LOS ALAMOS NATIONAL LABORATORY

ANNUAL REPORT TO THE REGENTS UNIVERSITY OF CALIFORNIA

S. S. HECKER • DIRECTOR

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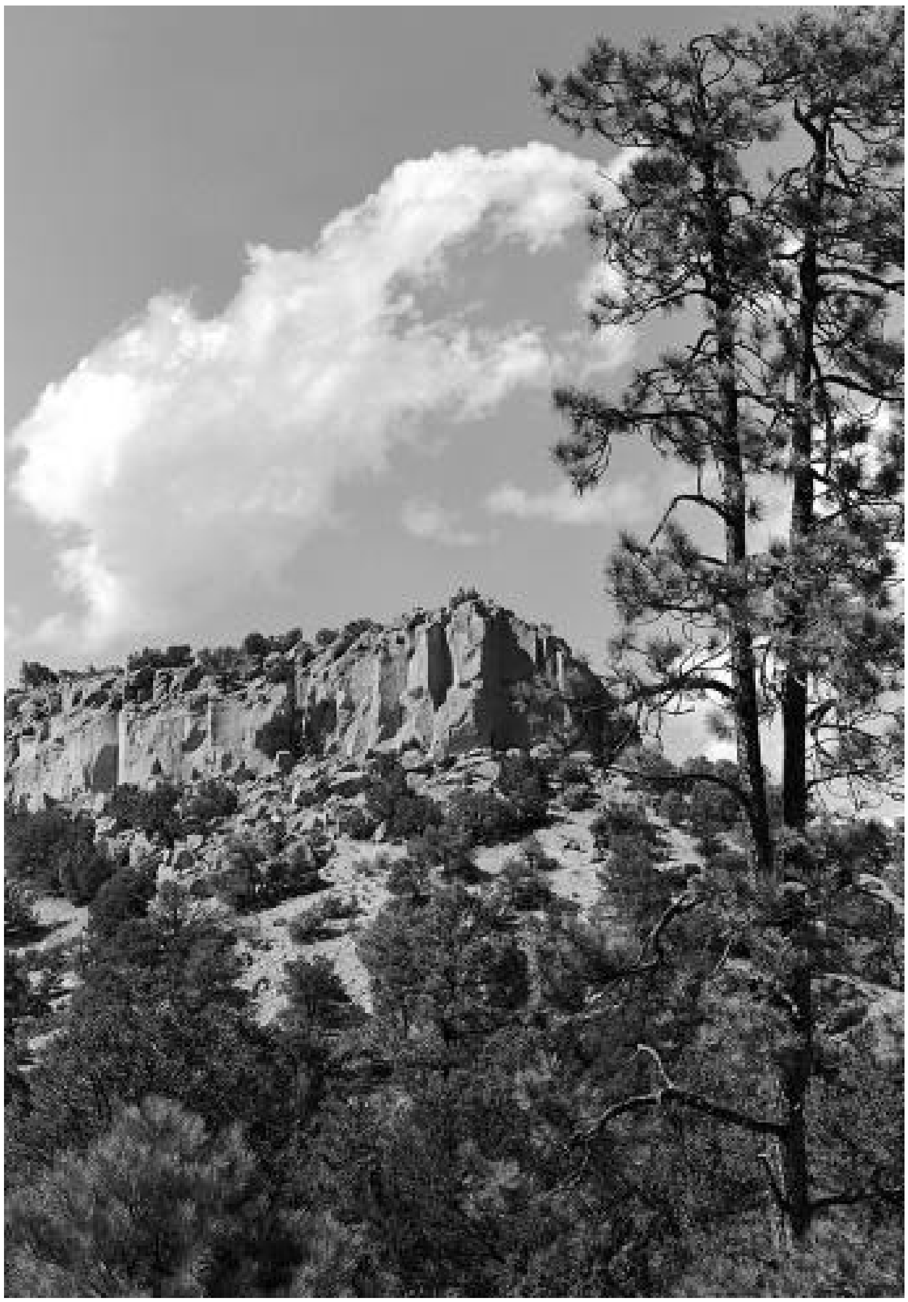

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Los Alamos National Laboratory

Annual Report to the Regents University of California

Los Alamos
NATIONAL LABORATORY

PROFILE

Established in 1943 as Project Y of the Manhattan Engineer District, Los Alamos National Laboratory's original mission was to develop the world's first atomic bomb. Today, Los Alamos is a multidisciplinary, multiprogram laboratory. The University of California (UC) has managed the Laboratory since its beginnings in 1943. An important consequence of this management is the Laboratory's commitment to maintaining the tradition of free inquiry and debate that is essential to any scientific undertaking.

The Laboratory's original mission to design, develop, and test nuclear weapons has broadened and evolved as technologies, U.S. priorities, and the world community have changed. Today, we support our core mission, *reducing the global nuclear danger*, with the technical competencies developed for our national security and other programs. These competencies in turn allow us to contribute to civilian and conventional defense needs where our ability to perform large-scale, interdisciplinary research and development gives us a competitive advantage. We use partnerships with industry and universities to increase the effectiveness of our own work and to help us learn from others. In all our programs, we continue to maintain an intellectual environment that is open to new ideas. In addition, we are committed to ensuring that all our activities are designed to protect employees, the public, and the environment.

DIRECTOR'S STATEMENT

Fifty years ago, a team of scientists, engineers, machinists, soldiers, and others from Los Alamos witnessed the realization of an immense effort as the fireball from the Trinity test lit the predawn sky of central New Mexico. In a few weeks another nuclear weapon would be dropped on Hiroshima and a few days later a third, the twin to the Trinity bomb, on Nagasaki. Less than a month after the Trinity test, the Japanese surrendered and World War II was finally over.

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Siegfried S. Hecker, Director

As we reflected this summer on the superb technical achievement that the Trinity test represents, we also were reminded that the end of the war brought an end to a particularly grim period of world history. It was a period that coined the terms *blitzkrieg, genocide, kamikaze, firestorm*, and *total war* and brought new and terrible meaning to the names of places like Auschwitz, Nanking, Bataan, Dresden, and Hiroshima. The events these terms and places represent must remain etched in our collective consciousness as terrible events that should never occur again.

For the most part, they have not happened again. Although we may have come very close to forgetting it at times during the ensuing Cold War, we learned the lesson of Hiroshima. The awesome destructive power of nuclear weapons has not been unleashed again in anger; the world's course was changed forever by the events that ended the war.

At the end of World War II, the world entered a period of transition. The Manhattan Project had demonstrated in graphic terms the application of science and technology to critical national problems. In 1945, Vannevar Bush, in his famous and still visionary report, *Science, the Endless Frontier*, called for a broader role for science in driving the nation's economic and military security.

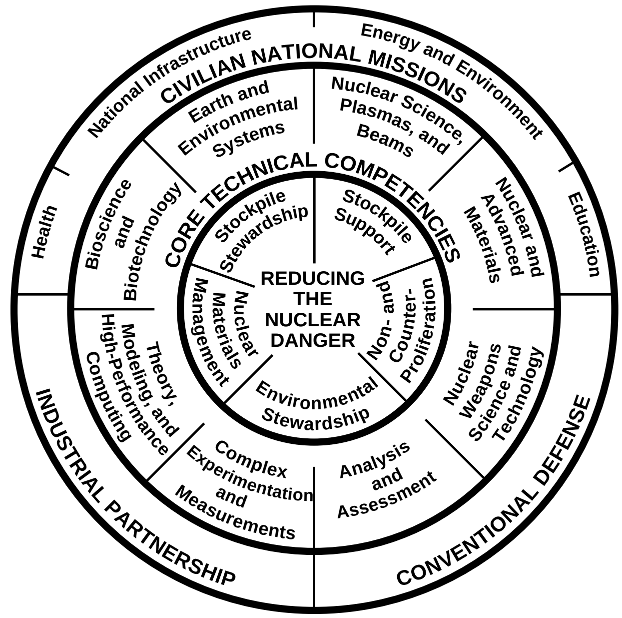
To a large extent, Vannevar Bush's prediction that science and technology would form the basis for national security and prosperity has proved accurate. Science and technology played a key role in the conduct of and in winning the Cold War. Now, with the Cold War over, the world has stepped back from the brink of destruction. Our nation and the rest of the world now face many other important challenges to which science can contribute solutions. Environmental pollution, the use of natural resources, a secure energy future, health, terrorism, crime, transportation, and a vigorous economy are among the issues that will concern us in the future.

For fifty years, this nation supported an immense effort in science and technology, based on the vision of Vannevar Bush and predicated on a mandate for absolute military superiority. The open traditions of scientific research and development in the West fueled ever-expanding opportunities for economic development. Today, continued support for science and technology in the face of a severely constrained federal budget cannot be taken for granted. The science and technology community must continue to demonstrate that federal investments in science and technology are critical to solving many of the pressing problems facing the nation.

In addition, the nation and the rest of the world must deal with the nuclear legacy; this imperative creates a special role for our Laboratory. Thousands of nuclear weapons still exist in the arsenals of the world, and much weapons-capable nuclear material could be diverted by nations desirous of nuclear capability. We must deal with an environmental legacy of fifty years of production of nuclear weapons in this country and in Russia. Finally, there is the realization that this country must retain its nuclear capability in the absence of nuclear testing.

The nation will use Los Alamos and its sister laboratories Lawrence Livermore and Sandia as the technical agents to address the remaining global nuclear danger. This summer, President Clinton signed a decision directive on the fate of the three nuclear weapons laboratories. Specifically, the President determined that "the continued vitality of all three Department of Energy nuclear weapons laboratories will be essential" for ensuring confidence in the safety and reliability of our nuclear weapons stockpile in the absence of nuclear testing. President Clinton explained that he based his decision to pursue a "zero-yield" comprehensive test ban treaty on assurances that the Department's nuclear weapons laboratories can meet the challenge of maintaining our nuclear deterrent under a comprehensive test ban through a science-based stockpile stewardship program without nuclear testing.

In the summer of 1994, even as the Galvin Task Force was conducting its review of the laboratories, we were working to incorporate



Schematic of the Los Alamos National Laboratory mission.

into our mission the evolving situation with respect to nuclear weapons. In the section "Institutional Issues" I outline how we are repositioning the Laboratory for the future, a process that we started several years ago. An essential part of that repositioning is a clarification of who we are and what we do.

Our core mission, summarized by the accompanying figure, is *reducing the global nuclear danger.* The five elements of that principal mission include

- nuclear weapons stockpile stewardship—keeping the weapons that the nation needs safe, secure, and reliable;
- nuclear weapons stockpile support—providing the capabilities ranging from dismantlement to reconstitution if some of the weapons require remanufacture in the future;
- nuclear materials management—ensuring the availability or safe disposition of plutonium, highly enriched uranium, and tritium;
- effective nonproliferation and counterproliferation technologies—keeping nuclear weapons, nuclear materials, and nuclear weapons knowledge out of the wrong hands; and

- environmental stewardship—cleaning up the legacy of fifty years of nuclear weapons development and production.

This mission is supported by eight core competencies: nuclear science, plasmas, and beams; nuclear and advanced materials; nuclear weapons science and technology; analysis and assessment; complex experimentation and measurements; theory, modeling, and high-performance computing; bioscience and biotechnology; and earth and environmental systems. These core competencies in turn provide the basis for our selective participation in civilian national missions, conventional defense research and development, and industrial partnerships. Work in these areas serves other important national needs while providing critical support to our core mission by strengthening and maintaining our core competencies. Thus "*reducing the global nuclear danger*" is an effective shorthand for our mission, but it requires an understanding of the competencies required to fulfill that mission and how they will be supported.

We have addressed not only what we do, but how we do our work. We have reenergized our traditional mission in nuclear weapons with recognition of the importance of our work in *reducing the global nuclear danger* but with a parallel recognition that we cannot be only a weapons laboratory. We must participate vigorously in the science and technology agenda of the nation, both to underpin our national security role and to remain one of the leading scientific institutions of the world. In addition, we are learning from the best of the private sector how to conduct our operations most effectively.

Although we began our quality journey several years ago, the release of the report of the Task Force on Alternative Futures for the Department of Energy National Laboratories, led by Bob Galvin, has done much to help us bring to pass the kind of change we know must occur. The Galvin Report suggested that the Department's laboratories could save at least 20 percent in costs, and Bob Galvin has suggested that this could be as high as 50 percent with a radical change in governance. The Department of Energy is responding to the Galvin Report with initiatives of its own, initiatives that support and parallel those we have instituted.

We have now embarked on a project to increase the productivity of our workforce. We began with the wrenching experience of the largest reduction of the Laboratory's workforce in its history. To concentrate on our primary product, science and technology in service to the nation, we set goals to increase the ratio of technical personnel to those who support them. We have reduced our workforce by approximately one thousand people, half of them contractors. Of the University employees whose positions were eliminated, more than half participated in a voluntary separation program.

The first phase of the project focused on reducing the number of support personnel. The success of this effort will depend on the extent to which we have reengineered our internal processes to increase our efficiency and on how well we can work with the Department to eliminate nonproductive work. In the coming year, we plan to increase the size and effectiveness of our scientific and technological staff and address issues of our research and development portfolio and its relation to our customer's needs. Although we do not anticipate large-scale layoffs within the next year, we may lose more positions as we continue to reengineer our support processes.

The Department has shown good faith in many ways, one of which is a pilot program to reduce dramatically many audits and assessments to a single annual audit in each of two areas: environment, safety, and health and business operations. These audits have validated the University's assessment of our practices, a particularly satisfying example of how far we have come in applying quality principles to our management.

Even as we expend significant effort on management issues, our technical staff members continue to produce exciting science and technology in service to the nation. They received another six R&D 100 Awards for the 100 greatest technical innovations with commercial potential as judged by *R&D Magazine*, leading the nation. Los Alamos work has caught the attention of the world in modeling and simulation of the Earth's magnetic field and in neutrino science. The following sections highlight some of the Laboratory's outstanding science.

As we approach the negotiation of a new contract between the Department and the University, we can look back on the successes of our present contract. The performance measures incorporated into that contract have helped to drive improvements in the management of the Laboratory. Our success in several areas that in early years of the contract were rated as needing improvement is a testament to the benefits that can be gained from working toward well-defined objectives. With the Department moving even more strongly toward performance-based contracting, our successes will help to strengthen the relationship between the Department and the University, a relationship that has served the nation so well.

Because the Department of Energy is changing its historical role as an owner with a strong community presence to one that is divesting itself of almost all its former commitments, we expect other changes in the contract as well. The local communities will look to the University to establish a strong and positive presence in northern New Mexico. We have seen this sentiment increase significantly within the past year. Clearly, time, resources, and changes in the contract are needed to enable and encourage these efforts.

I look forward to reinvigorating the University's relationship with the Department in a new contract, one that acknowledges the progress we have made and lays the groundwork for future improvements. As Bob Galvin has said, "Renewal is not the natural talent of government"; together with the University we can bring that talent to the table, and the nation will be the beneficiary.

National Security Needs

"The United States must and will retain strategic nuclear forces sufficient to deter any future hostile foreign leadership with access to strategic nuclear forces from acting against our vital interests and to convince it that seeking a nuclear advantage would be futile. . . . I consider the maintenance of a safe and reliable nuclear stockpile to be a supreme national interest of the United States. . . . We can meet the challenge of maintaining our nuclear weapons deterrent under a Comprehensive Test Ban Treaty through a Science-Based Stockpile Stewardship program without nuclear testing."

President Bill Clinton, August 11, 1995

Reducing the Global Nuclear Danger

The end of the Cold War, the negotiation of arms reduction treaties, and years of declining budgets have brought significant changes in national security activities at Los Alamos. In the last two years, a number of new developments have emphasized and clarified the role of Los Alamos in the nation's security. Our mission has shifted from designing, developing, and testing new nuclear weapons to one of *reducing the global nuclear danger*.

The year 1995 has been striking in terms of the evolution of post–Cold War national security policy. The Nonproliferation Treaty was renewed in May, and the signatories agreed to seek a comprehensive test ban treaty in 1996. In August President Clinton announced the administration's decision to seek a "zero-yield" comprehensive test ban treaty and simultaneously created a set of safeguards that condition U.S. entry into such a treaty. The first of these is the Science-Based Stockpile Stewardship program. Another is the possibility of opting out of the treaty under "supreme national interest" if a sufficient concern for confidence in the U.S. stockpile could not otherwise be remedied. Finally, in September the President laid to rest long uncertainty about the future of, and need for, the weapons laboratories by deciding that science-based stockpile stewardship requires the vitality of all three.

We continue to work closely with our customers in the Departments of Energy and Defense on a wide range of critical projects and technologies. We contribute to *reducing the global nuclear danger* by maintaining strong portfolios in nuclear weapons stockpile stewardship and stockpile management, nuclear materials management, nonproliferation and counterproliferation, and environmental stewardship. Particularly important are our interactions with Russia and the states in the former Soviet Union. While the focus of our defense work and service to the nation's security at Los Alamos remains the support of nuclear weapons and assurance of their reliability, we apply our broad technical competencies to a wide range of national security problems.

Stockpile Stewardship

Since the beginning of the Cold War era, the nuclear weapons stockpile has been maintained through a strategy of surveillance, nuclear and nonnuclear testing, remanufacture, and replacement. In accordance with the recent Nuclear Posture Review, the United States does not now develop new nuclear weapons designs for the stockpile. Therefore, we must extend the life of current weapons far longer than originally planned. Most of the weapons that remain in the nation's stockpile are Los Alamos designs, and the Laboratory has a statutory responsibility to ensure that these weapons are safe, secure, and effective if they are ever needed.

To execute the Laboratory's stewardship responsibility without underground nuclear testing and a development cycle for new weapons requires an approach based on scientific understanding of weapons function. Scientists must be able to predict confidently whether a change observed in an aging weapon will affect its reliability or safety and evaluate the effects. At the same time, they must be able to certify the safety and reliability of any alteration required. The Nuclear Posture Review also requires us to maintain the capability to design and certify new warheads, should the nation require them in the future.

For these reasons, the President directed the Department of Energy and the nuclear weapons design laboratories to initiate a program of science-based stockpile stewardship, one in which an improved understanding of the fundamental weapons science replaces assurance based on nuclear testing. Science-based stockpile stewardship requires greater emphasis on understanding the basic science of nuclear explosions. To fully understand how aging affects the individual materials and the entire system could require an increase in computational power approximately 10,000 times that available now. New experimental facilities will also be required for access to physical processes that were previously accessible only through underground nuclear tests. These facilities may also be available for research and may provide unique opportunities in areas not directly related to nuclear weapons. These capabilities will enable us to benchmark and validate the computational models and develop the fundamental understanding where gaps in our science base exist. We will also require enhancement of the traditional surveillance process to one that integrates science and surveillance to provide more predictive analysis and to better anticipate aging.

Archiving

One of our most important responsibilities is to ensure that critical information from fifty years of nuclear weapons testing and development is properly collected and preserved. We are formally reviewing Laboratory-wide records, from design calculations to engineering drawings, for electronic storage that is accessible to future scientists. In the absence of nuclear testing, new computational models can be benchmarked with this existing nuclear weapons testing archive.

Accelerated Strategic Computing Initiative

We are developing and acquiring the new computational capabilities required for science-based stockpile stewardship under the Accelerated Strategic Computing Initiative. High-performance computing is absolutely critical to understanding the results of experiments from new facilities, correlating the results with archival data from past nuclear and other tests, integrating the findings, and developing new models for predicting weapons performance. Under this initiative, Los Alamos will create the leading-edge computational modeling and simulation capabilities that are essential for future requirements of stockpile stewardship. Los Alamos will provide leadership in developing ways to link multiprocessor servers in various geographic locations into a supercluster for work on large complex calculations.

Enhanced Surveillance

A new suite of tools and technologies under development will allow the laboratories to predict, up to ten years in the future, problems that may occur in the enduring stockpile. Because much of the former nuclear weapons complex is no longer available for manufacturing new parts or weapons in the event of stockpile problems, we must be able to anticipate early the need to acquire manufacturing capability. We must therefore have the investigative tools to diagnose potential problems before they affect the stockpile. Enhancing surveillance will link science with surveillance in a way analogous to the interaction of biomedical research and clinical medicine.

Dual-Axis Radiographic Hydrotest Facility

The Dual-Axis Radiographic Hydrotest (DARHT) facility will house a pair of advanced electron accelerators that will generate x-rays to provide high-resolution images of dense materials shocked or imploded by high-explosive detonations. Because two axes are planned, we will be able to make essential time-resolved or three-dimensional measurements on non-nuclear implosions with sufficient accuracy to observe changes caused by aging processes. The Department recently completed an environmental impact statement (EIS) and a record of decision on DARHT. As the facility is developed, containment of the debris from most shots will be phased in over time for added environmental protection. We may also incorporate improved accelerator technology when we install the second axis. DARHT's capabilities are essential to our stewardship mission.

Accelerator Production of Tritium

At present, the United States has no facility able to produce tritium for nuclear weapons; the Department is recycling tritium recovered from dismantled weapons to meet stockpile needs. However, as the existing stores of tritium decay, a new source will eventually be required. To mitigate risk, the nation has embarked upon a dual-track approach for producing this material by maintaining two options: an accelerator source and a reactor source. Los Alamos, long a world leader in accelerator research and development, is poised to develop accelerator technologies to produce this critical material. Accelerator production has the advantages of dramatic reduction of high-level wastes, intrinsic safety, and flexibility in sizing to meet changing requirements.

Pulsed Power

High-energy lasers and electrical pulsed-power facilities are complementary tools in addressing high-energy-density physics associated with nuclear weapons stewardship, making different aspects of the high-energy-density regime accessible to experiment. In particular, pulsed power in the microsecond regime, in current use at Los Alamos, enables highly precise, macroscopic hydrodynamics experiments associated with the physics of weapon primaries and secondaries. We will use these experiments to benchmark calculations associated with potential physical defects caused by aging.

Application of Neutron Beams to Stockpile Stewardship

Researchers will use the Los Alamos Neutron Science Center (LANSCE) to address many issues associated with aging by applying highly developed materials science expertise in neutron diffractometry, small-angle scattering, reflectometry, and inelastic scattering. LANSCE will support a better understanding of the science underlying models for predicting the behavior of explosively compressed plutonium, the surveillance of light materials deep inside an aging nuclear device, and the study of the performance and sensitivity of high explosives. The high-intensity, high-energy neutron beams are also useful to test methods for locating defects nondestructively with neutron radiography. There are many smaller yet exciting research developments as well. Exploratory investigation of advanced means of radiography, including advanced x-ray radiography and a new approach using high-energy protons, is involving Los Alamos with its sister weapons laboratories. Los Alamos is also developing collaborations with researchers at Lawrence Berkeley National Laboratory and the Stanford Linear Accelerator Center.

Stockpile Support

With the end of the Cold War and the reduction in the size of the nuclear weapons complex, Los Alamos has assumed responsibility for several missions that previously belonged to other sites. These missions include surveillance of components from the nuclear package and the demonstration of technologies and capabilities required to remanufacture some components. These assignments require us to establish the formality of operations and quality assurance necessary to meet Department of Energy standards; they will also allow us to exercise many of our existing facilities and capabilities for operating with and handling nuclear materials and explosives.

The Department of Energy's 1992 decision to end plutonium operations at the Rocky Flats Plant brought the responsibility for pit surveillance to Los Alamos. Pits are the fission cores of nuclear weapons. Since that time, we have reestablished the pit evaluation program at the Laboratory, including transfer of equipment, personnel, process documentation, and hardware. In the past year, Los Alamos nondestructively evaluated forty pits in a "shelf-life" program, which will provide continuous data on how pits change with time, and destructively evaluated nineteen others.

The Department is also developing its options for the production of plutonium pits for weapons stockpile replacements. Currently, the TA-55 plutonium facility at Los Alamos is the only facility in the nation capable of producing stockpile-quality pits. However, TA-55 is a research and development facility with only a small production capacity. The Department's decision will depend strongly on future production requirements for the stockpile. The Department is also preparing a programmatic EIS that will examine all possible alternatives for pit production. The Laboratory has emphasized that small-lot pit production is very much in the spirit of the new integrated research and development, enhanced surveillance, and remanufacturing paradigm brought about by international arms reductions and science-based stockpile stewardship. However, if the requirements are greater, on the order of hundreds per year, then a new production site should be planned and constructed. Los Alamos staff will help in that planning process. The University of California President's Council is continuing to collaborate with the Laboratory on this issue.

With the shutdown of operations at the Mound Plant in Ohio, the Department assigned detonator evaluation responsibility to Los Alamos. We have demonstrated the capability to perform these evaluations; the first evaluation of a stockpile return component took place late in 1995. Included in the assignment to fabricate detonators for the future stockpile is the design and manufacture of detonator simulators used in stockpile evaluation flight test units. Though these simulators do not actually enter the nuclear stockpile, we have demonstrated the ability to meet the same rigorous quality standards as those required for stockpile components.

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A scientist examines the test chamber used to verify the performance of detonators. The detonators are returned from the stockpile as part of the Laboratory's surveillance activities.

In FY 1995, we also demonstrated the capability to manufacture other parts used in the physics package. We pressed and machined several lithium salt parts and fabricated a nuclear package case from uranium alloy. As we develop these capabilities, we are also improving manufacturing techniques to minimize waste and process time.

Los Alamos also received responsibility for the tritium loading of neutron tubes for a neutron generator designed by Lockheed-Martin. Although it was expected to take up to five years to transfer the skills needed to perform this work, Los Alamos researchers applied their knowledge of tritium hardware and processes and transferred the production capability to the Laboratory with significant improvements. The result is a system that will provide tritiated targets to Sandia National Laboratories for incorporation into neutron generators on schedule within months instead of years.

Advanced Design and Production Technologies

A shift from a large, capacity-based complex to one that is smaller, more efficient, cost-effective, and capability-based will require more flexible remanufacture of weapons components. The complex must integrate research and development with surveillance.

In cooperation with the Department, we are developing the Advanced Design and Production Technologies Program, which will provide the accelerated research and development necessary for improved remanufacturing through the prototyping, testing, and implementing of a broad spectrum of advanced design and manufacturing technologies. Implicit in this program is heavy reliance on modeling and simulation and on partnerships with industrial firms. In particular, these efforts aim to reduce the footprint, waste, and environmental burden of future manufacturing capabilities.

Nonproliferation and Counterproliferation

The proliferation of weapons of mass destruction and the means to deliver them remain major national security issues despite the end of the Cold War. We are developing and applying Laboratory science and technology to deter, detect, and respond to proliferation and to ensure U.S. and global security. We are also performing research into a wide variety of technologies that have broad application in both national security and dual-use areas.

Los Alamos scientists are developing better capabilities to detect and recognize signals from nuclear explosions in the atmosphere or in space. The array of low-energy x-ray imaging sensors (ALEXIS) Earth-orbiting satellite is one example. The Space Sciences Laboratory at UC–Berkeley built the ALEXIS telescope detectors, designed and obtained the telescope filters, and continues to collaborate on astrophysical science issues.

Los Alamos, in partnership with Sandia National Laboratories, is also developing the fast, on-orbit recording of transient events (FORTÉ) satellite to improve our ability to detect clandestine atmospheric nuclear tests by measuring the nuclear-generated electromagnetic pulse from such tests. This small, inexpensive satellite, designed by Los Alamos researchers, will also serve as a data-gathering tool to help scientists investigate Earth's ionosphere and the physics of lightning.

In collaboration with the Morgantown Energy Technology Center and the Hanford Reservation, the Laboratory is developing an advanced light detection and ranging (LIDAR) system for detecting and characterizing effluents associated with nuclear processing activities. Los Alamos is advancing the technology for this application and will use a second-generation system for airborne experiments in FY 1996.

Los Alamos is developing software tools that can locate phenomena of interest in large quantities of data. Current application areas for the tools include nonproliferation, looking for evidence of covert nuclear activities or noncompliance with arms control treaties; and computer security, looking for misuse and intrusion attempts.

The Laboratory has developed new methods to integrate video spatial data with radiation-time data to monitor the movement of nuclear materials for safeguards applications. This approach is well suited to large automated facilities and would also find applications at reactors, spent-fuel storage facilities, reprocessing plants, and nuclear material storage vaults.

Nuclear Materials Management

A very important element of *reducing the global nuclear danger* is the development of technologies that result in safer, more secure storage of special nuclear materials. Los Alamos has achieved several notable successes, both in managing our own nuclear materials inventory and in providing technical leadership for the entire Department of Energy complex.

The special recovery line will process special problem pits now in storage at Rocky Flats and Pantex Plants. Up and operating, the line processed the first pit late in 1995. Another project will reprocess plutonium components from retired nuclear weapons into a shape more suitable for storage. Because the resulting shape is unclassified, it is verifiable to international controls organizations. This past year, Los Alamos also fabricated mixed oxide fuel pellets, the first ever to be made from plutonium weapons components. Although the United States does not use mixed oxide fuels for reactors, this technology may find use in our collaborations with the former Soviet Union. In addition, Los Alamos has developed the first container certified for the long-term storage of plutonium. Plutonium was actually packaged in one of these containers for the first time June 1, 1995.

Los Alamos also provided technical support for the new management contractor at Rocky Flats Plant, including input to project plans, peer review of proposals, and development and demonstration of specific processes. In particular, we developed and demonstrated a process to stabilize plutonium and conducted on-site training for the Rocky Flats operations staff.

Hydride-Dehydride Recycling of Plutonium

Plutonium recovery traditionally involves a multistep acid leaching process that generates substantial mixed waste. In a process honored with an R&D 100 Award this year, Laboratory scientists developed a one-step, zero-waste method of recovering metallic plutonium that can be applied to the thousands of nuclear weapons built during the

A Laboratory scientist demonstrates the plutonium hydride-dehydride process, which takes place in a vacuum chamber inside a glove box.

Cold War. The hydride-dehydride recycling process takes advantage of plutonium's strong affinity for hydrogen gas, causing the weapons component to react with hydrogen to form plutonium hydride powder. Dehydriding takes place as the powder is heated, releasing the hydrogen and depositing 99.9 percent of the plutonium in metal form in the bottom of a crucible.

Environmental Stewardship

To incorporate environmental stewardship into every Los Alamos activity, the Laboratory is working to ensure that waste minimization and pollution prevention play a pivotal role in all activities. As our waste management operation becomes more sophisticated, we will have less need to handle "end-of-pipe" problems; instead, we will focus on preventing waste from entering the pipe.

In the past year we have made significant progress in environmental restoration. We cleaned up forty-six contaminated sites and completed the decontamination and decommissioning of several buildings in our former plutonium fabrication area (the predecessor to the Rocky Flats Plant), reducing the airborne emission of radionuclides from this facility by 90 percent. Nearly 900 potentially contaminated sites have been evaluated and closed out, needing no further action. Between 70 and 120 contaminated sites are slated for cleanup in the next year, depending on budget availability.

Our waste management efforts continue to implement methods and procedures to streamline operations and extend the capacity of our treatment and disposal facilities. In addition, the upgrade of the chemistry-metallurgy research facility has saved millions of dollars through collaborations between waste minimization experts and the upgrade designers. Our efforts in waste management and minimization have also benefited our decontamination and decommissioning project. Implementing pollution prevention recommendations in environmental restoration projects will save almost 10 percent in FY 1996 decontamination and decommissioning costs alone.

We also continue to develop and implement new treatment technologies, including high-gradient magnetic separation of contaminated soil and supercritical carbon dioxide cleaning. We are formulating a proposal to dry up all liquid waste streams from our plutonium facility by combining several new, commercially available methods into the waste treatment process.

Other technology developments at the Laboratory include a system that remotely monitors the thermal stress of workers in protective suits. The Laboratory uses this system, which won an R&D 100 Award last year, to test new types of protective equipment. In addition, we developed hand-held radiation monitors that not only detect radiation above background but also perform limited analysis to determine the isotopic source of the radiation. We are also developing monitors capable of detecting low levels of alpha-emitting contamination in the field, a particularly difficult problem, with application to environmental remediation as well as to portal or vehicle monitoring.

Conventional Defense Activities

The conventional defense programs sponsored by the Department of Defense (DoD) are vitally important to the future of the Laboratory. DoD funding enables us to make innovative contributions to national security, as well as to our core mission of *reducing the global nuclear danger*. Numerous Laboratory-developed technologies are in development for the military services and are in several general technological areas.

Los Alamos develops conventional munitions concepts and related projects in high explosives and energetic materials, advanced warheads, and lethality and survivability for DoD and nuclear weapons technology applications. We partner with DoD to improve nonnuclear munitions capabilities across all the military services mission areas, to provide tools for designers to use in developing new munitions, and to benefit our own core nuclear weapons programs. We are developing models that will predict how explosives behave in accidents or fires, as well as new, safer explosives that equal the performance of today's best materials.

We can also offer DoD special expertise and assistance in many advanced concepts, from advanced materials to low-observable technologies, from nonlethal weaponry to nuclear space reactors. Recent advances in the development and deployment of retrofit armor to protect crews in aircraft flying humanitarian missions in Bosnia have gained DoD interest and media attention.

We are developing diagnostic sensors for arms control verification, monitoring, and compliance programs. Our LIDAR systems allow remote sensing of biological agents and the detection of theater ballistic missiles. We also work closely with DoD counterproliferation agencies to provide active protection for our deployed forces and national interests from weapons of mass destruction.

In addition, we are actively developing environmental technologies for a wide range of DoD applications, from pollution prevention and environmentally conscious manufacturing to waste minimization, treatment, and disposal. The environmental impact of waste streams within the DoD, as well as the waste byproducts of military production, and the environmental threat from former Soviet Union military sites are significant future challenges.

Because of our advanced computational capabilities, Los Alamos can offer solutions for large-scale, complex problems for both defense and dual-use applications. Our simulations allow computer-assisted experimentation on weapons systems and can significantly increase our understanding of how such complex systems behave in the battlefield environment. They also allow us to demonstrate how our proposed technologies can affect the battlefield—a powerful means to support program development and acquisition decisions. One current application helped DoD analyze options that supplement the new Air Force C-17 airlifter procurement with commercial aircraft to support rapid overseas deployment capability.

Laboratory-to-Laboratory Interactions with the Russians

Collaborative scientific work at Russian institutes has increased dramatically over the past two years, and major experiments and theoretical work have continued with our counterparts from Arzamas-16, the first Russian nuclear design laboratory. Basic scientific results include direct measurement of the upper critical field in a high-temperature superconductor, compression of argon to five times the normal liquid density, and spectroscopy of plasmas in very high magnetic fields.

The industrial partnering program, begun in 1994, has allowed collaborations with scientists in over twenty Russian institutes on projects that will have substantial interest for U.S. industry. This program engages Russian scientists who were previously involved with weapons of mass destruction and are now working on projects that will, in only one or two years, attract private investment. In this way, we can accelerate weapons conversion activities in the former Soviet Union. Los Alamos has more than twenty-five projects underway, ranging from development of parallel computing algorithms to prototyping computer-based roll-forming systems for titanium alloys.

The most remarkable success story comes from the technical respect and trust engendered by these collaborations. In the spring of 1994, all U.S. government efforts to secure nuclear materials in the former Soviet Union stalled. The national laboratories, with Los Alamos in the lead, suggested a “laboratory-to-laboratory” approach, and in one weekend the principle was accepted by scientists at Arzamas-16. Within six weeks the first contracts for specific projects were in place, and within six months we were demonstrating complete nuclear material control and accountability systems with the Russians. By working directly with our technical counterparts, we achieved cooperation faster than anyone expected.

Nuclear-weapons-accident equipment developed by the Laboratory is loaded into a Russian aircraft in Albuquerque.

Now, all the major Ministry of Atomic Energy facilities have become participants in the program, along with six U.S. national laboratories. As an example of an early result, we took several of the technological pieces that constitute a major facility demonstration at Arzamas-16 and installed them at the Research Institute for Physics and Engineering in Obninsk. This facility, with two critical assemblies, now has 800 kilograms of plutonium and 2.3 tons of highly enriched uranium under positive safeguards. The enthusiasm for this joint program has even inspired the directors of the weapons assembly and disassembly plants, and we are planning systems for those institutes. At the current rate, we expect to have all of the Russian weapons-grade nuclear material under positive controls in five to seven years.

Accident Response Equipment Delivered to Russia

Nuclear-weapons-accident response specialists in the former Soviet Union will now be better prepared for responding to any accident because of equipment provided by Los Alamos to the Russians. The equipment can be used to deal with a variety of scenarios, including dismantlement, a damaged weapon that is spreading radioactive material, or a weapon embedded in accident debris. Laboratory specialists in nuclear accident response have provided training and equipment to their counterparts in the former Soviet Union for the past two years. In a precedent-setting collaboration, nine scientists and engineers from the Russian nuclear weapons laboratories were trained in the use of this equipment at Los Alamos last September.

CIVILIAN NATIONAL NEEDS

The great strength of our Laboratory is the quality of the science and technology it applies to its missions. The Laboratory's identity and international recognition rests upon its sustained performance in satisfying national needs in science and technology. It is no coincidence that Los Alamos is embedded within a major research university. Association with the University of California not only assists us in recruiting the best talent available, it reminds us that science and excellence must be our highest priorities. We can take the long-term view of a government laboratory, yet we have the talent and reputation that allow us to move rapidly into emerging areas of science and technology.

Programs in civilian science and technology, supported by other Department of Energy offices such as the Office of Energy Research, as well as work for other federal agencies in the civilian sector, help support necessary capabilities. Further, maintaining the quality of the Laboratory's work requires that our scientists be integrated into the broader scientific and technical community. We interact strongly with university researchers, and we are increasingly working in partnership with industry to help meet mission requirements.

Whether in basic research, the human genome or other bioscience programs, materials research and development, energy technologies, high-performance computing, space, or the application of Laboratory-developed technologies to commercial applications, activities in civilian research and development serve important national needs while helping to maintain the vitality of the Laboratory.

As we apply our core competencies to civilian needs, we reinforce the reputation of the Laboratory for quality science and technology. The following are a few technical highlights demonstrating the quality of the science in several of our core competencies. We also highlight here the role we play in education and our partnerships with industry.

NUCLEAR SCIENCE

Los Alamos Neutron Science Center

The Los Alamos Neutron Science Center (LANSCE) includes the Manual Lujan, Jr. Neutron Scattering Center, the Weapons Neutron Research facility, the world's most powerful proton linear accelerator, and the proton storage ring. LANSCE is a major component of the Laboratory's strategic plan to become the center in the United States for the development and use of spallation neutron sources for research and applications. This neutron laboratory initiative is vital to the Laboratory in a number of ways. It helps to maintain at Los Alamos a set of core technical competencies that are critical to the Laboratory's mission. Neutron science and technology supports advanced materials science, nuclear science, particle beam technology, and nuclear weapons science, all of which are competencies needed to fulfill the Laboratory's role in the stewardship and support of the nation's nuclear weapons stockpile. LANSCE is also expected to be the central facility for development of the technology to satisfy one of the paramount stockpile support requirements, namely, the production of tritium. Finally, LANSCE will provide opportunities in basic research, which will help to establish it as both a magnet to attract new talent to Los Alamos and, through science-based stockpile stewardship, a bridge to the weapons program for that talent.

A major upgrade of LANSCE is underway, with a series of modifications that will provide for more reliable and convenient operation in support of science-based stockpile stewardship and other research. The role of LANSCE as a magnet facility for new talent will be further strengthened, and even broader scientific horizons reached, if we can realize our plan of construction by the year 2000 of the long-pulse spallation source and associated instrumentation for neutron scattering and fundamental physics research.

Neutrino Science

Los Alamos researchers have participated in the forefront of neutrino science for many years, starting with the use of liquid scintillation detectors by Fred Reines, Professor Emeritus at UC–Irvine and winner of the 1995 Nobel Prize for Physics, to first detect the free neutrino. More recently, Los Alamos joined the Russian-American Gallium Experiment (SAGE) collaboration at the Baksan neutrino observatory in the Caucasus Mountains in Russia in 1985. SAGE was the key to defining the modern solar neutrino problem—verifying the observation of neutrinos from the primary fusion processes in the Sun but demonstrating that the observed solar neutrino flux has no apparent astrophysical solution. In addition, Los Alamos, with UC–Berkeley, is a collaborator in the Sudbury Neutrino Observatory, which will provide the first model-independent tests of the solar neutrino problem. All these experiments are aimed at determining whether new physics, specifically neutrino oscillation, is necessary to explain the observed results.

The liquid scintillation neutrino detector at Los Alamos has been operating for three years searching for an excess of electron antineutrinos. The neutrino source is singular in that the fraction of electron antineutrinos is very small compared with the number of the other three types, the muon neutrino, the muon antineutrino, and the electron neutrino. The background is expected to be small because the detector can detect both final-state particles. The first two years of operation yielded a number of events that was roughly five times that expected from conventional physics (nine events instead of two). This result was published in *Physical Review Letters* and generated substantial press coverage because of its implications for particle physics. This publication was accompanied by another letter from the University of Pennsylvania noting no observable signal.

In the current year, we expect to almost double our data sample. We are also searching for neutrino oscillations by observing pions that decay in flight. This search has systematic errors very different from those in our other search involving muons that decay at rest and offers another independent view of the possible signal.

Data from electron neutrino scattering on carbon have been analyzed, showing cross sections in agreement with expectations. We expect to publish these data within the next few months. Early in the year, data on muon neutrino scattering on carbon were published in the *Physical Review*. This cross section is much smaller than predicted.

Both the muon neutrino–carbon scattering and the current oscillation signal have caused a great deal of interest in the particle and nuclear physics community. This interest is unlikely to decline much in the near future, given the effect that these data are having on neutrino physics.

Earth and Environmental Systems

Understanding the Geodynamo

A fundamental goal of geophysics has been a coherent understanding of the geodynamo, the mechanism that generates the Earth's magnetic field in the liquid, electrically conducting, outer core. Near the turn of the century, Albert Einstein described this as one of the five greatest unsolved problems in physics. Until now, all models of the geodynamo have been simple and certainly not self-consistent. The international geophysics community has long acknowledged that a more detailed self-consistent description of the magnetohydrodynamics of the Earth's core would be required to begin to answer many fundamental questions about the structure and evolution of the geomagnetic field.

A researcher from Los Alamos, collaborating with a professor at UC–Los Angeles, has produced the first three-dimensional, time-dependent, self-consistent numerical simulation of the generation of the Earth's magnetic field by convection in the Earth's liquid core. The solution is a self-sustaining dynamo that has maintained a magnetic field for roughly 40,000 years. The most exciting feature, one that has never been simulated before, is a reversal of the dipolar part of the magnetic field that occurs near the end of the simulation. For decades, geologists have observed evidence of magnetic pole reversals in the geologic record. These simulations indicate that for the first time, we now understand the processes that have caused the pole reversals.

Revitalizing the Santa Barbara Oil Fields

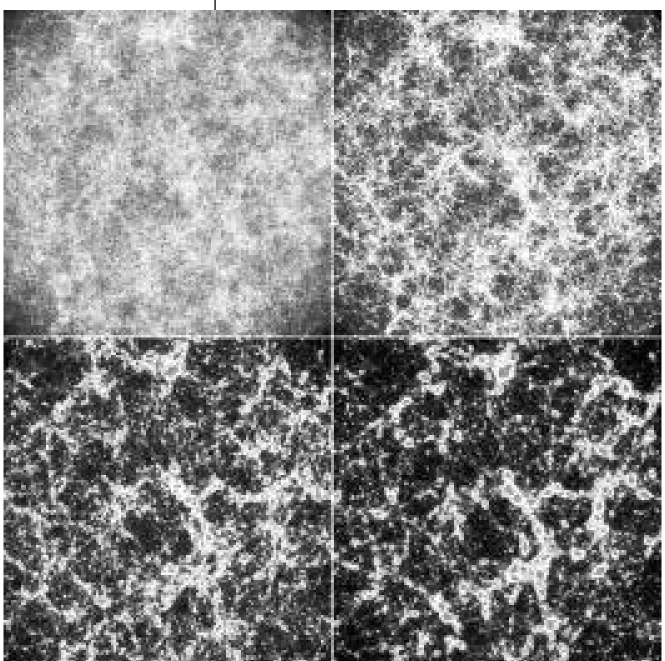
More than one-half of domestically produced hydrocarbons are from fields operated by independent oil and gas producers. Most of these producers operate older fields. This is especially true in California. One such company, Pacific Operators Offshore, in a historic collaboration with the State of California, the Department of the Interior, and the Laboratory, is attempting to redevelop the Carpinteria Offshore Field near Santa Barbara after nearly two-and-a-half decades of production. This effort is being guided by Laboratory-assembled computer modeling technology, which exploits the Internet as a shared computing environment. The technology developed will be shared with the petroleum service sector and will result in lowered costs for such state-of-the-art services in the future. Success here will not only benefit the company, the State of California, and the federal government but also possibly hundreds of independent producers who face the task of revitalizing the nation's sagging oil production.

The Carpinteria field has produced nearly 100 million barrels of oil and 90 billion cubic feet of gas since its development began in 1966. The field is located offshore near Santa Barbara, California, traversing both state and federal waters. Although a significant quantity of oil remains, inefficient production practices have led to the premature abandonment of a number of wells. Further, environmental pressures will result in the dismantling of the two platforms nearest the shoreline in the near future. Environmentally benign methods can produce this oil and result in jobs and both private and public revenue streams.

Theory, Modeling, and High-Performance Computing

Modeling the Structure of the Universe

A fundamental problem of astrophysics is the formation of structure on subgalactic to cosmological distance scales. Los Alamos researchers have developed programs that use over 100 million particles to simulate the formation of galaxies in unprecedented detail. The evolution of matter in the universe is simulated from a time shortly after the Big Bang to the present epoch. Incorporating initial conditions from several cosmological models, we have shown that the cold dark-matter model is compatible with some of the constraints that were previously thought to rule it out.



Four frames show consecutive stages of the matter distribution in a cosmological simulation from shortly after the Big Bang to the present. Over time, the mass becomes more clumped, forming structures similar to those observed. The region of space in the first frame expands as the universe expands to about 600 million light-years across in the final frame.

Molecular Medicine for the 21st Century

In the next century, mankind will be under attack by newly emerging viruses and deadly strains of old menaces that have become drug resistant. New drugs and vaccines will be necessary to fight these threats and ward off pandemics. By combining the Laboratory's high-performance computing power with advanced techniques in data analysis, Los Alamos researchers are using their expertise in theory and computation to help select the most promising vaccines and drug treatments, rapidly evaluate changes in pathogens, and propose new, ingenious schemes to defeat contagious diseases.

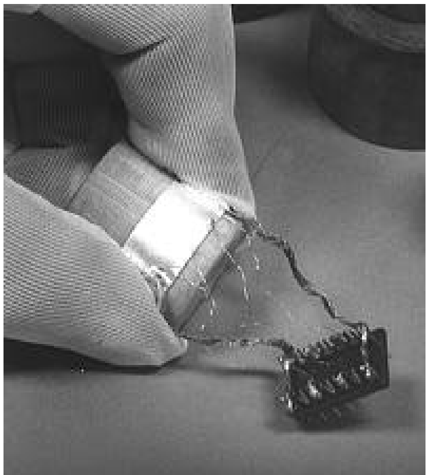
This new field of molecular medicine uses computers to design drugs and vaccines and to measure their effectiveness against viruses. The underlying concept is to randomly generate billions of pieces of RNA (ribonucleic acid), DNA (deoxyribonucleic acid), and proteins and then to determine which of these best fit into receptors on the protein envelope that encapsulates the virus' genetic material. Top candidates thus identified are then produced in the laboratory along with mutations. These potential drugs are tested against the virus to determine their effectiveness. This process mimics natural mutation but on a vastly accelerated time scale.

Advanced Materials

High-Temperature Superconductors

Los Alamos researchers have taken a giant step toward application of new high-temperature superconducting technology with the development of a flexible, metal-ceramic tape that can carry record-breaking levels of electric current at relatively high temperatures.

The Los Alamos team uses ion-beam-assisted deposition, similar to spray-painting at the atomic level, to deposit a cubic zirconia layer on nickel. Then a pulsed-laser process deposits the superconducting compound on top of the cubic zirconia. The resulting tape can carry one



A short segment of the Los Alamos–developed thick-film superconducting tape is flexed around a spool.

million amperes of electricity per square centimeter, a current density nearly 100 times greater than other high-temperature superconductors and 1,250 times greater than the copper wire standard in houses.

One of the most important things about the metal-ceramic tape is its flexibility. It can be wrapped tightly around an object as thin as a soda straw and stands up to repeated twisting and bending without cracking, and unlike other superconductors in its class, the Los Alamos tape loses none of its superconductivity in strong magnetic fields. That characteristic is important because so many electrical applications, from motors to medical devices, require wires to function in magnetic fields.

Progress in Prosthetic Implant Technology

Los Alamos materials researchers, in collaboration with scientists at Arizona State University and the Harrington Arthritis Research Center in Phoenix, have successfully completed initial experiments that may improve bone implant devices, such as hip-replacement joints. The researchers believe that their coating technique using “sol-gel” materials and ion implantation will improve the bond between the implant device and the bone.

When surgeons perform a hip replacement, their goal is to have the bone grow around the artificial joint. By coating the titanium replacement with a mineral substance found in bone called hydroxylapatite, the patient’s bone grows into the coating. The goal of the researchers is to develop a graded layer—from porous hydroxylapatite on the outside that bonds to the bone, to a dense layer of hydroxylapatite next to the titanium. By ion-mixing an initial layer of hydroxylapatite into the metal and following with less-dense layers, researchers expect to make the bond as strong with the metal as it is with the bone. The sol-gel and ion-beam coating techniques are well suited to implants because the processes will coat irregularly shaped devices.

Directed-Light Fabrication

Directed-light fabrication is an automated process for fabricating three-dimensional, fully dense, metal parts by fusing metal powders in the focal zone of a laser beam. Development of this process, which won an R&D 100 Award in 1994, is the result of combining Laboratory laser and materials expertise. The process has many advantages over conventional metal fabrication processes, including the elimination of patterns or molds, the reduction in finishing costs because of the near-net-shape of the product, and the ease of making changes in the computer-generated design. Directed-light fabrication is ideal for low-volume production and rapid prototyping of complex shapes. Replication or modification of existing parts is also efficient because the parts can be laser-scanned to obtain the original design information directly.

Bioscience and Biotechnology

Physical Map of Human Chromosome 16

After six years of intense work, Los Alamos scientists have completed a physical map of human chromosome 16, a chromosome that contains genes responsible for leukemia, breast and prostate cancers, neurological and kidney diseases, and blood disorders. This map, which is at a resolution 100 times greater than previously achieved by other mapping strategies, is the third of the twenty-two human chromosome maps to be completed as part of the Human Genome Project. This project is an international effort to identify all the DNA found in humans.

The map describes how our genetic information, as defined by nucleotides, is aligned along the DNA molecule. Chromosome 16 contains about 3 percent of the information estimated to exist in the entire human genome. With this map, researchers will be able to search more rapidly for new genes in addition to the 250 that have been identified to date on this chromosome. Successful application of the data from our chromosome 16 map includes the recent reports of the isolation of genes associated with both Batten disease, a childhood neurodegenerative disorder, and polycystic kidney disease, the second-leading cause of kidney failure.

DNA Repair and the Immune Response

Preservation of our genetic information is essential to guard against mutation and to lower the risk of cancer. This task is controlled by a complex array of biochemical machinery. Instrumental to this process is the recognition and repair of damaged DNA. Recently, Los Alamos researchers identified an important part of the machinery that recognizes DNA strand-break damage and sets the repair process in motion. They discovered that four different mutant cell types that had lost the ability to repair DNA strand-breaks contained defects in the expression of activity of a single enzyme. This enzyme, called DNA-PK, is important for DNA repair because it binds to the end of the damaged DNA strands and modifies other proteins bound to the DNA to initiate damage repair.

In addition to identifying the role of DNA-PK in DNA repair, these findings provided strong evidence that the same enzyme is required in the process of creating the immune response. One of the mutant cell types identified by the Los Alamos researchers as lacking DNA-PK was derived from a strain of laboratory mice that lack a functional immune system. These mice lack the capacity to generate the immunological diversity that allows the immune system to respond to a large variety of viruses, bacteria, and other pathological insults. Our findings establish a unique, dual role for the DNA-PK enzyme in controlling biochemical processes associated with both DNA repair and the immune response.

EDUCATION

The Laboratory conducts a wide variety of science education programs covering all grade levels. One of our strong efforts is the application of new technologies to the educational process. Laboratory staff are offered as consultants to school districts to help them plan and design computer networks. After the schools have obtained the necessary equipment and connections, teacher workshops are held to train teachers and administrators to use these facilities. We also hold workshops to help teachers learn to integrate the technology into their standard curriculum.

To provide a roadmap for other schools to follow, we document the methods used and the results obtained when different types and sizes of school districts implement computer networking. The Laboratory is conducting a major national survey of school districts. The survey is designed to describe the effective practices in grades K–12, the degree of technology integration into the schools, their methods, and the current status of their computer programs. This project will assist federal agencies in developing sound criteria for funding networking proposals and assist schools in planning, implementing, and evaluating their own network models.

Over the past year the Laboratory has worked with thirty-five schools in nine school districts, and has held twenty-one workshops for more than 400 teachers and administrators.

Industrial Partnerships

For almost a decade, we have promoted working with industry as an important part of the Laboratory's future. We continue to believe that we must work with industry to ensure that our technology is the best and that it has an impact in civilian areas. Partnerships with industry have also become more important in the defense sector as changing defense requirements reshape the military-industrial complex.

During the past ten years, the political winds for industrial partnering have blown rather unpredictably. Ten years ago, there was little interest within industry and only a handful of politicians, led by Senators Domenici and Bingaman, who promoted getting more private-sector benefit from federal research expenditures. In 1989, Congress passed legislation to promote partnerships between federal laboratories and U.S. industry, employing the concept of a cooperative research and development agreement (CRADA).

This legislative initiative, combined with specific set-aside funds in the Technology Transfer Initiative (TTI) of the Department of Energy, allowed the Laboratory's industrial interactions to grow to the nearly 200 collaborative agreements we have today, with an annual budget of roughly $50 million supporting our Laboratory staff. During this time, industry obviously developed interest in the Laboratory. In turn, we found that industry's problems are very challenging and that we can learn much from industry. Clearly, the partnership between industry and the Department's laboratories began to flourish.

Early this year, the new Congress signaled its concerns that federal support of industry research and development represents a form of "corporate welfare." The Department of Energy redirected TTI partnerships to achieve a much closer tie to its defense mission in areas such as advanced manufacturing processes. The Laboratory, in turn, is emphasizing a closer tie of industrial partnerships to our missions. This has been a confusing period for our staff, which had embraced the importance of industrial partnerships.

We are convinced that working with industry will enhance the long-term viability of the nuclear weapons program, as well as strengthen other programs at the Laboratory. At the same time, we must continue to demonstrate that we can have a positive effect on industry. Otherwise, there is no incentive for industrial partners to participate and to share costs. To this end, we must continue to build better bridges to our industrial partners.

Several examples of industrial interactions illustrate their depth and breadth. With a small business we have further developed a new acoustic technique into commercial gear usable for a wide range of acoustic, nondestructive evaluations. These same acoustic technologies are being used for the characterization of some weapons components. We anticipate that such improved acoustic technologies will contribute significantly to the requalification of weapons components, thereby minimizing the need for additional production of plutonium components.

A laboratory test set with three transducers and a precision silicon nitride ball in place for acoustic characterization of a ball bearing. The ball is about one inch in diameter.

We expect one CRADA to achieve the development of better down-hole perforators for oil well casings for the oil industry. Perforators puncture an oil well casing in a controlled fashion after an oil-bearing strata has been identified outside the casing. One benefit of this project is the development of an economically viable commercial supplier of parts for high-explosive detonators, which supply Department of Energy missions as well as Department of Defense and commercial markets.

With General Motors and the University of Wisconsin, Los Alamos is exploring novel ideas for the surface treatment of materials. These ideas promise cost-effective ways to improve the hardness and wear resistance of materials, such as those used in gears or dies, in an environmentally benign plasma process. This project maintains and enhances plasma physics and pulsed-power competencies at Los Alamos, critical areas underlying many of our defense missions. It also supports the development of improved materials for enhanced nuclear weapons safety and a process for the decontamination of the surfaces of equipment used at sites like Rocky Flats. This latter application is now under license to a small business.

A final indication of the potential of the Laboratory's technology for industry is our record of R&D 100 Awards. This year our researchers picked up six of these awards at the ceremony in Chicago in September, for a total of forty-four over the past eight years, far more than any other institution or company in the world.

One of the R&D 100 Awards this year was for the invention of a new, nonsurgical treatment for some common prostate problems. Noncancerous enlargement of the prostate gland affects more than half of all men past the age of fifty and three-quarters of all men over seventy-five. Laboratory scientists, working with Indigo Medical Inc. of Palo Alto, California, have invented a new, nonsurgical way to treat this disorder. The Indigo 830 combines a compact laser with a fiber-optic laser-light-delivery needle that evenly heats excess prostate tissue causing the prostate to shrink over a period of weeks after treatment.

Working with industry is not an option for the Laboratory but a business necessity. The nation's research and development enterprise will be strongly networked in the future, and our laboratory must be an integral part of that network. This participation is especially necessary in the era of science-based stockpile stewardship, in which we can no longer rely on underground nuclear test results, but must benchmark our science and technology against the world's best. To be the best in science, we must work closely with universities. To be the best in technology and the application of science, we must work closely with industry.

University of California Relationship

The Challenges of a Performance-Based Contract

Part of the University's new contract in 1992 was a significant departure from previous contracting practice. A number of specific performance measures were written into the contract along with a process for updating those performance measures. This approach, now known widely as performance-based contracting, was pioneered in the Department of Energy by the University and is beginning to show significant benefits. By providing clear expectations, performance measures reduce ambiguity and increase accountability. The process of identifying measures helps clarify and prioritize expectations. By paying attention to the important issues of performance that concern the Department, we have improved our relationship with our customer and improved the quality of our operations across the board.

Performance in Science and Technology

A key component of the University's annual assessment of the Laboratory involves an evaluation of the quality of our science and technology, the Laboratory's primary product. The University of California President's Council is charged with conducting the review and preparing a report of its findings and recommendations. The primary basis of this assessment is review by external peers. At Los Alamos we have established fifteen peer-review committees, one for each of our technical divisions. From results of the peer reviews, the President's Council judged the quality of the Laboratory's science and technology to be excellent to outstanding. Given the high academic research standards of the University of California, we take great pride in this endorsement of Los Alamos as a premier scientific institution.

To provide counsel regarding those factors that may influence our ability to meet future challenges, the President's Council also undertook an institutional-level assessment of the Laboratory. The assessment evaluated our performance in areas that affect the current climate for conducting science and technology and areas that influence our future. Again, the President's Council found many positive indicators. The council noted that our core mission was well conceived and viable and that we have the core competencies to support our mission and its attendant programs. The council was also "gratified that the morale of the Lab staff is so positive" in light of many negative influences and pressures on the Laboratory and recognized our "concerted efforts to raise and keep morale as high as possible." Our efforts to increase university collaborations, particularly those with the University of California were also recognized.

The President's Council also noted areas that would benefit from increased management attention, including more effective ties between the Laboratory's program offices and divisions. We are addressing this issue. With respect to factors that influence our future, the council noted that we are doing an effective job of tactical and strategic planning, that we are involving our staff in these efforts, and that the plans are realistic and flexible. The council was also pleased that we had made changes in the way we allocate our discretionary resources, funds that are critical for establishing the foundations for our future.

The science and technology assessment process has become an important part of the management of the Laboratory. As the Department of Energy has gained experience with the process, it has become more engaged and is using the information from the University and the review committees as the foundation for its assessment of the laboratories. We believe that this interaction has resulted in a much more credible and meaningful assessment of the Laboratory. The past assessment, in particular, saw greatly improved communication and cooperation among the Department's operations and area offices, the University, and the laboratories. Our peer-review committees, with the President's Council and its panels, have provided much valuable advice and insight. The information gained from independent and impartial review is of great benefit in helping us make decisions about appropriate new directions for the Laboratory.

Performance in Business Operations

Laboratory performance for FY 1995 in operational areas shows marked improvement over the performance evaluations in FY 1994 and FY 1993. As we entered into the new contract in 1992, we envisioned the evaluation process described in Appendix F of the contract as a mechanism to measure contract compliance, but we have gained much more. Appendix F has

Los Alamos National Laboratory Performance in Business Operations, FY 1993–FY 1995

Functional Area	Performance Results, Adjectival Ratings* FY 1993	FY 1994	FY 1995	Change 1993–1995
Laboratory Management	NR	NR	E	–
Operational Support				
ES&H	M	M	E	M to E
Facilities Management	NR	M	E	M to E
Safeguards and Security	NI	E	FE	NI to FE
Administrative Support				
Financial Management	E	M	E	M to E
Human Resources	M	M	M	–
Information Management	NR	NR	E	–
Procurement	E	E	E	–
Property Management	U	M	E	U to E
Cumulative	M	M	E	M to E

*NR—Not Rated
U—Unsatisfactory
NI—Needs Improvement
M—Meets Expectations
E—Exceeds Expectations
FE—Far Exceeds Expectations

become the cornerstone of performance-based management for the current contract and the model for the entire complex. Last year, we experienced significant improvements in the working relationships among the Department, the Laboratory, and the University, which led to improvements in the evaluation process. The performance measures in Appendix F also help minimize the costs associated with intrusive oversight. The table shows how the University rated our performance the past three years. The Department has generally concurred with these evaluations, increasing its concurrence over time. The results reflect significant improvement in performance and demonstrate the effectiveness of performance-based management.

Technical Interactions

Los Alamos continued to increase the number of collaborations with University campuses this past year, with strong support from the Office of the President. A major part of that increase was made possible by University of California Directed Research and Development (UCDRD) funds. We are using UCDRD funds, provided from the contract management fee, to enhance our collaborations with the campuses in technical areas that are important to the future of the Laboratory. Three types of activities are supported with UCDRD funds: the Collaborative University–Los Alamos Research (CULAR) Program, the Visiting Scholar Program, and Research Partnership Initiatives.

The CULAR program supports peer-reviewed collaborative research activities between Los Alamos and a University campus. There are now fifteen projects with an average of 80 percent of the funds going to the campuses. In addition, there are twenty-one active Los Alamos Collaborative Research projects, now funded by Laboratory Directed Research and Development funds. The Los Alamos collaborative research projects will be phased out at the end of 1997, but we anticipate that the CULAR program will increase to allow an approximately constant level of investment.

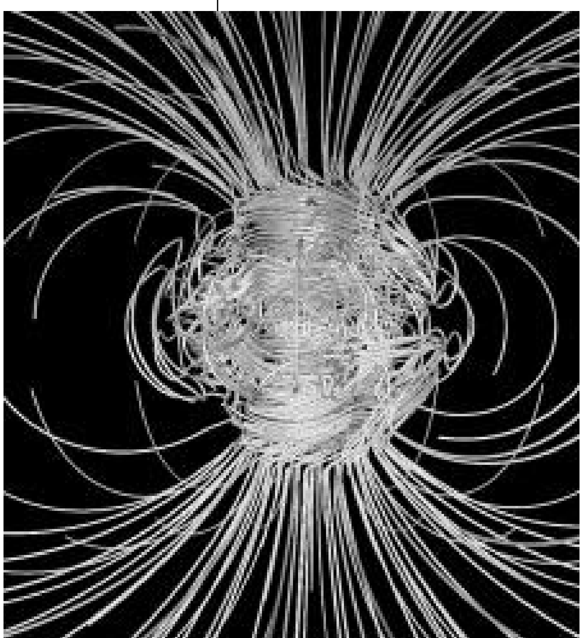
The Visiting Scholar Program supports University faculty in research at Los Alamos or supports Los Alamos staff in research and related teaching at campuses for a period of six months to a year. A small pilot program has begun with the visits slated to start next spring. The first participants have been selected, and the first regular call for proposals for visits to start during the next academic year has been issued.

Research Partnership Initiatives provide seed funding to build collaborative activities that have the potential for attracting external funds and becoming self-sufficient. Twelve types of initiatives received funds. These activities are in three Los Alamos core competencies: earth and environmental systems; nuclear science, plasmas, and beams; and nuclear and advanced materials.

Our continuing participation in the Institute for Geophysics and Planetary Physics (IGPP) continues to reap benefits. One of the activities that grew in part out of IGPP was highlighted in the 1993 Report to the Regents. LIDAR measurements that we made during the Central Equatorial Pacific Experiment attracted significant interest from the global-climate community. In 1995, UCDRD supported a collaborative effort to publish scientific results based on the LIDAR data and to make the database easily accessible to the scientific community.

Two collaborations that were also supported in part by IGPP garnered international recognition in

1995. A team led by Tim White of UC–Berkeley discovered the fossils of the oldest known hominid. Los Alamos geologists provided field and geochemical support and helped in dating the related geologic strata at the hominid site in Ethiopia. Another collaboration focuses on modeling the Earth's geodynamo (described previously in this report). The team from Los Alamos and UC–Los Angeles achieved the first successful modeling of the reversal of the Earth's magnetic field.



Lines of force of the magnetic field within the Earth. Convection in the liquid core generates the field.

A collaboration involving UC–San Diego, UC–Riverside, UC–Santa Barbara, other universities, and Los Alamos led to the first evidence for neutrino oscillations. Researchers carried out the measurements with the liquid scintillation neutrino detector at Los Alamos. This work was also described previously in this report. UCDRD funds supported additional run time on the accelerator and continued involvement of the University faculty members.

Los Alamos participated with other University-operated laboratories and campuses in the creation of the new Institute for Nuclear and Particle Astrophysics and Cosmology. We anticipate that the institute will encourage efforts to attract external funding for collaborative work that bridges the disciplines of nuclear physics, particle physics, astrophysics, and cosmology.

Los Alamos is working with the University to identify programmatic areas for interaction where a University-wide effort could affect issues important to the State of California and the nation as a whole. Many candidates have been proposed, including waste management, clean manufacturing, earthquakes, atmospheric particulate pollution, and water management. We have worked with the campuses and other laboratories to collect information about each area, and the time is near for selecting the final two or three to receive special attention from the University system.

Technical collaborations between the Laboratory and University faculty are extensive. In 1994, University faculty members and Los Alamos staff jointly authored 153 refereed publications. This amounts to about 22 percent of all of the papers jointly published by Los Alamos staff and faculty members from all U.S. universities and more than 10 percent of all the refereed papers published by our staff.

INSTITUTIONAL ISSUES

"Each institution in the U.S. Government should be continually challenged to renew. This is not the natural talent of government."
Robert W. Galvin

POSITIONING THE LABORATORY FOR THE FUTURE

Renewal of our Laboratory is necessary not only because of extraordinary geopolitical changes symbolized by the fall of the Berlin Wall in 1989 but also because of dramatic changes in public accountability and our business environment. Renewal will result in a sharper programmatic focus for the Laboratory and increased productivity so that we can deliver more science and technology for every dollar we receive from the federal government.

With the collapse of the Soviet Union, our compelling national mission changed from the development of nuclear weapons to *reducing the global nuclear danger.* This mission is supported by a sound science and technology base, complemented by carefully selected civilian programs and industrial collaborations, to round out our vision of the future. This vision provides the necessary compass to guide us as we face the difficult job of reorienting internal priorities.

We feel a great sense of urgency in renewing our institution. The dramatic change in our operating environment was brought home with the Department of Energy Tiger Team inspection in the fall of 1991, which followed the much publicized shutdown of the Department of Energy's Rocky Flats plutonium plant in June 1989 because of environment, safety, and health concerns. The Tiger Team inspection of every aspect of our operations by 167 inspectors for seven weeks served as a wake-up call for our Laboratory. We realized that we would have to excel not only in what we did, our traditional role in science and technology, but in how we did our work. In 1992, I reported that we also needed a business revolution so that we could give the nation the greatest value for its money while we continued to solve critical technology problems. We had begun our quality journey by recognizing the need for change.

We continued by studying the best business practices and quality techniques of other organizations. In particular, we looked to Motorola, to AT&T, and to Milliken for lessons in implementing change at the Laboratory and incorporating quality principles into our work. We sought to learn from industry what we could and then apply those lessons to our own situation, that of a first-class research and development institution. The primary lessons learned were to

- create a shared vision with our employees,
- look to the customer to define quality, and
- look to and empower our employees to achieve our shared vision.

We proceeded by developing what we call a customer-focused, unified laboratory.

As we looked at our processes and practices, we found that a hierarchical organizational structure stood in the way of empowering our employees and of providing effective communication. Therefore, in the fall of 1993 we radically overhauled the upper and middle management structure of the Laboratory. We removed a complete layer of management and reduced the overall number of managers by nearly half in senior positions and by more than one-quarter in all management categories. The University's early retirement program (VERIP III) greatly facilitated this management transition. As a result, we are now operating with a very flat structure with only three layers of management, many new faces, and a more diverse management team.

Reinvigorating Our Mission

Our main institutional thrust in 1994 was to reinvigorate our mission—to develop that shared vision of the future. As the nation and the world celebrated the end of the Cold War and the collapse of the Soviet Union, a strong drive to collect on the peace dividend emerged. The pressures on our Laboratory were in the direction of defense conversion—with emphasis on civilian and industrial missions. However, the revelation that followed the Gulf War of early 1991, that Saddam Hussein had very nearly succeeded in developing a nuclear capability, brought the realization that the global nuclear danger was not just from the Soviets. Examining our role in the history of the nuclear age and the responsibility with which we carried out that role, we began to redefine our mission.

The establishment, in February 1994, of the Galvin Task Force on Alternative Futures for the Department of Energy National Laboratories, reporting to the Secretary of Energy Advisory Board, drove this process even further. The visits of the task force to the Laboratory, and indeed the entire Galvin Task Force process, coupled with our own strategic planning process, helped focus our attention on the need to clearly define and articulate our mission to our employees, to our stakeholders and customers, and to the nation at large.

The inquiries by the Galvin Task Force about our role within the Department's laboratory structure forced us to confront this issue in clear terms. As a result, we developed a newly clarified sense of purpose, one that recognized our unique role in the world and one that reemphasized our commitment to excellence in science and technology in service to the nation.

The release of the Galvin Task Force Report less than a year ago did much to accelerate the pace of change. The report validated the Los Alamos role in *reducing the global nuclear danger* and the broader role of the Department's laboratories, including Los Alamos, in conducting the nation's research and development. More important, coming as it did close on the heels of last November's dramatic shift in the political scene in Washington, the report brought home to the Department the need for change. The Galvin Task Force Report concluded that the Department's system of governance was "broken and should be replaced with a bold alternative." The symptoms of this failure were several, but they included high overhead costs, inadequate mission focus, and outdated management systems at the laboratories, as well as institutional fragmentation, inordinate focus on compliance issues and process at the expense of product, and an inability to recognize excess research and development capacity on the part of the Department.

The report laid much of the blame for the situation at the feet of the Congress and the Department of Energy.

Much has changed since the release of the Galvin Task Force Report, but much is still to be done. Although the Department and the Congress have largely rejected the Galvin Task Force call for a bold alternative governance for the laboratories, the Department is moving to address many of the problems that led to that proposal. It has announced a strategic alignment initiative that has the potential to address many of the governance problems internal to the Department. With the strong support of the President, the Department has clarified its goals for the nuclear weapons program and has committed itself to a strong, science-based stewardship approach that will support continued excellence at the weapons laboratories. The Laboratory Operations Board, with strong external representation, was established and is pressing the Department and the laboratories to become more efficient and effective.

After the Tiger Team's visit, we noted that with increasing third-party regulation of our activities, brought about by a series of court decisions not directly involving the Laboratory, the Department's prescriptive regulation and oversight were stifling real progress, adding immeasurably to our costs, and failing to produce the desired results. Efforts to institute risk- and cost-based management to environmental, safety, and health issues were stymied by a reluctant bureaucracy. Today, with the guidance of the Committee on External Regulation of Department of Energy Nuclear Safety, the nation is moving toward legislation that may result in the end of Department of Energy regulation of the laboratories. We would be like other industries, regulated on the basis of our performance. This initiative, if implemented by appropriate legislation, will effectively reduce our bureaucratic costs.

For our part, last year we followed up on our mission redefinition by developing a series of tactical goals to help position the Laboratory for the future. These goals cover both programmatic and operational issues and will help define both what we do and how we do our work in the next century. We have begun working toward these goals, and the early indications are positive.

Workforce Productivity Project

Encouraged by the changes within the Department of Energy and driven strongly by the increased concern of our staff about bureaucracy and costs, we embarked on the Workforce Productivity Project in the summer of 1995. From my own testimonies to congressional committees, it had become clear that securing a healthy future for the Laboratory required the ability to demonstrate not only that we had a compelling national mission but also that we spend the taxpayers' money effectively. We have to demonstrate that government organizations, just like the private companies, are serious about reducing costs and increasing productivity. Working with the Department of Energy, we are trying to take some of the unproductive, bureaucratic work out of the system and to reduce our overhead costs by eliminating positions no longer required.

Enhancing productivity has many facets. From our interactions with many private-sector companies, we learned that eliminating unproductive work and reducing support functions and staff were imperative. We began by focusing on the ratio of employees who contribute directly to our product, science and technology, to those employees supporting them. We targeted an improvement of approximately 15 percent, from 0.94 to 1 to 1.1 to 1 by the fall of 1995. To accomplish this change, we had to terminate approximately 1,000 employees (500 University employees and 500 contractor employees). This process was extremely painful and was fought bitterly by some of the employees. The situation is exacerbated by the fact that the Laboratory is the largest employer in northern New Mexico. It was mitigated to some extent by the voluntary separation program we negotiated with the Department, which resulted in 252 University employees leaving for severance pay and educational assistance. We also continue to provide relocation assistance for former employees, and we are working with the Department to provide community assistance to cope with the loss of jobs in the area.

Our goal for this year is to focus on all aspects of productivity: increasing the ratio further to 1.3 to 1; increasing the time fraction that scientists, engineers, and technicians actually spend on technical work; and closely controlling all expenditures. To accomplish these goals, we are reengineering the work processes throughout the Laboratory to identify unproductive work and excess positions. We will do this deliberately and rely more on retraining where possible and on attrition instead of a major reduction in force.

Our efforts over the past five years are beginning to bear fruit. We are well positioned to address national needs in science and technology, and we are increasingly competitive with other providers of research and development. We know who we are, what we are about, and where we want to go in the future. We have a plan for getting there, and we have made progress in moving in the right directions. We also have a management structure in place and are continuing to drive a quality culture at the Laboratory. We expect to be the employer of choice and the national research and development provider of choice. We are well on our way to reaching that goal.

A New Approach to Operations

Environment, Safety, and Health

As pressure to operate the Laboratory more cost-effectively has increased, we have changed the way we operate our facilities and conduct our operations. We are emphasizing more teaming with the University and with the Department of Energy; greater interactions and openness with the public and regulating agencies; a more business-oriented approach; and greater emphasis on our social obligations in both the near and long terms. Our goal is to move away from a compliance-oriented approach to one in which compliance is a byproduct of excellence in the way we conduct ourselves. Activities in environment, safety, and health (ES&H) are highly visible to the public and to our customers in the Department of Energy; we must continue to improve our performance in this area. Aligning our services with customer demands will result in market-driven sizing of staff, with significant reduction in costs, while we still effectively meet our regulatory and social obligations.

We are reengineering the delivery of our services to become better aligned with the needs of the Laboratory. Currently underway is a deployment effort that fully integrates ES&H employees into facility management and operational projects. During the last year, a large step forward took place in the advancement of work standards for field-deployed radiological control technicians who were required to complete rigorous formal training leading to individual certification. Deployment of radiological team personnel to user locations is among the first deployment efforts at the Laboratory. Concurrently, we are working to maintain and optimize essential institutional functions and capabilities.

Performance Measures

We are using direct performance measures to improve ES&H services and reduce costs. In 1994, efforts to reduce waste streams exceeded the goal of 5 percent per year. The number of stacks that require continuous monitoring has been reduced from 100 to 33 over a two-year period. Solid wastes have been reduced by more than 33 percent from 1993 to 1994, and the Laboratory has reduced the total number of liquid waste outfalls by 24 percent since 1993.

Current dose optimization techniques ensure that all radiation exposures are as low as reasonably achievable (ALARA) and within legal limits, but they take social and economic factors into account so that costs involved do not outweigh the benefits. The ALARA radiation protection program has reduced the dose to individuals by over 60 percent from 1990 to 1994. Injuries and illnesses have been reduced in frequency and severity, reflected by a greater than 14 percent reduction in workers' compensation costs.

Standards-Based Management

The Department has traditionally regulated the ES&H aspects of work at its laboratories through a complex system of policies, orders, and rules. The Department is now developing an integrated standards program that will provide a basis for enhanced protection of employees, the public, and the environment. A key element in the program is a "necessary and sufficient" process, which starts with an analysis of a particular work activity and its potential hazards and leads to the adoption of appropriate standards for that activity. During 1995, Los Alamos was selected to initiate a pilot program associated with radiation protection. We anticipate that understanding the requirements will lead to more effective and efficient work processes and significant cost savings throughout the Department of Energy complex.

Another aspect of the cost-effectiveness of performance measures involves Department of Energy oversight responsibilities. The Department, the University, and the Laboratory completed a two-week pilot assessment of ES&H in November, using mutually agreed upon performance measures. The success of the pilot inaugurates an oversight process that dramatically reduces the number and associated costs of external Department of Energy appraisals based on confidence in Laboratory self-assessments performed as part of the University contract.

Technology Development

To more efficiently meet its obligations to protect the environment and the health of Laboratory employees and the public, the Laboratory has initiated an applied technology development program to address special problems at Los Alamos. Initiated in FY 1994 and expanded in FY 1995, this program expedites development, evaluation, and application of new technologies to reduce risks. Initial efforts have focused on neutron dosimetry, air monitoring for exposure assessment, and protection for glove box workers.

We have successfully collaborated with faculty members from the UC–Los Angeles and UC–Berkeley Schools of Public Health to initiate a joint multiyear research study to better address issues of hazard surveillance in the defense nuclear industry and industrial settings. This is one way the Laboratory and the University can use their complementary expertise to solve ES&H-related problems of Department of Energy, local, and national interest and concern.

Facility Management

As part of the restructuring of Laboratory management, most responsibilities for facility management have been distributed to the technical divisions. The consolidation and restructuring of the work performed within facilities is more closely aligned with programmatic needs. We have begun efforts to reengineer for operating efficiencies that present major opportunities for significant cost reductions in FY 1996.

Our preliminary efforts at reengineering the delivery of facility services show promising results. For example, the redesign of the “small-job ticket process” has shown the potential to reduce the number of steps from 40 to 10; the number of handoffs across various departments from 8 to 2; and the time to complete the process from 21 days to 2 days. Implementing these redesign efforts will produce very competitive service delivery.

The Laboratory has also steadily improved its safeguards and security performance. In the 1993 Department of Energy annual survey, six of eight major topical areas were rated marginal. In the 1994 survey, six of the eight were rated satisfactory; in the 1995 program review, all topical areas rated less than satisfactory in the 1994 evaluation were upgraded to a rating of satisfactory.

Diversity

Affirmative action and related diversity issues drew considerable national and local attention during 1995. In concert with the University’s evaluation of affirmative action practices, the Laboratory reviewed its policies and position. The Laboratory, which is governed by federal regulations, reaffirmed for our concerned constituents that potential changes in the University’s practices would not affect our affirmative action policies supporting the hiring and retention of employees. The Laboratory, like the Regents and the University, remains committed to having a diverse workforce. We are committed to increasing opportunities for underrepresented groups, particularly residents of northern New Mexico. A group of New Mexico state legislators met with representatives of the University last summer to discuss their concerns about the Laboratory’s diversity practices.

To that end, the Laboratory engaged in a year-long diversity strategic planning process. Begun in September 1994 and completed in October 1995, the diversity planning process included extensive stakeholder participation and review. The resulting plan focuses on objectives and strategies for improving diversity in five key Laboratory areas: workforce; technology transfer; subcontracting; science education outreach; and community involvement and outreach. Priorities for FY 1996 include using strategic recruitment to increase the number of women and minority employees in the Laboratory’s scientific and technical areas, improving employee communication on diversity issues, and establishing a comprehensive career development program so that all employees (including women and minorities) may more effectively compete for positions of increasing responsibility. To support these important efforts, we established a new senior-level Laboratory Diversity Office in October 1995. This office reports to me and is charged with leading the Laboratory’s diversity program as outlined in the strategic plan.

National Environmental Policy Act

In August 1994, the Department of Energy announced its intention to prepare a new sitewide EIS for Los Alamos to provide a comprehensive and cumulative look at the environmental impacts of both ongoing Laboratory activities and projected activities and operations foreseen within the next five to ten years. This EIS will enable the Laboratory to become a better steward of the environment and will be useful as a planning tool.

An EIS for the DARHT facility (DARHT was discussed more fully in the section on National Security Needs) was completed in record time, a little over ten months, a success that could not have been accomplished without a teaming partnership between the Department, the Laboratory, and the University. In part because of the extreme importance of the project, and in part because of the visibility engendered by the citizen lawsuit, which resulted in the DARHT project being enjoined, the DARHT EIS, more so than any other Department EIS in recent memory, has claimed the attention of individuals in the highest levels of government and has received high praise from the Department of Energy and the Department of Justice.

Outreach and Openness

Since the March 1993 Regents Oversight Committee meeting with Native American leaders and concerned citizens of northern New Mexico, we have made significant progress in how the Laboratory conducts its outreach and involvement activities and have institutionalized the practice of seeking and considering the opinions of our stakeholders. The Laboratory has formalized partnerships with neighboring Native American tribes by implementing cooperative agreements aimed at developing and enhancing relationships, primarily on environmental matters. A pueblo accord advisory group met twice in 1995 to help implement the accords and cooperative agreements and to foster improved communication and cooperation. We have completed the establishment of the Northern New Mexico Citizens Advisory Board in cooperation with the Department of Energy. These successes earned the Laboratory a Platinum 1995 Department of Energy Team Quality Award for improvement in community involvement and outreach.

In July 1995, the Laboratory merged key community outreach and stakeholder participation functions in a new office to improve the coordination of involvement and outreach functions, serve customers and stakeholders better, and reduce costs. The new structure continues to focus on tangible initiatives, such as one in which the Laboratory and the Northern Rio Grande Intergovernmental Council—an organization of regional local and county elected officials—have agreed to enter into a cooperative agreement aimed at addressing issues of mutual interest, such as diversity. The Laboratory Outreach Information Center initiative has also proved successful, with the first office opened in Taos in September 1995, and a second one in Española in December 1995. A third center is being created in Los Alamos through expansion of the Laboratory's existing community reading room. Efforts to offer economic assistance to our neighbors resulted in over $20,000 in university scholarships being awarded to students from communities and Native American tribes throughout northern New Mexico.

Human Radiation Experiments

Because of its unique historical position, the Laboratory played a major role in the heavily publicized evaluation of human radiation experimentation by the Department and its predecessors, contributing almost 30 percent of the funding for the entire effort to review human radiation experiments. As a result of this evaluation, we are working on major changes to improve access to historical records and archives for scholarly review and to facilitate the release of information about our activities to the public. Recognizing our responsibilities and historical position, we also prepared a tutorial volume of *Los Alamos Science* on radiation and its effects and on the larger issues of human experimentation and the legacy of these experiments at Los Alamos. We expect that this publication will do much to educate our employees and the public on radiation issues and in clearing the air of questions about the role and motivation of Laboratory scientists involved in these experiments.

AWARDS AND HONORS

Each year, many Laboratory employees are recognized in various ways for their professional achievements. They receive specific awards, prizes, and honorary appointments made by professional groups, which judge the most deserving candidates. Professional organizations and institutions usually recognize the outstanding achievements of their members by electing them to an honorary rank and by bestowing prizes for these achievements. Academic institutions may bestow professorial appointments or grant honorary degrees. The administration of professional organizations is entrusted to those members who have achieved a high level of respect from the membership. All these honors reflect high levels of achievement by the recipients.

The complete list of Laboratory employees honored during 1995 is too long to be included here. This partial list is intended to demonstrate the range of achievements and professional involvement of our staff.

Nobel Prize

Fred Reines, Professor of Physics Emeritus at UC–Irvine, received the 1995 Nobel Prize for Physics. Reines, who joined the Laboratory in 1944, was honored by the Royal Swedish Academy of Sciences for his discovery, with the late Clyde Cowan and others, of the free neutrino. The discovery was made possible by the development of large liquid scintillation detectors at Los Alamos.

E. O. Lawrence Award

Laboratory chemist Greg Kubas received the E. O. Lawrence Award, one of the most prestigious awards bestowed by the Department of Energy. Kubas was recognized for his discovery of a new type of chemical bonding, which has revolutionized the way scientists think about how hydrogen interacts with metals and has improved the prospects for hydrogen's use as an energy source.

Honorary Degrees and Election of Fellows

Awarded by External Organizations—Laboratory scientists Terry Mitchell and Frank Gac were granted a University of Cambridge honorary Doctor of Science degree and a University of Missouri–Rolla honorary degree in ceramic engineering, respectively. About twenty Laboratory employees were elected to the rank of fellow by various professional organizations. Among them were Larry Wardlow, Hugh Smith, and Harry Ettinger, who became Fellows of the American

26812

Fred Reines examines Herr Auge, the liquid scintillation detector at Hanford, where the team led by Reines first detected the free neutrino. Reines received the 1995 Nobel Prize for Physics for the discovery of the neutrino.

Academy of Physicians Assistants in Occupational Medicine, the American College of Preventative Medicine, and the American Industrial Hygiene Association, respectively. Robert Ecke, Susan J. Seestrom, and Richard Sheffield became Fellows of the American Physical Society. Kay Adams was elected a fellow by the International Women's Forum, and Alan Graham was awarded the Gledden Senior Visiting Fellowship by the University of Western Australia. Kenneth Hanson and John Petrovic were elected Fellows of the Society of Photo-Optical Instrumentation Engineers and the American Society for Materials, respectively.

Awarded by the Laboratory—In 1995 eight technical staff members were appointed Laboratory Fellows in recognition of their outstanding achievements in a variety of scientific disciplines. The newly appointed fellows are Jill Trewhella, Daniel Strottman, John Petrovic, Albert Migliori, John Kammerdiener, James Jett, Gary Glatzmaier, and Albert Charmatz. The number of Laboratory Fellows who are also regular employees is limited to about 2 percent of the Laboratory's technical staff members and thus represents a very select group. Since the inception of the fellows program in 1980, only 117 technical staff members have been honored with the rank of fellow.

R&D 100 Awards and Industry Week*'s 50 Stars*

In 1995 the Laboratory won six R&D 100 Awards. This international awards program, sponsored by *R&D Magazine*, honors the top 100 technical advances of the past year. These technologies are nominated in an open competition and selected according to technical and commercial criteria. This is the third time the Laboratory has won more of the R&D 100 Awards than any other institution. It brings the Laboratory's total to forty-four awards in the past eight years, one-third more than any other organization during this period.

John Petrovic, a Laboratory Fellow in the Materials Science and Technology Division was chosen as one of *Industry Week*'s 50 research and development "stars."

Laboratory Distinguished Performance Awards

These awards, made by the Laboratory to its own employees, recognize individuals or teams for job performance above and beyond that which is normally expected. In 1995, the awards were presented to thirteen individuals, three small teams, and four large teams. Among the teams recognized were the Thick Superconducting Film Team, the Laboratory-to-Laboratory Project for Nuclear Material Control in the Former Soviet Union, and the C-141 Aircraft Armor Development Team.

Laboratory Fellows Prizes

Three Laboratory scientists, Jill Trewhella, Robert Benjamin, and Chris Hammel, were each honored with the Laboratory Fellows Prize for their research and contributions to their scientific disciplines.

Achievement Awards from External Organizations

Laboratory employees received 35 achievement awards of various types from nongovernmental professional organizations external to the Laboratory. Among the recipients were the following: Robert Penneman received the Glenn T. Seaborg Award for his outstanding accomplishments and meritorious achievements in actinide separation science; Deirdre Ragan, a graduate research assistant in the Materials and Chemical Design Group working toward her doctorate at UC–Santa Barbara, received a Fulbright Fellowship for studies in Sweden; Gerry Wood received the American Industrial Hygiene Association's John White Award for his research publication, "Service Life of Organic Vapor Cartridges"; Computing, Information, and Communications Division personnel received the Computerworld-Smithsonian Award for their development of the Parallel Ocean Program; Yuri Taranenko received the American Geophysical Union's F. L. Scarf Award for outstanding dissertation research in solar-planetary science; and Charles Bathke received the American Nuclear Society's Outstanding Technical Accomplishment Award for his work in the field of fusion energy.

Appointments and Elective Offices in External Organizations

Thirty Laboratory employees were elected to administrative positions in external professional organizations or appointed to advisory posts during the year. Among them were Larry Wardlow, who became the president of the American Academy of Physicians Assistants in Occupational Medicine; Joe Thompson and Harry Crissman, who became councilors of the American Physical Society and the International Society of Analytical Cytology, respectively; Larry Hersman, who became president of the New Mexico branch of the American Society for Microbiology; Morton Bradbury, who was appointed to the advisory boards of the Advanced Light Source and the X-Ray Microscope facilities at Lawrence Berkeley National Laboratory; and Charles Bathke, who was elected to the executive committee of the Fusion Energy Division of the American Nuclear Society.

Twelve Laboratory employees were appointed editors or to serve on editorial boards of professional publications. Among them were Scott Cram and James Freyer, who became associate editors of *Cytometry* and the *International Journal of Radiation Oncology, Biology and Physics*, respectively, and Harry Crissman, who was appointed to the editorial boards of *Cancer Molecular Biology*, the *European Journal of Histochemistry*, and *Cytometry*.

Twelve Laboratory employees were appointed to adjunct positions at various universities. Among them were Thomas Terwilliger, who was appointed an associate member of the UC–Los Angeles Laboratory for Structural Biology, and Thomas Whaley, David Chen, and Walker Wharton, all of whom were appointed adjunct professors at the University of New Mexico.

Awards from Governmental Agencies

Approximately 100 employees were recognized for outstanding achievements by various governmental agencies, including the Department of Energy, the Department of Defense, the Environmental Protection Agency, the National Aeronautics and Space Administration, the National Science Foundation, the International Atomic Energy Agency, and the State of New Mexico. Among the honors were numerous Department of Energy Weapons Program Recognition of Excellence Awards; Special Merit Recognition for Military Applications and Stockpile Support; and a National Aeronautics and Space Administration Public Service Group Achievement Award. The State of New Mexico gave its Distinguished Public Service Award to Laboratory engineer Joseph Garcia. The first-place Environmental Protection Agency Region VI Administrator's Environmental Excellence Award was conferred on Philip R. Fresquez for "contributions to and support of beneficial use of biosolids research activities."

Patents

In 1994, 49 patent applications were filed and 37 patents were awarded to Laboratory employees. In 1995 the corresponding numbers are 71 and 30.

Los Alamos Industrial Partnership Recognition Awards

The Laboratory recognized fifty-nine Laboratory researchers and industrial specialists for their work in transferring Los Alamos technologies to the private sector. The awards honor Los Alamos staff members who have made outstanding contributions to the promotion of technology that will improve the economic, environmental, or social well-being of the United States, while at the same time directly supporting the Laboratory's mission.

BUDGET AND STAFFING

Funds to operate the Laboratory come from the Department of Energy, the Department of Defense, various federal agencies, and other organizations in the private and public sectors. These funds support a broad range of research and development activities that reflect national priorities. As these priorities change, the Laboratory and its sponsors adjust the budgetary allocations for specific programs.

Environmental restoration, waste management, and corrective action funding comes from Department of Energy Defense Programs.
The budget for nuclear weapons research, development, and testing has stabilized somewhat. The Department provided, directly or indirectly, 88 percent of our operating funds in FY 1995; the Department of Defense provided 6 percent, with other organizations and agencies providing the balance.

Delays in setting budgets for this fiscal year have increased the uncertainties in our estimates for FY 1996.

Resource Estimates—FY 1994–FY 1996

	Funding ($M)			Personnel (FTE)		
	FY 1994	FY 1995	FY 1996	FY 1994	FY 1995	FY 1996
DOE Defense Activities	515	523	606	3,380	3,660	3,790
Environmental Restoration, Waste Management, and Corrective Actions*	217	210	138	1,070	910	520
DoD and Intelligence	100	85	81	600	510	480
Energy Research and Technology	243	278	227	1,970	2,060	1,760
Total	1,075	1,096	1,052	7,020	7,140**	6,550

**Much of the funding for environmental restoration and waste management will cover contract labor and goods and services.*

***There were 7,005 FTEs on board as of October 1, 1995; there were 7,144 average FTEs through September 1995.*

SUMMARY

The year 1995 was extraordinary for Los Alamos. We celebrated the fiftieth anniversary of the Trinity test and the end of World War II, to which our Laboratory contributed so much. We were reminded that an institution such as ours must have a compelling national mission, and with the help of the Galvin Task Force, we formulated that mission as *reducing the global nuclear danger*.

President Clinton announced his decision to seek a "zero-yield" comprehensive nuclear test ban while underscoring the vital importance of nuclear deterrence to the security of the United States and the free world. In addition, he strengthened the foundation of the future of the nuclear weapons program—science-based stockpile stewardship, which will require the expertise of all three nuclear weapons laboratories.

We continued to demonstrate the importance of linking our defense work to university science and industrial technology. Our ties to the nation's universities, especially the University of California campuses, were strengthened. That critical link was recognized with the award of this year's Nobel Prize for Physics to UC–Irvine Professor Emeritus Fred Reines for his pioneering work while he was at Los Alamos in the 1950s. We continued that tradition with many articles in the most prestigious scientific journals. We also demonstrated the utility of our technology by winning six R&D 100 Awards and by entering into numerous CRADAs with American companies.

Finally, we undertook a bold action to increase the scientific productivity of our workforce after learning much from our industrial colleagues about their productivity and quality efforts. These actions, although painful and difficult for all concerned, will help to position the Laboratory as a continuing leader in the nation's science and technology community. As we continue to take action to increase our value to the nation, we strengthen our own institution and lay the groundwork for its future success. We will be able to continue to provide good jobs in northern New Mexico for a long time to come, while serving the nation under the proud stewardship of the University of California.

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Los Alamos
NATIONAL LABORATORY

Los Alamos, New Mexico 87545