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Los Alamos National Laboratory

A Profile

Laboratory visitors find information and assistance at the recently completed reception center

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Background and History

Los Alamos National Laboratory was established in 1943 as Project Y of the Manhattan Engineer District—the secret wartime program to develop the world's first nuclear weapons. A letter to President Franklin D. Roosevelt signed by Albert Einstein pointed out that "extremely powerful bombs of a new type may . . . [conceivably] be constructed" and that Hitler had stopped the sale of uranium from Czechoslovakian mines taken over by Germany. Roosevelt responded by appointing General Leslie Groves to take charge of an American nuclear effort. Groves, in turn, selected J. Robert Oppenheimer, at that time professor of physics at Berkeley, to head the group of thirty to one hundred scientists then believed needed to perform the research, develop the technology, and produce the actual bombs. In keeping with the tradition of academic freedom and openness that was cherished by Oppenheimer and his scientific colleagues, the University of California was selected to manage this crucial part of the program rather than industry or government itself.

Twenty-seven months later, that mission was completed in time to end the war against Japan without the necessity of an invasion. Many, including Oppenheimer, who had interrupted their lives and careers to work at Los Alamos returned to take up their previous concerns. But Norris E. Bradbury, who assumed the directorship of the Laboratory, felt there was much scientific work yet to be undertaken, and the University of Cali-

fornia agreed to continue managing the program in the service of the public.

Human, Physical, and Financial Resources

Under the leadership of Bradbury, of Harold M. Agnew, who succeeded him, and of Donald M. Kerr, the current director, the Laboratory has become one of the world's foremost scientific institutions. With 7,000 people, a figure that is not expected to increase significantly, it is the largest employer in northern New Mexico. The technical staff totals nearly 3,000 and represents most of the disciplines of science and engineering: 31 percent took their training in physics, 32 percent in engineering, 12 percent in chemistry, 9 percent in mathematics or computer science, and the remaining 16 percent in materials, earth, environmental, or life sciences. Slightly more than half hold doctors' degrees in their fields, and nearly a quarter more hold masters' degrees. In addition, the 4,000 personnel providing technical and administrative support represent many different professions and vocations.

During the 1984 fiscal year, the cost of Laboratory operations will exceed $580 million, of which $482 million is provided by the Department of Energy and nearly $100 million by other agencies. Activities funded by the Department of Energy include defense programs (amounting to $370 million) and a variety of other programs on basic research, nuclear fusion and fission, energy conservation, safety, the environment, and nuclear wastes. Such programs total $112 million.

In addition to the Department of Energy, the Laboratory applies its capabilities to the solution of problems for the Nuclear Regulatory Commission, NASA, the Departments of Defense, of Health and Human Services, and of the Interior, the Environmental Protection Agency, and several other agencies.

Set at an altitude of 7,300 feet on the Pajarito Plateau of the Jemez Mountains, the Laboratory's thirty-two technical areas occupy forty-three square miles of rugged terrain. The gross area of Laboratory buildings is 5,700,000 square feet, with a replacement cost estimated at $3 billion.

Defense-Related Programs

Defense programs continue to be the largest of the Laboratory's multifaceted activities. Under the Department of Energy's assistant secretary for defense programs, Los Alamos research and development include nuclear weapon activities, verification and control technology, safeguards and security of nuclear materials, nuclear materials production, and defense waste management. The primary goal of the nuclear weapons program is continued development of state-of-the-art warheads that are safer, smaller, more efficient, more reliable, and more survivable.

During the past five years, three new strategic warheads designed here, the W76 (Trident I), W78 (Minuteman III), and W80-1 (air-launched cruise missile) entered the national stockpile. Development continues on the B61 bomb, the W80-0 warhead for the navy cruise missile, and the W81 warhead for the navy standard missile II. The Laboratory was recently assigned responsibility for design of two new systems, the stand-off antisubmarine warfare weapon and the Trident II warhead. Two-thirds of the weapons currently in the nation's stockpile are Los Alamos designs.

For many years, the Laboratory has been engaged in a program of strategic defense research, or ballistic missile defense. In accordance with presidential policy, it consolidated and expanded existing research on neutral particle beams, free-electron lasers, electromagnetic rail guns, and the vulnerability and lethality of warheads.

As an integral part of nuclear weapons development, the Laboratory continues to conduct underground nuclear tests at the Nevada Test Site. In addition, it plays a leading role in organizing and staffing the nuclear emergency search team (NEST) for the Department of Energy, which is responsible for ensuring the prompt discovery of nuclear materials should any be lost or stolen.

The Laboratory's capabilities are applied also to several nonnuclear defense problems. Principal programs focus on advanced concepts for weapons, nonnuclear munitions, and low-intensity conflict. High-performance shaped charges and new naval torpedo warhead designs are examples of new concepts contributing to national security needs.

Among numerous applied research and development efforts supported by defense programs at Los Alamos is the inertial confinement fusion program, in which lasers deliver huge amounts of energy in billionths of a second for heating micropellets of fuel to create a fusion reaction. Primary emphasis here is the evaluation of carbon dioxide lasers as the driving force. The Laboratory pioneered the development of several such lasers; the latest, known as Antares, began operation in 1983 and is producing energy in the 35- to 40-kilojoule range, a sixfold increase over previous achievements.

The Laboratory continues to be deeply committed to developing verification technologies in support of arms control measures. Assessments of foreign technology, questions of technology transfer, and the ability to detect nuclear explosions underground, in space, and in the atmosphere are important components of this responsibility. Los Alamos has also developed instrumentation for on-site detection and verification of nuclear material inventories, and it offers regular training in safeguards technology for inspectors of the International Atomic Energy Agency.

After four decades, Los Alamos National Laboratory continues to pursue its multiple missions as national security needs evolve. Its commitment to the nation's security is strengthened by current trends toward improving national defense. As a consequence, the Laboratory is intensifying its efforts in nuclear weapon programs and in both nuclear and nonnuclear defense technologies.

Energy-Related Programs

An adequate supply of energy now and in the future is a vital national concern. At Los Alamos, a comprehensive program of basic research supports applied work in energy technology. Primary goals of the Laboratory's energy programs are to develop advanced nuclear fusion concepts and technology, the technology for nuclear fission reactors and fuel cycles, and alternative energy concepts.

For more than thirty years, scientists at the Laboratory have been investigating nuclear fusion as a source of energy, drawn by the appeal of its virtually unlimited fuel supply and its potential for environmental acceptability. Los Alamos is a leader in developing magnetic fusion technology as well as in heavy-ion inertial fusion. While supporting the national effort in magnetic confinement, the Laboratory's program focuses on advanced fusion concepts, such as the reversed field pinch and the compact toroid. The reversed field pinch experiment has exceeded its original goals, demonstrating self-sustainment of that configuration and promising a less expensive path to fusion energy as well as a potentially cost-competitive, compact reactor.

Other magnetic fusion projects include reactor system studies, investigations of reactor fuel at the tritium systems test assembly, and the design and partial construction of the accelerator that will test prospective reactor materials at the Hanford Engineering Development Laboratory. In addition, as lead laboratory in the new heavy-ion fusion program, Los Alamos works closely with Lawrence Berkeley Laboratory to develop experiments to test accelerators and targets.

Scientists at Los Alamos are continuing to develop the technology base needed to exploit nuclear fission as an energy source. As deputy project manager for nuclear technology in the SP-100 space reactor program, the Laboratory is working on advanced reactors and exploring possibilities for multimegawatt space power systems, for terrestrial defense reactors, and for power supplies for the new detection system that will replace the existing DEW line. The Laboratory also has an active program of nuclear waste management and is providing support for site characterization of a proposed high-level waste repository in Nevada.

Using Los Alamos computer programs to simulate potential fission reactor failures, scientists can predict the course of accidents, evaluate emergency systems, and determine corrective actions for any given reactor design. These programs show excellent agreement with small-scale experiments and have also proved valuable in analyzing the Three Mile Island accident.

Alternative energy programs include the development of a fuel cell that is potentially useful in either military or commercial vehicles. This program is being expanded for applications to conservation as well.

Producing geothermal energy from hot, dry rock has been a Laboratory program since 1970, and the Los Alamos effort is now supported also by government agencies of the Federal Republic of Germany and Japan. A prototype system demonstrated the technical feasibility of the concept; recently the program achieved a massive hydraulic fracture in a deep reservoir.

Los Alamos was one of the first national laboratories to investigate the use of passive solar energy for heating and cooling buildings. A major focus of this work is to determine performance efficiencies of residential designs for any part of the country. Computer models have been simplified for use with hand calculators and are available to the public, along with a handbook for passive solar design. The Laboratory's J. Robert Oppenheimer Study Center incorporates active solar heating and cooling concepts developed here.

Other Research Programs

Through its traditional multidisciplinary approach to solving problems, the Laboratory has evolved into an institution with research programs spanning the entire range of science. Its defense efforts often generate ideas and techniques that have wider applications. For example, the unique states of matter that are found in nuclear explosions demand innovative approaches to understanding such problems as particle transport. Los Alamos scientists originally developed Monte Carlo and discrete ordinates methods to answer these needs; those techniques have become fundamentals of computer modeling in many technologies.

Another defense research project that yielded significant scientific results is the Vela satellite program. Beginning in 1963, Laboratory instruments aboard these satellites monitored for nuclear tests in space. They also led to the discovery of a totally new class of astronomical objects and provided opportunities to study the solar wind and increase understanding of solar-terrestrial relationships, including the effects of the sun on earth's climate and weather. The cosmic x-ray record provided by these instruments is still yielding insights into some of the basic questions of physics.

Materials science has always been an integral part of the weapons program. Laboratory scientists increase their understanding of material properties by probing its atomic structure with ion beams. Research on electrically conducting polymers looks to the future; those exotic plastics now challenge the most esoteric theoretical approaches, but they may have wide practical applications in the future.

Los Alamos has long been a major producer of both stable and unstable (radioactive) isotopes. Besides shipping these versatile tracers all over the world—they are valuable tools in physics, chemistry, biology, medicine, and agriculture—Los Alamos scientists use them to study metabolism and genetic diseases.

In fact, the Laboratory is designated a national resource for stable isotopes, and for flow cytometry as well. Using flow cytometry, individual chromosome types can be identified and sorted. Their DNA is then cloned through recombinant DNA technology, so the genetic information is purified and concentrated, allowing detailed molecular analyses of individual chromosomes. Another international resource is the genetic sequence data bank (GenBank), which is cosponsored by the Departments of Energy and Defense, the National Institutes of Health, and the National Science Foundation. This data bank joins Los Alamos computer expertise—originally developed for weapons calculations—with molecular genetics to collect, organize, and analyze genetic data both for fundamental research and for applications in medicine and agriculture.

Current work in theoretical biology includes studies of cholesterol metabolism in tissue cells, the kinetics used by T-killer cells to interact with tumor cells and destroy them, and the fluid mechanics of cell

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motion and division. At the same time, Laboratory physicists are investigating the interactions of elementary particles and evaluating experimental tests of grand unified theories that seek to encompass the four natural forces: gravity, electromagnetism, and the strong and weak nuclear forces.

Interdisciplinary Research Centers and Major Resources

To foster scientific collaboration between the University of California and the Laboratory, the University established a branch of its Institute for Geophysics and Planetary Physics at Los Alamos in 1980. Projects include research in geophysics, atmospheric and space sciences, and related areas. Besides administering a program of grants, the Institute has sponsored conferences and workshops on a number of topics, including the Valles Caldera, mineral matter in peat, and interstellar migrations. At a recent conference, experts in anthropology, history, demographics, biology, astronomy, and space science studied the social and evolutionary implications of extended human presence in space.

Reflecting its commitment to interdisciplinary research and development, the Laboratory itself has established centers that encourage scientists from different disciplines to focus on particular problems. The Center for Nonlinear Studies investigates the dynamics of nonlinear systems, those characterized by sharp, unstable boundaries and erratic or chaotic behavior. Nonlinear behavior is characteristic of many natural phenomena, so understanding it will bring advances in a variety of fields.

The Center for Materials Science was established to enhance contributions to the Laboratory's defense, energy, and science programs, with significant efforts in condensed matter physics, metallurgy, ceramics, and materials chemistry. Materials engineering programs include processing plutonium and other critical elements, fabricating and analyzing many advanced materials, and preparing and studying high explosives.

Although not a research center in the strictest sense of the term, portions of the land occupied by the Laboratory are designated a National Environmental Research Park. They have been preserved from human encroachment, llowing scientists to track large mammals, study plant species, and determine the impact of the Laboratory and the townsite on the environment.

Among the Laboratory's resources is the half-mile-long linear accelerator known as the Los Alamos Meson Physics Facility. Primarily a tool for nuclear and elementary particle physicists, this accelerator was designed to provide a beam of protons of variable energy up to 800 million electron volts and an average current of one milliampere. It is a national asset available to qualified members of the scientific community worldwide and is used extensively for research in radiobiology, radiotherapy, and solid-state physics. The accelerator beam also feeds a weapon neutron research center used to study condensed-matter physics as well as to provide data on the physics of nuclear weapons. A proton storage ring will help develop this complex into a world-class center for neutron scattering research, open for experiments proposed by scientists from around the world.

In another technical area, the Laboratory operates a unique resource for studying, recycling, and purifying plutonium, the most complicated of the actinides.

Since World War II, the Laboratory has been one of the world's leading scientific computing centers. A system called the Integrated Computing Network links user terminals, communications and worker computers, and large-capacity storage and output systems into a sophisticated tool for workers in both theoretical and applied fields. Los Alamos scientists over the years have contributed significantly to design innovations and improvements of supercomputers produced by several companies and are now studying the problems of developing artificial intelligence. The Laboratory's computing complex currently includes two Cray X-MPs, four Cray-1s, and four CDC 7600 computers, as well as many smaller computers for both classified and unclassified work.

Another major resource is the J. Robert Oppenheimer Study Center. Among the significant technical collections in the country, the library includes 300,000 bound volumes and journals, and more than half a million reports from around the world. Except for classified material, this repository of scientific knowledge is open to any user, scientist or nonscientist alike. The building itself was designed as a place in which scientists and technicians from the Laboratory can meet with colleagues from industry, government, universities, and other laboratories worldwide in either classified or open sessions.

Other far-reaching cooperative ventures are the Laboratory's industrial and international initiatives. Several private companies participate in joint research, and flexibility in contractual arrangements encourages cooperation in future industrial applications of technology developed at the Laboratory. Cooperative international projects in support of the Caribbean Basin and Central American initiatives are progressing, with Los Alamos scientists conducting mineral and geothermal assessments of several islands and countries. Joint research with the Mexican Nuclear Research Institute and Mexican Petroleum Institute is also proceeding successfully.

With its many-faceted programs and its exceptional resources, Los Alamos National Laboratory is a valuable asset to the country and to science. From its earliest days under Oppenheimer's leadership to its present ties through the Institute for Geophysics and Planetary Physics and its research collaborations, the Laboratory's relationship with the University of California has advanced the nation's security, enhanced its energy options, and strengthened its scientific base.

Los Alamos National Laboratory, operated by the University of California for the U.S. Department of Energy, is an affirmative action/equal opportunity employer.

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