible systematic refurbishment and preventative maintenance activities to correct developing problems. An important factor here is to be able to detect subtle changes to the weapon system well in advance of the change causing a safety, reliability, or performance issue. This is essential to prepare for upgrades or life extension efforts that may take many years to fully implement.

As we gather more data and gain experience, we review and upgrade our surveillance programs—refining sampling plans, measuring additional attributes, introducing new diagnostic tools, and improving analysis methods. We are also taking on responsibility for surveillance of pits from Livermore-designed weapons in the stockpile to better balance the workload. These activities had been conducted at Los Alamos.

In addition, we are improving the sensors and techniques used to inspect all stockpiled weapons. In concert with the Enhanced Surveillance Campaign and as part of the Directed Stockpile work, we have developed processes to deploy newly emerging diagnostics into the core surveillance program. These diagnostics are enabling us to better diagnose and quantify the condition of the stockpile, and to identify aging characteristics at the earliest possible time. For example, Livermore, in cooperation with Y-12, has completed the development of an analytical model and the development and deployment of a suite of diagnostic tools that enable us to understand the aging behavior of secondary assemblies. We are also completing development of high-resolution x-ray tomography for imaging weapon pits; first phase deployment at LLNL is complete and has been demonstrated, and deployment at Pantex is continuing. Furthermore, development continues of high-energy neutron radiography for nondestructively detecting small voids and structural defects in weapon systems.

Stockpile Safety and Performance Assessments

Assessments of the safety and performance of stockpiled weapons and modification actions must be demonstration based—that is, grounded on existing nuclear test data, non-nuclear tests, fundamental science experiments, and simulations using validated computer models. To the extent possible, non-nuclear tests are used to assess weapon safety and performance. Together with past nuclear test results, they also are used to validate computer simulations. Once validated to the extent possible, these simulations guide expert judgment in making complete, integral assessments of stockpile issues. Such demonstration-based assessments underpinned Livermore's W87 stockpile life extension program (discussed below) and will provide similar support to our W80 life extension work. In addition, this methodology is applied to the assessment of issues that arise in the course of ongoing stockpile surveillance and is the foundation of our Annual Certification assessments.

Annual Stockpile Certification. Annual certification of the stockpile is fully reliant on the laboratories' assessment capabilities. Formal review processes for certification of weapon safety and reliability in the absence of nuclear testing have been established as part of the Stockpile Stewardship Program. It is essential that judgments and decisions made by the stockpile stewards are credible among themselves, to DoD and others in the nuclear weapons community, and to the Administration and Congress, and the Annual Certification process is an essential means to that end.

Annual Certification is based on the technical evaluations made by the NNSA laboratories and on advice from the laboratory Directors, the commander-in-chief of the U.S. Strategic Command, and the Nuclear Weapons Council. In the course of Annual Certification, our Laboratory collects and reviews all available information about each stockpile weapon system, including physics, engineering, and chemistry and materials science data. This work is subjected to rigorous, in-depth review by scientists, engineers, and managers throughout the program. In addition, it is reviewed by several DoD groups. Livermore completed its support of the 2001 Annual Certification cycle in September 2001, when I sent my Annual Certification letter to the Secretaries of Energy and Defense. In conjunction with their colleagues at Sandia, Livermore personnel are now well into the 2002 cycle and are on a pace to complete our support of that cycle on schedule.

Stockpile Maintenance and Refurbishment

Each year, the Nuclear Weapons Stockpile Plan sets the requirement to maintain a safe and reliable nuclear weapons stockpile, and it specifies the number of weapons of each type to be in the stockpile. Among other responsibilities, the DoD establishes military requirements, which are incorporated into the plan. These requirements drive the Directed Stockpile Work workload for NNSA, particularly in the resource-intensive area of refurbishment activities and life-extension programs. The W87 life-extension program is in its production phase and activities are planned for the B61, W76 and W80 systems.

The W87 Life Extension Program. In April 2001, Admiral Richard Mies (commander-in-chief of U.S. Strategic Command) and General Gordon visited Livermore to celebrate certification of the life-extension refurbishment of the W87 ICBM warhead. Formal certification was completed with signing of the Final Weapon Development Report by Sandia Director Paul Robinson and myself. This first completed certification of a warhead refurbished through a life-extension program (LEP) is a groundbreaking milestone for the Stockpile Stewardship Program. It demonstrates effective cooperation of the laboratories and the production facilities to overcome physics, engineering, and manufacturing challenges to meet DoD requirements without conducting a nuclear test.

The development activities for this program included extensive flight testing, ground testing, and physics and engineering analysis. High-fidelity flight tests, incorporating the latest technological advances in onboard diagnostic instrumentation and telemetry, provided added confidence in the reliability of the design modifications. Assessment of nuclear performance is based on computer simulation, past nuclear tests, and new above-ground experiments that addressed specific physics questions raised by the engineering alterations and computer simulations.

The objective of the W87 LEP was to enhance the structural integrity of the warhead so that it may remain part of the enduring stockpile beyond the year 2025 and meet anticipated future requirements for the system: the W87/Mk21 is planned as a single RV option for the Minuteman III ICBM. The first production unit was completed at the Pantex Plant in February 1999, and production is proceeding on schedule for completion early in 2004.

Life Extension of the W80. Under the direction of the Nuclear Weapons Council, the W80 Project Officers Group (POG) is pursuing an LEP for the W80 cruise missile warhead, which was developed by Los Alamos and Sandia/New Mexico. A formal study that defined refurbishment options and their feasibility (known as a 6.2 study) was completed in 2000. Livermore and Sandia/California participated as an Interlaboratory Peer Review team. In this role, the California team evaluated proposed modifications to the warhead for feasibility, aging effects on the modifications, impact to the DOE complex, and production issues. The W80 POG has selected a final refurbishment option for the LEP, and NNSA has assigned the associated engineering development task to Livermore and Sandia/California. This assignment better balances the workload among the laboratories and provides a vehicle for the Laboratory to develop the skills of the next generation of stockpile stewards. The California laboratories will also be the design agencies for certifying the safety and reliability of the refurbished warheads, the W80 Mods 2 and 3. Los Alamos and Sandia/New Mexico will continue to be responsible for certification of the W80 Mods 0 and 1.

During 2001, the New Mexico and California teams completed a baselining study to establish a modern understanding of the current W80 and its performance. Livermore is now continuing to conduct above-ground experiments and simulations on the current warhead in preparation for beginning work on the LEP modifications. At this time there is a Congressional hold on NNSA work for the LEP as the Air Force defines its plans for parallel life extension work on the cruise missiles themselves.

ACCOMPLISHMENTS AND CHALLENGES IN STOCKPILE STEWARDSHIP CAMPAIGNS

As I have earlier described, stockpile stewardship campaigns are focused, technically challenging, multifunctional efforts that address critical capabilities that will be needed to achieve certification of stockpiled weapons as more challenging issues arise. Eight campaigns are aimed at providing the scientific understanding needed to certify the nuclear weapons stockpile and to support required weapon modernization in life extension programs. Three additional campaigns focus on weapon engineering. They provide specific tools, capabilities, and components in support of weapon maintenance, modernization, and refurbishment, as well as certification of weapon systems. The final six campaigns support readiness by focusing on sustaining the manufacturing base within the weapons complex. Examples of Livermore's major contributions to these multi-site campaigns are highlighted below.

Experiments, Theory, and Modeling to Better Understand Plutonium

One of the major success stories of the Stockpile Stewardship Program is the significant improvement we are making in understanding the properties of plutonium. This is a very important issue—we need to understand aging in plutonium and the effect of aging-related changes on the performance of an imploding pit of a stockpiled weapon. The required capacity of the production complex depends on the anticipated lifetime of plutonium pits in the stockpile. An accurate assessment is necessary. If we underestimate the lifetime of pits, we may overinvest in facilities to remanufacture plutonium parts. If we overestimate the lifetime of pits, the nation could find itself critically short of capacity for plutonium operations when it is vitally needed.

Laboratory Experiments and Modeling. Available information indicates that plutonium used in pit applications is stable; however, we must assess the effects of long-term aging. Plutonium's properties are among the most complex of all the elements. To study the subtleties of plutonium, we have combined advances in theoretical modeling with the use of sophisticated experiments. For example, we are using old pits and accelerated-aging alloys to determine the lifetime of pits. Accelerated-aging samples are plutonium alloys with a mixture of isotopes to increase the rate of self-irradiation damage so that the material "ages" faster.

Data from our materials, engineering, and dynamic experiments show, so far, that pits are stable. Livermore has conducted important experiments on old pits using advanced materials characterization tools such as our Transmission Electron Microscope, the most powerful such instrument in the NNSA complex. Using the Transmission Electron Microscope, we have discovered nanoscale (10^{-9} inch) bubbles that are likely filled with helium in the microstructure of aged plutonium. The plutonium appears to be accommodating the helium, which is created through self-irradiation, in a stable form. The presence of these bubbles was predicted theoretically using computer simulations of the radiation damage process.

Experiments at the Nevada Test Site. Livermore is conducting sub-critical experiments at the Nevada Test Site to investigate the properties of plutonium shocked and accelerated by high explosives. Matter can be ejected from the free surface of materials that undergo shock. The experiments characterize ejecta, which is thought to affect the performance of primaries in weapons. Performance is being studied as a function of plutonium age as well as surface finish and manufacturing technique. Results will affect estimates of pit lifetime and decisions about future production of replacement pits, and improve our fundamental understanding of performance.

Unlike our first three subcritical experiments, tests in the current Oboe series are performed inside individual confinement vessels. Eight of the nine planned Oboe experiments have been completed, two of them in 2001. By using small expendable vessels, up to 12 separate experiments can now be conducted in the same underground test chamber—the zero room—over several years. Following the test, after the chamber is determined to be contamination-free, personnel are allowed to enter the zero room to retrieve films and data. The use of the vessels for subcritical experiments is resulting in significant cost reduction and improved data return. In the past, each subcritical experiment followed a complex schedule with time-consuming preparations, and after each test, the zero room, with all its diagnostic equipment, was permanently contaminated and could not be reused.

In addition, we are bringing into operation the Joint Actinide Shock Physics Experimental Research (JASPER) Facility at the Nevada Test Site, a two-stage gas gun for performing shock tests on special nuclear materials. JASPER experiments, which are planned to start during this fiscal year, will complement other experimental and modeling activities by providing scientists more precise equation-of-state data at extreme conditions than can be obtained from other types of experiments. To support the planned JASPER experiments, two inert-atmosphere gloveboxes have been installed in the Device Assembly Facility (DAF). These gloveboxes will be used to assemble the special nuclear material targets into their final experimental configuration. We are now performing the final design modifications to the target chamber necessary to qualify the facility for use with plutonium.

Modeling and Experiments to Probe Weapon Performance

The Contained Firing Facility/Flash X-Ray Facility. Hydrodynamics testing is the most valuable experimental tool we have for diagnosing device performance issues for primaries in stockpiled weapons. Through hydrodynamics experiments conducted at Livermore's Site 300 and the Dual-Axis Radiographic Hydrodynamic Test Facility (DARHT) at Los Alamos, weapon scientists are able to characterize the energy delivered from the high explosives to a mock pit, the response of the pit to hydrodynamic shocks, and the resulting distribution of pit materials when they are highly compressed. These three pieces of information are critical for baselining weapons, certifying stockpile performance, and validating hydrodynamics simulation codes.

Over the past decade, we have made tremendous advances in the development of diagnostics capabilities and experimental techniques used in hydrodynamic testing. We are now able to gather far more revealing data from hydrodynamic tests than was possible when we developed the weapons that are now in the stockpile. The most sophisticated type of hydro experiment is the "core punch," in which scientists use high-energy radiography to record a digital image of the detailed shape of the gas cavity inside a pit when it is highly compressed. In 1998, we carried out the first core punches on two important stockpile primary devices: the W76 SLBM warhead and the B83 strategic bomb.

The Flash X-Ray Facility was shut down in 1999 and work began on an upgrade that will contain the debris created by explosive testing. Construction of the Contained Firing Facility is now finished, and the qualification testing has been completed to assure its ability to contain debris from experiments that use up to 60 kilograms of high explosives. The first stockpile-related experiment was executed last month. Livermore is now able to conduct these critically important experiments with isolation from the surrounding environment.

Three-Dimensional Simulation of a Nuclear Weapon Explosion. Our hydrodynamic testing of mock primaries is complemented with a vigorous simulation program that achieved a remarkable milestone in October of 2001. The first-ever three-dimensional simulation of a full-system nuclear weapon explosion was completed using the ASCI White computer at Livermore. Demonstrating the ability to use a single code to simulate in three dimensions the operation of a full weapon system, from primary implosion through secondary explosion, marks a major step forward in our weapon simulation program. This achievement demonstrates an unprecedented capability for addressing the complex 3D behavior expected from an aging stockpile.

The complex computer model that was used, called a “burn code,” employs tens of millions of zones—hundreds of times more than a comparable two-dimensional simulation. The work was completed through an intense, sustained effort that involved weapons code developers and computer support personnel. It required innovative three-dimensional algorithms able to represent the relevant physical processes and run efficiently on the machine’s parallel architecture. The simulation ran a total of 43 days on 1024 processors of the ASCI White computer and produced tens of terabytes of data. Analyzing and preparing the data for visualization again required the parallel processing capability of ASCI White. This post-processing enabled our weapon scientists to get an accurate and detailed picture of the full operation of the weapon from beginning to end.

Modeling and Experiments of High-Explosive. Some of the most technically challenging problems involve modeling the chemistry of detonation occurring at conditions up to 500,000 atmospheres pressure and many thousands of degrees centigrade. Conventional explosives have been successfully modeled in the past using the assumption of instantaneous reaction rate. The most advanced weapons in the stockpile use insensitive high explosives in which the detonation reaction rates are much slower. Livermore scientists have now linked a sophisticated chemistry code, Cheetah, to the hydrocode ARES. In the simulations of detonation, ARES determines the motion of the materials, Cheetah provides at each time step the state of chemical reactions and equation-of-state data for the relevant intermediate and final reaction products, which affects subsequent hydrodynamic performance. Although the work is in the early stages, simulations are identifying detonation phenomena not previous resolved.

The safety of the stockpile continues to be of paramount importance. Although we believe that the stockpile is safe, the vulnerability of nuclear weapons to complex stimuli involving fire, mechanical crush, and shock remains a critical issue. To help meet this assessment challenge, we have developed the capability in the ALE3D code to simulate a weapon in a coupled thermal-chemical-mechanical-hydrodynamic environment, which is typical of a weapon in a fire scenario. An experimental effort is collecting fundamental material property data from which models are developed and then implemented in ALE3D. This capability is being used to help assess both weapon safety and safety issues at the Pantex Plant.

High-Energy-Density Weapon Physics (HEDP) Calculations and Experiments

To determine the performance of thermonuclear weapons, we need to accurately model how various types of radiation interact with their surroundings. The fundamental physical processes are particularly complex in the dynamic high-energy-density conditions present during the functioning of a weapon. Materials behave very differently at star-like pressures and temperatures. Modeling weapon performance is made even more difficult by the fact that many of the issues we need to consider are inherently three-dimensional. Weapons have been designed as one- or two-dimensional objects but they are in detail three-dimensional and age three dimensionally (e.g., cracks or other irregularities). To address these issues in the absence of nuclear testing requires high fidelity three-dimensional modeling that requires the computing power that ASCI promises to deliver. It also demands experimental facilities and capabilities that can generate data in the relevant regimes to develop and validate these models.

High-Energy-Density Physics Experiments. Extraordinary progress continued to be made during the past year toward developing quantitative metrics for stockpile assessment and warhead certification. Analysis based on these metrics has been the basis for defining a detailed experimental weapons-physics program to be conducted at HEDP facilities. The Omega laser at the University of Rochester and the Z machine at Sandia continue to be used effectively to examine physics issues important to improving our understanding of weapon performance, and to aid in the design and planning of future NIF experiments. For NIF, which will deliver nearly 60 times the energy density of Omega, we are actively working to develop the associated experimental infrastructure required to support those experiments. Although the assessment and warhead certification approaches of the national laboratories differ, they all require an enhanced understanding of HEDP weapon behavior as an essential component of their Stockpile Stewardship Programs. We are jointly exploring ways to collaborate closely on topics of mutual interest in this area while attempting to maintain a necessary level of independence in order to assure independent peer review of critical stockpile issues.

High-Energy-Density Physics Modeling. Livermore researchers achieved a number of major three-dimensional HEDP simulation milestones during the past year. Two major milestones in 2001 were the first-ever three-dimensional simulation of the thermonuclear performance of a weapon secondary and the three-dimensional simulation of the integrated performance of a modern two-stage nuclear weapon. In addition to the codes developed to simulate nuclear weapon performance, the Laboratory continues to develop the three-dimensional code HYDRA. In 2001 HYDRA was used to simulate the performance of targets being designed to achieve ignition and thermonuclear burn on the NIF in three dimensions. The simulations conducted this year included the first ever-integrated three-dimensional simulation of the entire ignition target (hohlraums and fusion capsule). All of the work cited above was carried out at the Laboratory using the ASCI White supercomputer.

ACCOMPLISHMENTS AND CHALLENGES IN TECHNICAL BASE AND FACILITIES

Assessments of weapon performance and certification of weapon refurbishments must be based on scientific and engineering demonstration to be credible. In the absence of nuclear testing, we rely on data from past nuclear tests as a benchmark, component-level experiments and demonstration, and advanced simulations for an integrated assessment of weapon performance and safety. This approach has enabled us to successfully certify the W87 life-extension refurbishment and address stockpile issues that have emerged to date. However, as the stockpile ages, we anticipate that more difficult issues will arise.

These needs—to be able to assess and certify both weapon performance and refurbishment actions—drive the Stockpile Stewardship Program's investments in much more capable experimental facilities, such as the National Ignition Facility (NIF), the Dual Axis Radiographic Hydrodynamic Test Facility and even more advanced hydro-test capabilities, and greatly enhanced numerical simulation tools developed through the Advanced Simulation and Computing (ASCI) program. We are not progressing as quickly as we could to acquire these greater capabilities because of competing needs for Stockpile Stewardship Program resources that must be balanced. The program must meet requirements for Directed Stockpile Work (e.g., life-extension programs) and pursue vigorous Campaigns in weapons science and technology. In addition, the nuclear weapons complex is in need of infrastructure recapitalization to support all of these activities. Program success requires both efficient, flexible, and modern manufacturing facilities and a work environment at the laboratories and production facilities that makes it possible to attract and retain an exceptional staff. Here, the discussion focuses on two areas where much more capable research facilities are required—NIF and ASCI—and on the need for infrastructure reinvestment.

The National Ignition Facility

Construction is continuing at Livermore on the National Ignition Facility (NIF), a major research facility housing a 192-beam laser and associated experimental capabilities. NIF will be the world's largest laser, delivering 60 times more energy density than the Omega laser at the University of Rochester (and the previous Nova Laser at Lawrence Livermore), currently the largest laser in the NNSA High Energy Density Science program. NIF will provide 1.8 megajoules of ultraviolet laser energy that can be used to compress and heat a small capsule filled with deuterium and tritium to conditions at which thermonuclear fusion occurs. NIF is a cornerstone and essential element of the Stockpile Stewardship Program. It will also provide scientific and technical information that may eventually lead to practical fusion energy production.

The baseline plan and schedule for NIF was included in General Gordon's certification of the NIF project, provided to Congress on April 6, 2001. The schedule provides for project completion at the end of FY 2008, and the NIF team's goal in the coming year is to achieve "first light" by delivering four laser beams to the target chamber. The FY 2002 budget provides $245 million for continued NIF construction and the FY 2003 budget provides the requested $214 million. The pace of construction has now been constrained over the past two years by available annual funding in the overall NNSA/DP budget, and the project could be completed significantly earlier at a lower total cost if more funding were available in the near term.

The Importance of NIF to Stockpile Stewardship. NIF is vital to the success of stockpile stewardship. It will be the only facility capable of well-diagnosed experiments to examine thermonuclear ignition and burn and to study the high-energy-density properties of primaries and secondaries in nuclear weapons. We need the facility for experimental study of key issues related to the effect of aging on weapons and for certification of the performance of refurbished weapons. In addition, NIF experiments provide the only available means for advancing critical elements of the underlying science of nuclear weapons. NIF experiments will provide necessary data for sophisticated computer simulation models being developed for stockpile stewardship, and the models themselves need to be tested in the physical conditions that only the NIF can provide. Finally, NIF will help to attract and train the exceptional scientific and technical talent that is required to sustain the Stockpile Stewardship Program over the long term.

In April 2001, NNSA released the report of the High-Energy-Density Physics (HEDP) Workshop, held January 30-February 2, 2001. This report reconfirmed NIF's essential role in the Stockpile Stewardship Program and recommended that NIF be completed to its full 192-beam configuration on its baseline schedule. The Workshop Panel included representatives from DOE, NNSA, DoD, the three NNSA laboratories, and Argonne National Laboratory. They reviewed presentations by experts in weapons design, high-energy-density science (HEDS), and Inertial Confinement Fusion (ICF) from the three laboratories that discussed options for NIF deployment, other HEDS facilities that can complement NIF, and Stockpile Stewardship Program needs for HEDS and weapons experiments/calculations for future stockpile certification.

NIF Project Technical Progress and Accomplishments. Overall the NIF project is more than 60% complete. Major progress continues to be made and at a rapid pace. In September 2001 the NIF conventional facilities construction, a $270 million project, was completed on schedule and on budget. In October, the Project completed installation of one-quarter of NIF's beampath infrastructure. Now in place are the precision-cleaned enclosures for the components of 48 laser beams. A strong partnership between the Laboratory, Jacobs Facilities Inc. (the contractor for installation, management, and integration), and the local building and crafts trade unions have enabled the Project to achieve these key milestones. We are continuing to install NIF infrastructure and at the end of March we have nearly 1/2 or 96 laser beams worth of precision-cleaned enclosures installed.

The NIF team continues to make outstanding technical progress. Last year I cited numerous examples of progress on crystals, laser amplifier glass and optics damage mitigation. Now nearly 80 percent of the required 3072 high-quality laser-glass slabs are in hand, and over half of the large crystals used for optical switches and frequency conversion have been grown. This year we have made even greater progress on the development of new optics polishing techniques that can reduce the damage potential of NIF optics much more than our requirements. We are currently implementing these new techniques at our vendors to provide the first optics for NIF's final focusing systems.

NIF's clean-room facilities are being commissioned, and production has begun on some components. Validation of NIF's clean assembly, transport, and installation requirements was demonstrated with the installation of a laser-glass slab assembly into NIF's main amplifier. In addition:

- We have begun installing equipment into NIF's core area for generating seed laser pulses, controlling the entire laser system, and powering the laser amplifiers.
- We are nearing the point where we will begin installation of actual laser components, glass, optics, crystals, flashlamps , etc. for the operation of the first four laser beams in the coming months.

In the coming year the NIF team's goal is to achieve "first light" by delivering four infrared laser beams through the entire laser chain into a diagnostics station. Soon after, these four laser beams will be transported to the final optics assembly where they will be converted to ultraviolet light and focused to the center of the target chamber. This achievement will serve to provide validation and confidence in all of NIF's systems and will allow operational activities to commence. As more of NIF comes on line, fundamental physics regimes for materials science, high-energy-density science, and thermonuclear ignition and burn will become accessible for study. NIF will provide temperatures and pressures needed to validate computer codes and address important issues of national security and basic science.

Reviews of the NIF Project. Over the past two years, regular reviews of the NIF Project have been held every six months. These reviews are managed by NNSA Office of Defense Programs and bring together experts in a variety of technical, fiscal, and project management fields to thoroughly review the status of the NIF construction project. The most recent review was held in November 2001. Mr. Willie Clark, from NNSA's Office of Project Management and Engineering Support, led this review. The findings and conclusions of this review included:

- The project has made impressive progress and has been responsive to previous review team recommendations.
- A strong management team is in place; the NIF Project organization is functioning very effectively.
- Significant safety improvements have been made.
- Effectiveness of NNSA oversight has improved.

In addition to these semi-annual reviews, NNSA staff in the Office of the NIF Project attend regular monthly Project reviews held at Livermore. These reviews provide detailed status reports and assessments of cost and schedule for the Project. We also provide quarterly reports on the NIF's construction project to the Deputy Secretary of Energy.

Preparation for NIF's Experimental Program. With the rapid progress being made on the NIF Project, we are at once pleased and concerned that experiments on NIF are becoming a reality in the coming year. We are pleased because NIF's promising role in the Stockpile Stewardship Program will become evident even with the first few laser beams, which will provide more energy than the entire Omega laser, the world's largest currently operating laser system. We have planned a campaign of experiments for the first phase of NIF operations that will help provide important scientific data on stockpile-relevant materials and that may help us to enhance our ability to reach fusion ignition using large short-pulse laser systems.

I am also concerned because the experimental program for NIF and for other high-energy-density science facilities is being placed under great pressure because of reductions in funding in the FY 2003 budget. These reductions place our experimental program in jeopardy by preventing the timely development and fielding of NIF's core diagnostic systems that are essential for collecting the data from experiments. We are also facing delays in the development and fabrication of the cryogenic target systems required for ignition experiments on NIF. Delay of these critical programs reduces our ability to provide NIF as a key facility for stockpile stewardship and impacts scheduled availability for upcoming Stockpile Life-Extension Programs.

We are currently working with NNSA and General Gordon to better understand our options for FY 2003 for these programs. Current projections, however, are not positive for providing for the effective utilization of NIF as it comes available in the next year.

The Advanced Simulation and Computing (ASCI) Program

The Advanced Simulation and Computing (ASCI) program (formerly called the Accelerated Strategic Computing Initiative) is greatly advancing our ability to computationally simulate the performance of an aging stockpile and to certify the details of refurbishment projects. To make the needed major advances in weapons science and engineering simulation codes, Lawrence Livermore, Los Alamos, and Sandia national laboratories are obtaining from U.S. industry dramatic increases in computer performance and information management. The ASCI program is integrating the development of computer platforms, simulation applications, and data management technologies. It will take a string of successive investments to achieve ASCI's long-term goals.

Livermore's partnership with IBM has been highly successful. We took delivery of ASCI Blue Pacific in FY 1998 and then ASCI White in FY 2000. Both machines exceeded their performance requirements and are being used to support stockpile stewardship through a variety of applications, some of which I have discussed. The important next step in ASCI at Livermore is a supercomputer capable of 60 to 100 teraops (trillion operations per second). It is planned for late 2004. Necessary funding was received in FY 2002 to begin construction of the Terascale Simulation Facility to house this computer. The building will be available in time to accept it.

ASCI White Successfully Meets Tri-Laboratory Needs for Stockpile Stewardship. In 2001, the Laboratory was home to the world's most powerful supercomputer, the IBM ASCI White machine, which is capable of 12.3 teraops. It was the latest step in ASCI's ambitious efforts to rapidly advance the state-of-the-art in computers, computational models, and data management tools needed to simulate the performance of nuclear weapons. It represented the first "most capable" system in the NNSA complex, a system of unique capability and the major resource for all three laboratories, two computing at a distance.

ASCI White is based on the next-generation IBM processor, node, and switch technology. It consists of 512 nodes, each with 16 processors. Exceeding its contractual performance requirement of 10 teraops, the machine is about a factor of three faster than Livermore's Blue Pacific computer, which was used to perform the first ever 3D simulation of the full functioning of a nuclear weapon primary. The machine also provides over 8 trillion bytes (terabytes) of main memory and about 110 terabytes of global disk space.
This system was successfully used and shared since early 2001 by all three NNSA laboratories. To meet each laboratory's requirements to run problems, calculations were interleaved in an integration schedule for the machine. Livermore successfully completed a three-dimensional secondary burn simulation in June 2001. The calculation demonstrated the modeling of 3D features at unprecedented resolution and validated scaling for several physics algorithms.

Calculations done by Los Alamos and Livermore for the three-dimensional prototype full-system coupled simulation were both completed on ASCI White in late 2001. The size and scale of ASCI White allowed the two laboratories to employ a level of spatial resolution and depth of physics models that were heretofore completely beyond reach in 3D. The speed, large memory, and stability of White were essential elements contributing to the successful series of calculations executed to accomplish these calculations. Similar problems are now being run in support of additional CY 2002 and CY 2003 programmatic deliverables. Sandia also used ASCI White to perform structural dynamics calculations for different environments that weapons might encounter. One terabyte of core memory was used on each structural dynamics calculation in simulations that were completed in late September 2001 and set many world records. These calculations demonstrated effective use of computing capabilities at a distance.

Simulation Modeling and the Problem-Solving Environment. ASCI is more than powerful computers; it is the development of advanced simulation techniques as well as data management and visualization tools. Three Gordon Bell Awards, two in 1999 and one in 2000, exemplify the outstanding simulation development capabilities at Livermore and a growing base of expertise in using the machines. Most notable was the 1999 Gordon Bell Award for best performance in supercomputing. A team led by Livermore researchers, with collaborators at the University of Minnesota and IBM, solved a supercomputer problem with broad applications.

Work by Los Alamos scientists provides a directly relevant example of data management progress in 2001. They were able to use visualization techniques developed by ASCI for the three-dimensional full system coupled simulation mentioned earlier. These tools allowed the scientists to run this calculation of unprecedented size on the Livermore 12-teraops system and then utilize the 32-node visualization partition on that computer to distill the data, send it back to Los Alamos, and interactively visualize the simulation results at Los Alamos. This capability was critical to enable Los Alamos' effective use of the system. The data not necessary for visualization was stored at unprecedented rates on the Livermore archive. For this particular calculation, Los Alamos stored 12.6 terabytes (roughly equivalent to 12 million novels) in 13 hours in the Livermore archive, approximately 50 times faster than would have been possible just two years earlier. Such advances in storage capability were necessary for the environment to function. They demonstrate the inherent balance necessary and careful planning undertaken in the ASCI simulation enterprise.

Beyond ASCI White and the Terascale Simulation Facility. The next supercomputer at Livermore after ASCI White will move us much closer to ASCI's goal of full-scale simulation of weapons performance using advanced physics models with data derived from extensive, first-principles physics simulations. The threshold for that capability is 100 teraops, and reaching the goal quickly is vital to success in stockpile stewardship. Plans call for ASCI "Q" (30 teraops) to be operational at Los Alamos in 2002, a 20-teraops machine at Sandia in 2003, and a 60- to 100-teraops machine for Livermore late in 2004. At the onset of the Stockpile Stewardship Program, ASCI set as a goal the delivery of a 100 teraops computer by 2004. The machine at Livermore will be as close to 100 teraops as can be afforded within budget limitations. It is important that plans for the 60- to 100-teraops machine not slip.

The 60- to 100-teraops machine will be very large, and will require the Terascale Simulation Facility (TSF) to house it. The congressional line-item funding for this project was sufficient to enter into a construction contract this year. This contract was recently signed and the groundbreaking ceremony occurred on April 4, 2002. The TSF will consist of a two-story computing facility with power and space to accommodate a 100-teraops-class system; assessment areas and networking control areas necessary for direction and assimilation of data; and a four-story office structure for staff to manage and utilize the simulation environment. We expect about 24,000 square feet of the machine room (of the 48,000 square feet planned) to be available and fully equipped to accept an ASCI-scale system by June 2004, just a few months ahead of the arrival of the system.

The two machine rooms in TSF will guarantee our capability to site any system required by the program. The TSF will function more like an experimental facility than a computer center by supporting very close cooperation between staff and analysts. Round the clock support for major runs, restart capability for huge simulations, vast storage archives, first-class data assessment facilities and on-the-fly trouble shooting will support a mode of operations where "runs" will be viewed as "shots," analogous to nuclear tests, requiring intense support to succeed. This was the model adopted by Livermore to support the White system, and it proved to be extremely successful.

Infrastructure Recapitalization

Stockpile stewardship requires major investments in new facilities and capabilities to make it possible for scientists and engineers to more thoroughly understand the performance of nuclear weapons. As discussed above, at Livermore these investments include construction of NIF and acquisition of ASCI supercomputers and the TSF. The Stockpile Stewardship Program will not succeed without the new-facility investments that are being made at the NNSA laboratories. Scheduled programmatic work at the laboratories and the plants has also placed exceedingly high demands on provided funding. The cumulative effect of necessary continuing attention to the highest and most immediate priorities over the course of the Stockpile Stewardship Program has been shortage of funds to recapitalize NNSA's underlying infrastructure.

In FY 2002, funding began for NNSA's new facility reinvestment initiative. The initiative focuses on those underlying infrastructure needs at NNSA sites in support of directed stockpile work and campaign programmatic requirements. Livermore fully supports the initiative and is already working on several high-priority recapitalization and disposition projects utilizing first year funding. At Livermore, only 68% of our employees currently reside in permanent space, and 53% of the temporary office space (trailers and modular buildings) is nearing or beyond end-of-service life. Overall, over 35% of Livermore's office and laboratory space is less than adequate and in need of rehabilitation. Our overall maintenance backlog is about $420 million if directly funded (with programmatic dollars, for instance). In addition, obsolescent equipment needs to be replaced. For example, the Laboratory struggles to keep pace with rapid advances in telecommunications capabilities, which are critically needed to use our supercomputers efficiently and securely and to upgrade our business operations. In addition, we have legacy facilities from long-discontinued programs as well as unusable or unsafe laboratory space that must be decommissioned, decontaminated (where necessary), and demolished. Our legacy facilities and other excess marginal space require considerable up-front investments to rectify. We also have to invest so that buildings at Livermore meet present-day seismic safety codes and the latest, more demanding safety criteria.

Currently, we invest $8 to $10 million per year of overhead into reducing our maintenance backlog. Over the next ten years, we estimate that Livermore will need an additional $25 million per year in new funding to apply to maintenance deficiencies, $10 million per year for demolition of its excess facilities, and $15 million per year to keep pace with technological changes. We will be working with NNSA to develop appropriate funding levels to address these concerns through the facility reinvestment initiative.

Our overall infrastructure recapitalization goal is to provide and maintain high quality, technologically state-of-the-art facilities capable of meeting current and future mission requirements effectively and efficiently. It is also important to note that sustaining the quality of our workforce is a particularly challenging task in view of the high demand in the private sector for skilled people. These upgrades will provide quality facilities in order to attract and retain the exceptional workforce that we need to accomplish our missions.

REDUCING THE THREAT OF PROLIFERATION OR TERRORIST ACQUISITION OF WEAPONS OF MASS DESTRUCTION

National security is threatened by the proliferation and potential use of nuclear, chemical, and biological weapons (collectively referred to as weapons of mass destruction, or WMD). The events of September 11, 2001, clearly demonstrated the vulnerability of free societies to devastation as a result of concerted efforts of extremists. Adding to this vulnerability are indications that terrorist groups, including the followers of Osama bin Laden, are attempting to acquire WMD. In addition, at least 20 countries, some of them hostile to U.S. interests, are suspected of or known to be developing WMD.

Livermore's Nonproliferation and Counterterrorism Program

Livermore is applying its nuclear expertise to the challenge of nuclear weapons proliferation. Because the threat of proliferation is not restricted to nuclear weapons and in response to legislation calling for enhanced U.S. capabilities against WMD proliferation, we are also developing the technologies, analysis, and expertise needed to help stem the proliferation of chemical and biological weapons. These activities build on the large investment in chemical and biological sciences at Livermore.

Our program in nonproliferation, arms control, and international security is tackling the problem of WMD proliferation across the entire spectrum of the threat. We take a comprehensive approach to the problem with activities to prevent proliferation at the source, to detect and reverse proliferant activities, and to counter WMD terrorism.

Improved scientific and technical capabilities are essential for WMD threat reduction. The NNSA's Office of Defense Nuclear Nonproliferation supports the bulk of the research and development activities that provide the technological base for those U.S. agencies with operational responsibility for characterizing foreign weapons programs and detecting proliferation-related activities, for detecting and mitigating the use of weapons of mass destruction against U.S. civilians, and for negotiating and monitoring compliance with arms reduction and other agreements.

Two aspects of the Laboratory's contributions in 2001 to the national WMD nonproliferation effort are highlighted here:

- **Assisting Government Agencies Defend against WMD Terrorism.** Long before September 11, 2001, Livermore was addressing the threat of WMD terrorism. We have developed technologies and tools to counter nuclear, chemical, and biological terrorist threats and are working closely with federal, state, and local response agencies to ensure that our technological solutions meet real-world operational needs. Many of our counterterrorism technologies and technical capabilities have been deployed, before September 11 and in its aftermath, to assist state and local governments defend against WMD terrorism.

- **Preventing Proliferation at the Source.** Proliferation is most effectively halted at the source—of weapons-usable nuclear materials, of weapons-related technology, and of

WMD expertise. We are a major player in the U.S.–Russian nonproliferation programs. These programs consist of an integrated set of activities to secure at-risk nuclear material in Russia, dispose of excess highly enriched uranium and plutonium, and assist in downsizing the Russian nuclear weapons complex by helping the Russian closed cities and weapons institutes develop self-sustaining commercial applications of their scientific and technical expertise.

Assisting Government Agencies Defend against WMD Terrorism

Countering terrorism has been a central element of Livermore's national security mission for many years. The events of September 11 have lent new urgency to our efforts to apply the Laboratory's technologies, tools, and expertise to assist state and local governments in preparing to defend against and respond to WMD terrorism. Effective defense against terrorism requires the integration of science and technology with emergency response operations, which in turn requires coordination and collaboration between research and development (R&D) institutions like Livermore and the various federal, state, and local emergency response agencies. We have made important and unique contributions to counterterrorism preparedness, and with increased resources we could do even more.

Countering the Nuclear Threat. Our Nuclear Threat Assessment Program has provided comprehensive assessments of nuclear threats for more than 20 years. This program is also the Department of Energy (DOE) lead for assessing illicit trafficking in alleged nuclear materials. We apply long-standing Livermore expertise in nuclear materials, nuclear weapons, and device diagnostics to develop improved capabilities for dealing with radiological emergencies, including terrorist events. We are also a key participant in the DOE's national nuclear incident response groups, including the Nuclear Emergency Search Team (which deals with nuclear terrorism or extortion threats), the Accident Response Group (which responds in the event of an accident involving U.S. nuclear weapons) and the Radiological Assessment Program (which assists state and local agencies). Livermore maintains a deployable response capability, called HOTSPOT, which can be deployed to any location by military aircraft to provide local radiological field support.

Specifically, the Radiological Assessment Program (RAP) provides technical and operational expertise to state and local agencies to mitigate the consequences of a radiological incident or emergency. It uses DOE and national laboratory experts with skills in assessing radiological and toxic contamination and the attendant risks to human health. The Livermore RAP team has primary responsibility for California, Nevada, Hawaii, and the U.S. Pacific Rim territories. It is called upon, on average, three to five times per year. In 2001, it responded to three requests for assistance along with normal exercises and training. Typically, RAP investigates containers suspected of housing radioactive materials, seeks the location of lost industrial or medical radioactive sources, and advises federal, state, and local authorities on the consequences of a radioactive release or personnel contamination. RAP regularly drills with similar teams from other federal agencies, state, local, and tribal governments as well as private companies and organizations. To deal with the latest emerging threats, RAP now includes training to recognize and respond to nuclear terrorism within the “nuclear triage” program being developed at DOE headquarters.

Livermore has developed a concept for correlated sensor networks for detecting and tracking ground-delivered nuclear devices or nuclear materials. A novel algorithm integrates data from the various sensors, together with information from other sources (e.g., an intelligent traffic system) to identify sources of concern, track their movement through the road network, and guide responders in intercepting the suspect vehicle. This concept has been successfully demonstrated in an urban environment. We have had discussions with the County of Los Angeles concerning deploying a prototype system in the county in order to gain real-world experience with the network in a congested metropolitan area and to work with the appropriate response agencies to develop a concept of operations.

Defending against Bioterrorism. The biodefense capabilities that have been deployed in the wake of September 11 have, at their core, advances in biological detection instrumentation and DNA signatures made at Livermore and its sister laboratory at Los Alamos. We are developing gold-standard DNA signatures of top-priority threat pathogens (anthrax, plague, etc.) and are working with the Centers for Disease Control and Prevention (CDC) to validate these signatures and distribute them to public health agencies nationwide.

We have made technology breakthroughs in biodetection instrumentation, pioneering the miniaturization and ruggedization of both flow cytometry and DNA identification devices. Our miniature thermal cycler unit makes possible DNA amplification via polymerase chain reaction (PCR) and identification in minutes rather than the hours and days previously required. Livermore’s miniaturized PCR technology has been licensed to private industry and forms the basis of today’s most advanced commercial biodetection instruments (e.g., Cepheid’s Smart Cycler, ETG’s handheld biodetector).

The Biological Aerosol Sentry and Information System (BASIS), developed jointly by Livermore and Los Alamos, was deployed as part of the overall security strategy for the 2002 Winter Olympic Games in Salt Lake City. (Cepheid Smart Cyclers are the heart of the BASIS field laboratory.) In developing BASIS, Livermore and Los Alamos worked closely with the many law enforcement, emergency response, and public health agencies that would be involved in dealing with a bioterrorism event to develop appropriate sample handling (chain of custody), communications, and response protocols.

Atmospheric Modeling for Consequence Management. The Atmospheric Release Advisory Capability (ARAC), located and operated at the Laboratory, is a national emergency response service for real-time assessment of incidents involving nuclear, chemical, biological, or natural hazardous material. ARAC can map the probable spread of contamination in time for an emergency manager to decide whether protective actions are necessary. ARAC is on call to respond to real incidents and can also be used to evaluate specific scenarios for emergency response planning, such as optimizing the siting of bioaerosol samplers or determining evacuation routes.

Since it was established in 1979, ARAC has responded to more than 70 alerts, accidents, and disasters and has supported more than 800 exercises. In addition to accidental radiological releases (e.g., Chernobyl, 1986; Three Mile Island, 1979), ARAC has assessed natural and manmade disasters (Mt. Pinatubo volcanic ash cloud, 1991; Kuwaiti oil fires, 1991). ARAC has also provided assessments to state and local responders to toxic chemical accidents (e.g., Richmond sulfuric acid cloud, 1993; Sacramento River Spill, 1991). State and local agencies can request ARAC support for actual releases or planning by contacting DOE's Office of Emergency Response or the ARAC program office at Livermore.

Chemical Analysis for Forensic Attribution. Timely and complete analysis of suspect chemicals can answer important questions related to nonproliferation, counterterrorism, and law enforcement. Our Forensic Science Center has assembled a unique capability for detecting and characterizing ultratrace levels of virtually any compound in any sample matrix. Expertise and instrumentation are available for complete chemical and isotopic analysis of nuclear materials, inorganic materials, organic materials (e.g., chemical warfare agents, illegal drugs), and biological materials (e.g., toxins, DNA). The Forensic Science Center also develops advanced laboratory and field capabilities for ultratrace analysis, including a portable (55-pound) gas chromatograph/mass spectrometer, field kits for thin-layer chromatography, and novel sample collectors using solid-phase microextraction.

The Forensic Science Center has begun the rigorous testing required to become the second U.S. laboratory certified by the Organization for the Prohibition of Chemical Weapons (OPCW), which is responsible for implementing the Chemical Weapons Convention (CWC). Under the terms of the CWC, all samples collected from inspected facilities must be analyzed at two OPCW-designated laboratories. The U.S. Congress mandates that all U.S. samples be tested in the U.S. Currently, the U.S. has only one designated laboratory, the Edgewood Chemical and Biological Forensic Analytical Center. Livermore will provide the second required facility.

Over the years, the Forensic Science Center has responded to many requests from law enforcement for assistance in forensic analysis of unique samples. The Center has been brought in to analyze the "cold fusion" explosion at SRI International, Supernote counterfeit bills, methamphetamine samples, biotoxins, suspect chemical-warfare specimens, and nuclear contraband. It has characterized explosive traces from the 1993 World Trade Center bombing, the Unabomber case, and the Fremont serial bomber; performed forensic sleuthing related to the Riverside "mystery fumes" case; and analyzed samples for the Glendale "Angel of Death" case. Locally, the Center assisted Livermore police by rapidly identifying a vapor that sickened response personnel at the scene of a suicide; once the chemical was identified (malathion), law enforcement agencies were able to take appropriate personnel-protection measures and complete their investigation.

At the height of the anthrax incidents, the Forensic Science Center was called upon to analyze a suspect powder found at a local business. Livermore scientists worked through the night to complete the analysis, confirming that the powder was harmless.

New Search and Inspection Technologies. There is a pressing need for technologies to improve the screening of passengers, baggage, and cargo. Candidate technologies, in various stages of development at Livermore, include computed tomography (CT), x-ray scanning, gamma-ray imaging, neutron interrogation, and ultrasonic and thermal imaging. We have recently established a national test bed for cargo container experiments. This facility will provide a nationally available test bed for determining whether inspection technologies in use and under development can be scaled to the magnitude of the shipping container problem. Outside agencies will be able to make measurements, using national laboratory or their own equipment and measurement techniques, on actual and mock weapons materials in actual cargo containers. Under DOE direction, Livermore will operate this test bed as a national service, providing a common basis for the comparison and evaluation of alternative approaches.

Two Laboratory-developed search technologies demonstrated their applicability to counterterrorism response when they were deployed to the World Trade Center. The first, a micropower radar, can “see” many feet into concrete rubble and could be a valuable tool for search and rescue operations. The other, a remote monitoring instrument that uses hyperspectral data to detect and identify trace gas emissions, was flown over Ground Zero to characterize hazardous gases emanating from the rubble pile.

Avoiding Surprise about Adversaries. One of the most critical, yet difficult, elements of homeland security and counterterrorism is gaining insight into the capabilities, intentions, and plans of persons, groups, or states hostile to the U.S. Our International Assessments Program (Z Division) is one of the strongest capabilities in the country for analysis and research related to foreign nuclear weapons and other weapons of mass destruction, including early-stage foreign technology development and acquisition, patterns of cooperation, and foreign cyber threats. This capability is more important than ever before, as the bipolar (U.S.-Soviet) world has disintegrated into a melange of traditional allies, regional and tribal allegiances, and transnational extremist groups. In the aftermath of September 11, we provided intelligence analysts and assessments as well as information-operations tools and expert personnel to the U.S. Intelligence Community. Our assessments of foreign weapons programs and activities provide important input to policy makers and diplomats as they develop strategies for U.S. responses to events affecting national security.

Risk and Vulnerability Assessments of Critical Facilities. Through our participation in DOE’s Vulnerability and Risk Assessment Program, we have made systematic assessments of the threat environment, cyber architecture, physical and operational security, policies and procedures, interdependencies, impact analysis, risk characterization, and possible mitigation measures for the 2002 Winter Olympic Games in Salt Lake City, eleven electric and gas infrastructures, and several independent service operators (ISOs), including the California ISO during the past summer’s electrical energy crisis.

We have analyzed the vulnerability of buildings, dams, and other structures to catastrophic damage from earthquakes and explosive events. For example, we have also evaluated the earthquake vulnerability of major bridge structures (including the Golden Gate and San Francisco-Oakland Bay bridges), the structural integrity of nuclear material shipping containers for a variety of impact scenarios, and the likely damage resulting from the explosion of natural gas storage tanks in a suburban environment.

Expert Personnel Assisting Homeland Security Agencies. A number of Livermore scientists serve on various task forces, committees, and advisory groups dealing with aspects of homeland security and counterterrorism. For example, a Livermore expert on x-ray imaging is a member of the National Academy of Science Committee on Assessment of Technology Deployed to Improve Commercial Aviation Security. Other Laboratory scientists serve as technical advisors to the U.S. Customs Service, the National Guard, and the Los Angeles Emergency Operations Center, and as members or advisors to various Defense Science Board task forces addressing homeland defense. Still others are assisting the California State Office of Emergency Services (OES) with training related to weapons of mass destruction and as members of the California Council on Science and Technology, which is providing technical advice to the OES's State Strategic Committee on Terrorism.

Engineering a Novel Truck-Stopping Device. In October 2001, the Governor of California contacted Livermore requesting assistance to develop a means of stopping tanker trucks, to keep hijacked trucks from becoming motorized missiles. The objective was to make it possible to stop these large trucks using equipment readily available to peace officers, namely their vehicles and their weapons. A retired Livermore engineer and consultant teamed with Laboratory engineers, technicians, and heavy equipment operators to develop a simple mechanical device to accomplish this. It can be readily attached to the back of a tanker truck. When bumped from the rear by the patrol vehicle, the device would cause the trailer braking system to lose air pressure automatically locking the trailer brakes. A prototype was demonstrated in Oakland in late November, and remote-controlled testing at high speeds was conducted at the Nevada Test Site in February and March.

Preventing Proliferation at the Source

With the collapse of the Soviet Union, ten years ago, arose the threat of materials and expertise related to WMD leaking from Russia to terrorists or countries of concern. Lawrence Livermore is a major player in the U.S.–Russian nonproliferation programs, which are striving to stem proliferation at its source. These programs consist of an integrated set of activities to secure at-risk nuclear material in Russia, dispose of excess highly enriched uranium and plutonium, and assist in downsizing the Russian nuclear weapons complex by helping the Russian closed cities and weapons institutes develop self-sustaining commercial applications of their scientific and technical expertise.

In light of the current focus on countering terrorism, we must not lose sight of the importance of these and other nonproliferation programs. By securing weapon materials, technologies, and expertise at the source, we keep the raw ingredients for weapons of mass destruction out of the hands of proliferators and terrorists. Attempts to counter WMD terrorism without simultaneously working front-end issues will not solve the problem.

Protection and Control of Nuclear Materials, and Accounting (MPC&A). The security of Soviet-legacy nuclear materials is critical to the security of the U.S. Through the NNSA's MPC&A Program, we are helping various Russian sites improve the protection of their fissile materials. Livermore specializes in vulnerability assessment, gamma ray spectroscopy, access control and security system integration, and information systems. We lead the MPC&A project teams for Chelyabinsk-70, Sverdlovsk-44, Bochvar Institute, and Krasnoyarsk-45 and provide project support for seven other sites.

Of the various laboratories involved in the MPC&A Program, Livermore is unique in its role with the Russian Navy. Since the work began in 1997, MPC&A upgrades for four nuclear refueling ships have been completed and commissioned. Our activities at the Russian Navy facilities have been some of the most successful of the entire MPC&A Program. Success is attributable to the combination of a highly focused user (the Russian Navy), an excellent subcontractor and system integrator (the Kurchatov Institute), and a highly trained team of NNSA and national laboratory personnel that has built an excellent working relationship with the Russian personnel. In September 2000, MPC&A cooperation was formalized through an implementing agreement between the Russian Navy and the NNSA that included further cooperation at Russian nuclear weapon storage sites. Work at a number of these sites is under way and is meeting with the same success as previous activities with the Russian Navy.

We participate in the NNSA's Second Line of Defense Program, designed to curtail the illicit transport of items of nuclear proliferation concern from Russia. Together with other participating DOE laboratories, we are working with the Russian Customs Service to equip high-risk border crossings with radiation detection equipment. Moscow's Sheremetyovo International Airport complex and a port on the Caspian Sea were equipped in October 1998. Seven other sites (including several possible transit points to Iran or North Korea) have been identified as high priority, and equipment is being installed. This past year, we completed, jointly with our Russian collaborators, a training manual and curriculum that will be used by more than 30,000 front-line Russian customs officials. In addition, several training courses on dual-use export controlled items were developed and incorporated into the Russian Customs Academy's professional curriculum.

Downsizing the Russian Nuclear Weapon Complex. To help accelerate the downsizing of the Russian weapons complex and to prevent displaced weapons workers from seeking employment with potential proliferators, the U.S. and Russia have launched the Nuclear Cities Initiative (NCI), a cooperative program to create self-sustaining civilian jobs for displaced workers in the closed nuclear cities of Sarov, Snezhinsk, and Zheleznogorsk.

We are leading a medical technology development project with the Avangard Electromechanical Plant (a weapons assembly facility) at Sarov. In September 2001, lengthy negotiations led by Livermore scientists culminated in a formal partnership agreement between the Avangard Electromechanical Plant (a weapons assembly facility) and Fresenius Medical Care (the world's largest provider of products for individuals with chronic kidney failure) to establish a commercial medical products manufacturing facility at Sarov. Eventually, the Avangard/Fresenius project will employ hundreds of former weapons workers in the production of dialysis equipment and treatment kits. This agreement represents a major milestone in U.S. efforts to engage a Russian serial production facility.

We are also involved in the NNSA's Initiatives for Proliferation Prevention (IPP), which focus on helping Russian research institutes find commercial nonweapons applications of their technical specialties. In spite of difficulties created by limitations on LLNL's ability to establish new contracts and requirements that IPP payments be free of Russian taxes, progress has been made on many existing projects. For example, LLNL has teamed with Cyclotec Medical Industries and the Biophysical Laboratory (Biofil) Ltd., a spin-off from the Russian Federal Nuclear Center Institute of Experimental Physics (VNIIEF, Arzamus-16), to develop and manufacture transcutaneous electrical nerve stimulation (TENS) devices for noninvasive treatment of traumatic short-term pain. TENS devices deliver low levels of electrical pulses that inhibit or interfere with the transmission of pain signals to the brain. Under this IPP project, TENS devices have been miniaturized and incorporated into adhesive-bandage- and orthotic- (splint and brace) type materials. The IPP-developed device is an order of magnitude smaller and lighter than products with similar functionality at one-quarter of the cost. The components for these devices will be manufactured in Russia and then shipped to the U.S. for testing and assembly. The total U.S. market for pain control products, pharmaceuticals, therapy, devices, and implants is estimated to be more than $2 billion. The U.S. National Institute on Drug Abuse (NIDA) has advised Cyclotec that it will recommend the use of the company's TENS products as "viable alternatives to drugs for pain relief."

Promoting Regional Security through Science and Technology Cooperation. As the current conflicts in Afghanistan and Israel highlight, regional conflicts are fraught with the potential to escalate rapidly, both in the level of violence and in the number of players. This escalation potential is particularly worrisome when the participants already possess or are striving to acquire weapons of mass destruction. In order to promote security and stability in these regions of concern, rather than attempting to intervene once conflict has spiraled out of control, we are supporting science and technology cooperation as a mechanism of engagement that is nonthreatening and beneficial to all involved.

Together with the U.S. Geological Survey (USGS) and under the aegis of the United Nations Educational, Scientific, and Cultural Organization (UNESCO), we have collaborated with seismological organizations from Turkey, Lebanon, Israel, the Palestinian Authority, Jordan, Kuwait, Saudi Arabia, Egypt, Yemen, and Oman in a seismology technical working group. This topic is of widespread concern in the area, given its active seismicity and recent damaging earthquakes in Turkey, Greece, India, and Afghanistan.

We are also participating in a number of projects in Central Asia. Some of these projects involve collaboration on radiation detection technologies, with the goal of improving border security in the region to prevent illicit smuggling of nuclear materials. Other projects are characterizing the composition and flow of groundwater and associated contaminants in an attempt to improve the preservation and use of regional water resources. Water—quality and quantity—is an important transboundary issue in Central Asia, affecting decisions related to the transport of oil and natural gas across the Caspian

Sea, hydroelectric versus agricultural use of water, and contamination due to Soviet legacy issues.

These collaborations leverage Lawrence Livermore capabilities in seismic monitoring and event analysis, radiation detection technologies, modeling of the flow of water and contaminants in underground aquifers, atmospheric science, biology and genomics, and energy resources. The projects can provide real benefits in, for example, interdicting illicit smuggling associated with weapons of mass destruction and reducing environmental stresses that undermine public health and regional economics. By speaking the common language of science and promoting cooperation on relatively “safe” transboundary issues, these projects can also help to develop indigenous capabilities that improve the regional standard of living, thereby enhancing stability and security in critical areas of the world and, ideally, removing motivations for the acquisition of weapons of mass destruction.

POST-SEPTEMBER 11 SITE SECURITY

Our response to the terrorist attacks on September 11 included swift actions to enhance the security of the Laboratory and to reevaluate what additional security measures are appropriate in view of the changed threat. Livermore's Safeguards and Security program is designed to protect special nuclear materials and classified information as well as personnel, property, and the public. A layered approach is used to both physical and cyber security with the amount of protection and the types of access controls provided depending on the relative attractiveness of the asset.

Post-September 11, we quickly took effective steps to provide a more robust site security posture at the Laboratory. Livermore now operates routinely at heightened security. Closure of non-essential perimeter gates and roadways near the nuclear materials "Superblock," increased patrols and random searches, additional armed officers at perimeter entry points, 100% search of all truck deliveries are among the measures being taken. To meet staffing needs to sustain the posture, we have embarked on an aggressive hiring and training effort. We also continue to improve our cyber security defenses, and the Laboratory has received funding to implement several physical security enhancements.

It is important that funding keep pace with the demands for greater security. In the area of cyber security, the threat continues to grow in sophistication while funding levels to implement upgrades remain nearly flat. As for physical security, the Laboratory has aggressively pursued technology solutions as a cost-effective alternative to increasing staff. An example is our development and continual improvement over the past 14 years of the Argus system for access control and alarm station management, which is now widely used in the DOE complex to significantly reduce staffing needs. The "Smart Camera" technology that Livermore developed is now being applied at the Laboratory, and other NNSA sites are eager to install it. There are numerous other areas where research and develop funding is needed to make technological advances that would reduce staffing requirements and/or provide greater security without increasing workforce size.

One factor that could radically modify workforce requirements and budgets for Safeguards and Security at the Laboratory is DOE's policies with regard to protection strategies, the Design Basis Threat (DBT), and the capabilities afforded potential adversaries. The DBT is being reexamined post-September 11.

In addition, Lawrence Livermore and Sandia/California national laboratories are taking steps to deal with a long-standing issue—the physical proximity of East Avenue. The road runs between the two laboratories and both have significant facilities close to it. Controlled access to East Avenue would provide enhanced security for facilities and personnel. We have DOE, political, and public support for moving forward on closure of East Avenue. Alameda County, the City of Livermore, and our neighbors are receptive to the proposal, and we are looking at methods to fast-track the project. NNSA has given the project high priority and is providing funding for a conceptual design.

ENVIRONMENTAL MANAGEMENT AT THE LABORATORY

We are very concerned about the proposed FY 2003 budget for environmental management efforts at the Laboratory, which constitutes a reduction of about 27 percent from the FY 2002 allocation. The Laboratory requires an additional $17.5 million above the budget request to maintain its existing environmental management program. Specifically, $8.1 million must be added to maintain the baseline groundwater cleanup program, and $9.4 million must be added for activities to manage newly generated wastes.

Environmental Restoration. Considerable work has been done to remediate soil and groundwater contamination at the Laboratory's main site and Site 300 to reduce risks, meet community interests, and satisfy regulatory requirements under Federal Facility Agreements. Both sites are on the Superfund list. The majority of the contamination at the main site occurred during World War II when it was a Naval Air Base. Solvents used to clean airplane engines were spilled on the ground, and they eventually leaked into the groundwater resulting in the current contaminant plumes. Discontinued Laboratory operations also contributed to the contamination, which threatened the drinking water for the nearby City of Livermore. Site 300, located 13 miles from the main site, has been used for high-explosives research and testing. Past operations resulted in the release of hazardous and radioactive materials.

Specific actions such as characterization of suspected contaminated areas, as well as the design, construction, and operation of treatment facilities have been negotiated and agreed to with the regulators and stakeholders in order to accomplish satisfactory cleanup. Unfortunately, shrinking budgets in recent years have made it extremely difficult to maintain the level of progress and to meet all of the set requirements and schedules despite the Laboratory's best efforts to accomplish needed work using innovative and cost effective methods. As a result, regulatory commitments are not being met in as complete and timely a manner as desired, and contamination may continue to spread, increasing the magnitude of the problem and cleanup costs.

With the proposed cuts in the FY 2003 Environmental Restoration budget, Livermore will miss critical cleanup milestones that have been negotiated by DOE with the State of California and the Environmental Protection Agency. Much of the existing groundwater cleanup equipment and operations will be shut down, leaving potentially contaminated areas unevaluated and allowing some areas with known contaminated groundwater plumes to continue to spread unchecked toward farming and residential areas. The amount of sampling, analysis, and regulatory reporting will decrease significantly; and there will be a significant delay in the cleanup of both the main Livermore site and Site 300.

Waste Management. Despite successful efforts over the last five years to reduce waste management costs, increases in DOE and regulatory requirements, coupled with yearly budget reductions, have put the Laboratory in a difficult position. The proposed reduction for FY 2003 is particularly large—$14.8 million compared to $21.3 million authorized in FY 2002 and $23.7 million required to sustain waste management activities at the Laboratory, which must meet state and federal regulations.

Hazardous Waste Management has two components to its budget. There is the basic cost of maintaining day-to-day operations and managing wastes of all types in a safe and compliant manner. There is also a proposal to clean up the Laboratory's legacy waste. Livermore has over 2,200 cubic meters of legacy mixed, low-level, and transuranic wastes in storage in facilities that should be relocated. Some of this material has been in storage for over 15 years; most of the waste has been stored outside and exposed to effects of weather; and container integrity is a looming issue.

Under the current proposed budget, it will be impossible to meet the Laboratory's programmatic needs with a safe, compliant waste management program. This will have severe impacts on the national security mission and will cause certain programmatic activities to be deferred and/or cancelled. In particular, because of Livermore's limited waste management handling capabilities, a number of critical research and development programs that generate RCRA-regulated waste will be put on hold to maintain compliance. In addition, all stored radioactive waste will remain at Livermore because there will not be funding available for disposal off site. Lack of space will prevent the Laboratory's Hazardous Waste Management Department from accepting newly generated radioactive waste. This will shut down critical work on stockpile stewardship. Furthermore, the proposed budget does not include sufficient funding to begin waste management operations in the new $62-million Decontamination and Waste Treatment Facility (DWTF), which features modern and safer technologies. Mixed and radioactive waste that has been stored on site for many years will continue to be stored outdoors instead of in the new facility.

The DOE Environmental Management Cleanup Reform Fund. The Laboratory has submitted a proposal to obtain an additional $30 million for accelerated environmental cleanup from the Environmental Management Cleanup Reform fund, which DOE proposes to create as part of the FY 2003 Environmental Management budget. We believe our proposal to be very competitive; however, an award from this fund will not adequately replace the $17.5 million shortfall in funding needed to maintain our existing environmental management program. For Livermore to qualify for any of the funds, the State of California will have to renegotiate its compliance agreements, which is one of the requirements.

SUMMARY REMARKS

The Stockpile Stewardship Program continues to make excellent technical progress in many areas, some of which I have highlighted here: notably, the W87 ICBM warhead life extension, completion of the Contained Firing Facility, progress on construction of the National Ignition Facility, the dedication and use of the ASCI White supercomputer, progress on future ASCI plans at Livermore, and numerous scientific and technical achievements that are improving our understanding of the aging of nuclear weapons and weapon performance. However, many difficult challenges lie ahead. There is continuing need for a strongly supported and sustained Stockpile Stewardship Program to maintain the safety, security, and reliability of the nation's nuclear deterrent over the long term. The NNSA's five-year plan for Defense Programs reflects the need for a strong program, and I support NNSA's plan and the budget request for FY 2003.

Strong and sustained support is likewise needed for our activities directed at reducing the threat posed by the proliferation and terrorist acquisition of weapons of mass destruction. As I have highlighted, Lawrence Livermore and our sister NNSA laboratories made unique and important contributions to homeland security post-September 11. We were able to respond so rapidly and effectively because of the technical and operational capabilities we had developed over the past decade and more to deal with the WMD terrorist threat. Although these technologies and systems performed extremely well, surpassing our highest expectations in many cases, still-better capabilities are needed to effectively protect the U.S. homeland from the threat of WMD terrorism. September 11 demonstrated the high level of technical innovation, operational sophistication, and determination of today's terrorists. The challenge we face in defending against such determined adversaries will only grow greater in the years to come. The nation must make a sustained commitment and long-term investment in the research and development required to create the improved warning, detection, and response capabilities needed tomorrow and in the future.

Post-September 11, we quickly instituted a more robust site security posture at the Laboratory. This heightened level of security has become the norm, and we have embarked on an aggressive hiring and training effort to meet staffing needs to sustain this posture. It is important that funding keep pace with demands for heightened security. Funding is also a concern in the area of environmental management. The progress we have made in remediating soil and groundwater contamination is in jeopardy with the proposed FY 2003 budget. At the proposed funding level, we will be unable to meet currently negotiated Federal Facility Agreements or to operate a compliant waste management program that meets facility infrastructure needs. It will also be impossible to support Livermore's programmatic needs with a safe, compliant waste management program. This will have severe impacts on the national security mission and will cause certain programmatic activities to be deferred and/or cancelled.

Finally, I wish to express my appreciation again for the support that this committee has provided for the important national security work that Lawrence Livermore performs for the country, during my tenure as director and throughout the Laboratory's history. We are celebrating our 50th anniversary this September and looking forward to the next half-century of service to the nation. Lawrence Livermore National Laboratory has a bright future with your continuing support.