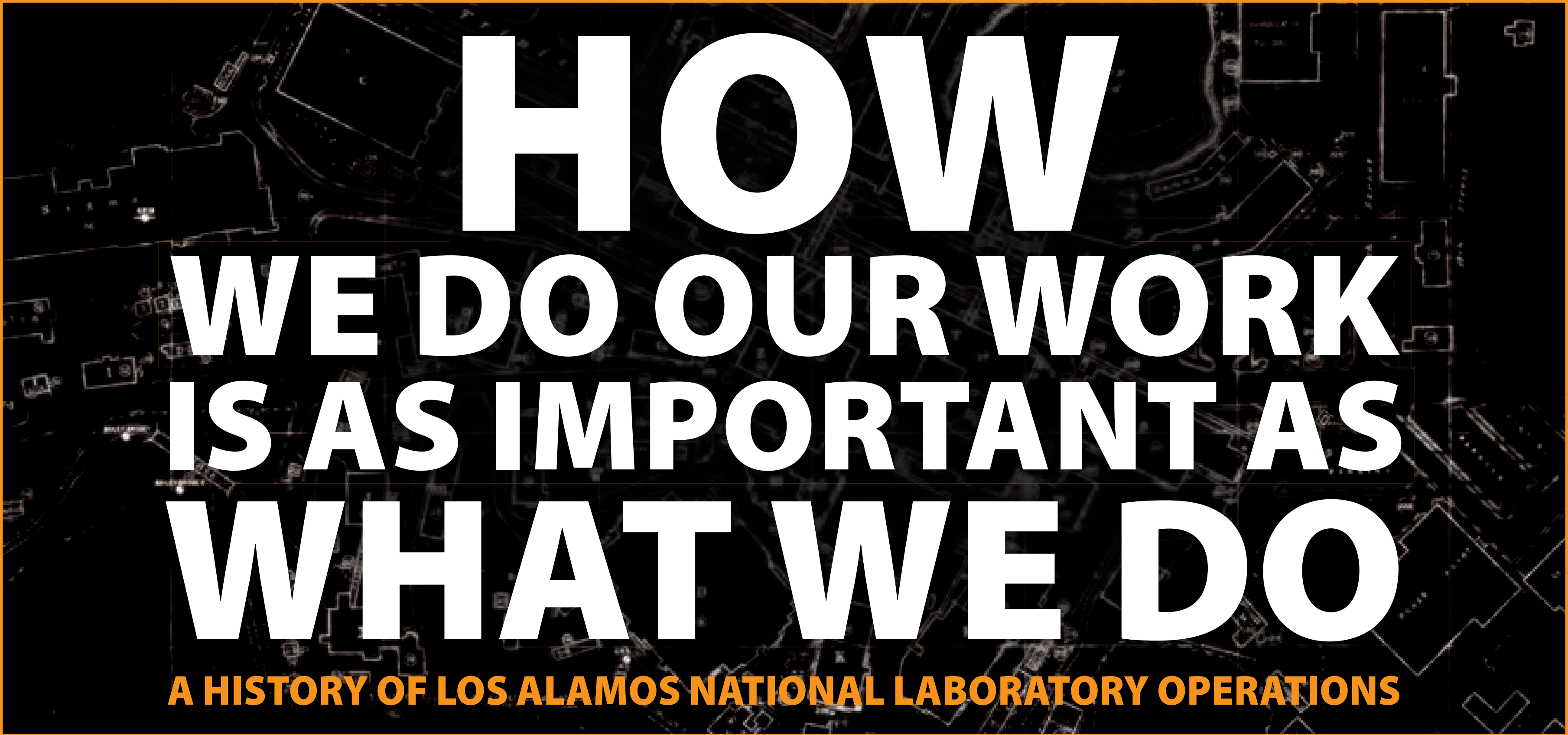

HOW WE DO OUR WORK IS AS IMPORTANT AS WHAT WE DO

A HISTORY OF LOS ALAMOS NATIONAL LABORATORY OPERATIONS

Rekha S. Pillai, PhD

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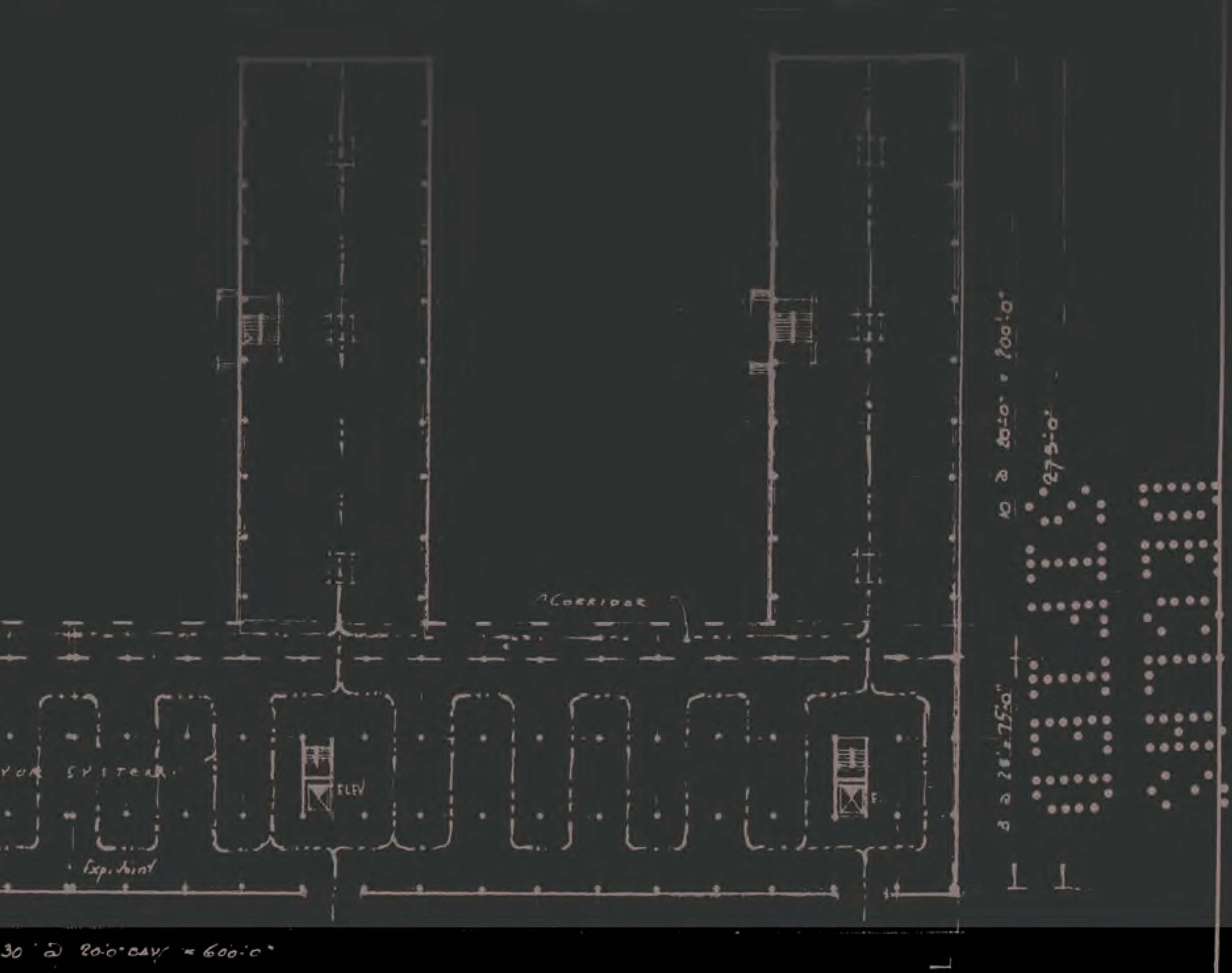

- GROUND FLOOR PLAN -

Scale 1/32" = 1'-0"

AREAS:	SQ FT
WAREHOUSE:	90,000
SHOPS & CORRIDOR	104,640
TOTAL:	194,640

U. S. ATOMIC ENERGY COMMISSION
OFFICE OF SANTA FE DIRECTED OPERATIONS

BUILDING TYPE STUDY III.

FILE
JOB
DRAWN M'G & MLB
CHECKED ML Bach

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Los Alamos
NATIONAL LABORATORY

NATIONAL SECURITY
RESEARCH CENTER

Los Alamos
NATIONAL LABORATORY

TRIAD
National Security, LLC

LA-UR-22-30602

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CONTENTS

The National Security Sciences Building, May 2020 (opposite page).

FOREWORD

Kelly Beierschmitt, Deputy Laboratory Director for Operations

The story of the history of the Laboratory, starting with wartime Project Y, is usually told with an emphasis on the famous scientists and key scientific accomplishments that contributed to the development and later refinement of atomic weapons design and associated technology.

This book focuses on the operations that enabled the mission of the Laboratory. Operations staff and leaders provided vital, behind-the-scenes contributions to the success of the Laboratory. We undertook researching and writing this book to better understand the history of the Laboratory's operations—its past operations leaders, innovators in operations, administrators, culture, systems, and technologies—and how they transformed over time to address changing national security mission.

We are looking at another big change in the Laboratory's future. Our objective with this book is to create a collective memory that tells a story of who we are, where we come from, and where we are headed. As we strive to change culture to improve safety, security, disciplined operations, quality, and environmental compliance, we can learn from past leaders and innovators by studying operational data that led to the creation of our current requirements, policies, procedures, and culture.

Although not a comprehensive operations history of the Laboratory, this book tells many of the important stories and relates them to today's considerations. We identify how organizations and groups were formed and how they evolved, which will help us better understand the timeline for cultural changes, the process for changes, and how to influence these changes rapidly to improve the Laboratory workforce. Hopefully this knowledge will help us transform the Laboratory to be a much better version than it ever was in support of delivering our national security mission and our evermore-complex, high-hazard plutonium operations and waste management.

PREFACE

Rizwan Ali, Director, National Security Research Center

In 2020, I received a query that was both exciting and unique. As the director of the Laboratory's National Security Research Center (NSRC), I'm fortunate to be able to say that requests that can easily be described as both are nearly daily occurrences.

This one, though, was different.

Director for Operations and Infrastructure Strategy Rekha Pillai told me that she and Deputy Laboratory Director for Operations Kelly Beierschmitt wanted to write a book, and they hoped to partner with the NSRC to do so.

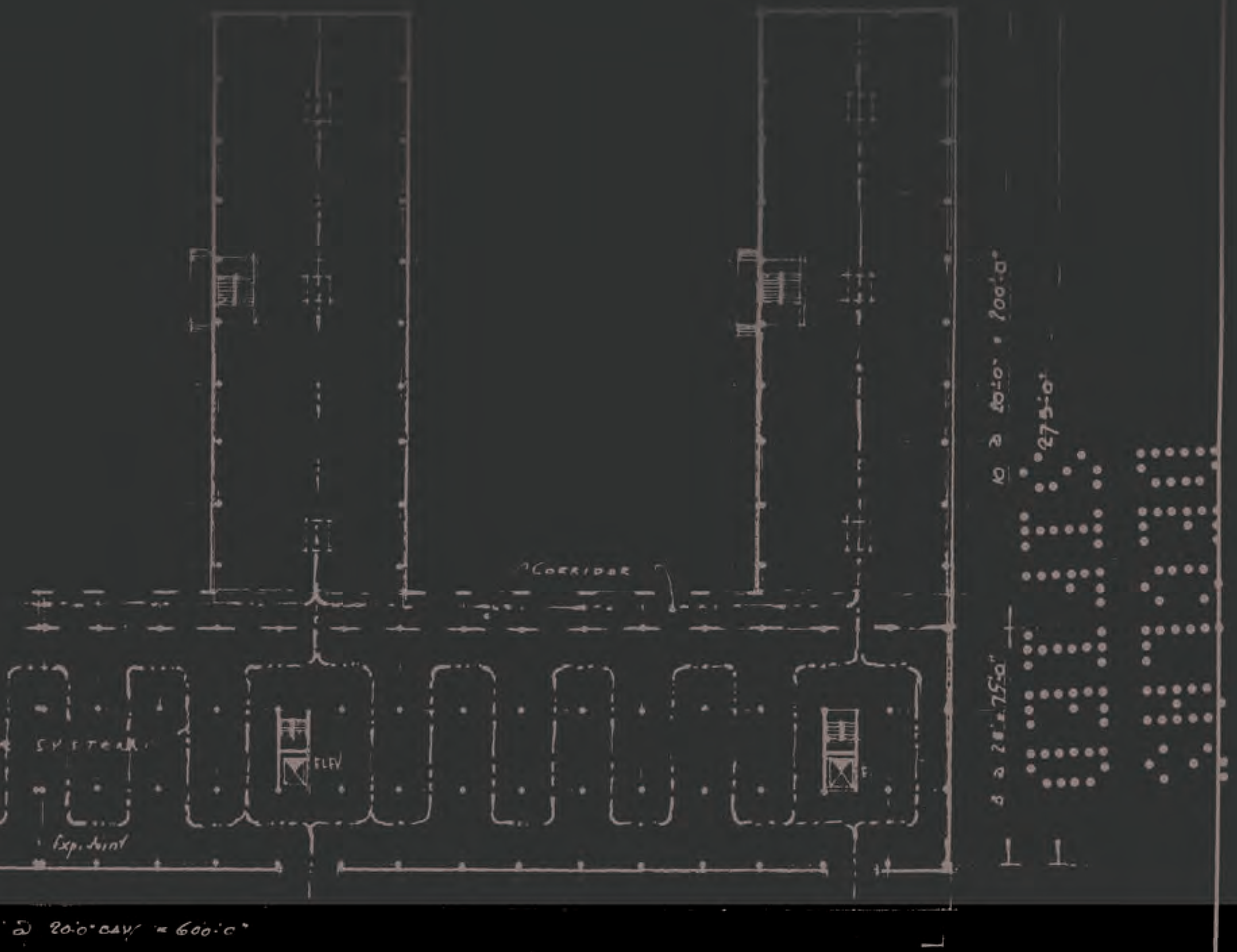
The NSRC is one of the largest libraries in the country and has a highly trained, expert staff of librarians, archivists, publications specialists, and historians. Our collections, which number in the tens of millions and include every medium imaginable, span the entire nuclear history. They support today's scientists in their national security work and are critical to the Lab's mission.

These collections also tell stories. Woven together, the NSRC's documents, data, and photos could—for the first time ever—aggregate and share the important accomplishments of the Laboratory's operations staff during the past 80 years, which is exactly what Dr. Pillai and Dr. Beierschmitt wanted to achieve. I wholeheartedly agreed, and the partnership was formed.

The book you're holding spotlights the Laboratory's infrastructure, facilities, business operations, and other support systems needed for national security. Its content was overseen by the NSRC and written by Dr. Pillai, historians from the Laboratory's Environmental Stewardship group, and a writer from the Laboratory's Technical Editing and Communications (CEA-TEC) group. The authors were supported by a team of NSRC and additional TEC staff.

Not intended to be a single definitive history book, this publication is a precursor to forthcoming, more in-depth books and reports. For the time being though, I'm confident you'll agree that what began as a query yielded an exciting, unique outcome.

I hope you enjoy reading this history of the Laboratory's operations as much as we enjoyed working on it.



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INTRODUCTION

In 1943, the Manhattan Engineer District established Project Y to research solutions to specific problems associated with the production of a nuclear weapon. Specifically, Project Y was established for the development, final processing, assembly, and testing of the atomic bomb. Based on U.S. Engineering Office studies and constraints established by Dr. J. Robert Oppenheimer and General Leslie R. Groves, the Los Alamos Ranch School in Otowi, New Mexico (a 49,383-acre site), was finally selected as the location for Project Y. The classified site was called "Site Y," and Santa Fe residents referred to the site as "The Hill."

The University of California, as operating contractor, administered the technical work and continues to be part of the management and operations team today. Zia Company was first contracted to manage operations for both the townsite and the Laboratory. Initial Project Y setup consisted of rehabilitating 31 buildings, constructing 111 buildings, and planning for utilities and streets. The new construction provided housing and other facilities for military personnel, housing and dormitories for technical personnel, a power plant, a dispensary, a school, a post exchange, stores and markets, and theaters. The Frijoles Canyon Lodge, located in Bandelier National Monument, was leased as additional housing during 1944, when shortages were at their peak. Electrical power to Project Y was established from New Mexico Power Company's Bernalillo-Santa Fe line. Initial design and engineering were provided by Albuquerque Engineering District and then by Manhattan Engineering District. To minimize delay in support of the emergency work, all design and engineering contracts were awarded to one architect-engineering firm: W. C. Kruger-Santa Fe. During this initial period, speed was the most essential factor that drove start-up activities, and start-up speed took priority over safety.

Today, Los Alamos National Laboratory (the Laboratory) includes 897 facilities, with an additional 415,000 square feet of leased space. During the last 75 years, the Laboratory has diversified its portfolio to become the National Nuclear Security Administration's premier national security laboratory, serving as their design agency for the W76, W88, B61, and W78 nuclear weapons systems and their production agency for pits and detonators. The Laboratory's mission-focused science, technology, and engineering portfolio has expanded to include

> accelerator science and technology;
>
> advanced computing to exascale and beyond;
>
> integrated capabilities for plutonium and actinide missions;
>
> leadership in quantum initiative and integrated nuclear materials; and
>
> ways to address the grand challenges regarding climate change, vaccine development and epidemic prediction, cybersecurity, and space exploration and modeling.

In the era of abundant digital technologies, Laboratory Operations—the largest organization—is evolving to become more modular, connected, distributed, and systems- and data-driven to support this growing, complex portfolio and to ensure the delivery of mission—reliably, safely, securely, efficiently, and effectively.

Now the Laboratory is again going through another significant growth phase—primarily driven by the pit-manufacturing mission—resulting in

- significant growth in staffing;
- changes in staff demographics;
- an exploding range of applications in web services;
- a mobile, changing operating environment; and
- significant changes to on-campus and off-campus infrastructure needs.

In addition, since 2020, the COVID-19 pandemic has brought with it changes in how the Laboratory delivers its mission and has introduced into its operations the need for understanding a "new normal." Because of significant growth in its mission and pandemic conditions, the Laboratory is experiencing some of the same types of issues faced during Project Y: difficulty obtaining skilled workforce in many areas, lack of a varied local labor market, transportation of employees via congested access roads, inadequate housing for staff, terrific time pressure, inability to manage peak staff needs adequately, frequent changes in design, and short-term and fragmentary planning; however, today, safe, secure, and disciplined operations are the most essential factors that drive Laboratory activities and performance—how we do our work is as important as what we do—the title of this book. The increased mission scope will require operations to focus on industrial management in addition to scientific management.

Growth in the Laboratory's production mission is swiftly driving an increase in operational capacity by

- increasing staffing;
- rapidly building new infrastructure;
- increasing efficiency of critical processes, such as waste management, criticality safety, nuclear material control and accountability, nuclear facility management, and security;
- building the pipeline for growing staff; and
- partnering with local and regional government and Pueblos to increase housing availability, improve community services, and broaden transportation options.

Working during COVID-19 has taught the Laboratory many ways to get work done while continuing to be effective, efficient, safe, and secure. The Laboratory is offering more flexibility to its staff by allowing those who can to work some or mostly from a location that is different than their onsite location and to commute less without compromising the quality of relationships with customers or oversight entities, collaboration, or communication. The post-COVID "normal operations" is different from the pre-COVID normal, and teleworking is accepted and even preferred by a portion of Laboratory staff.

Security check at Site Y (opposite page).

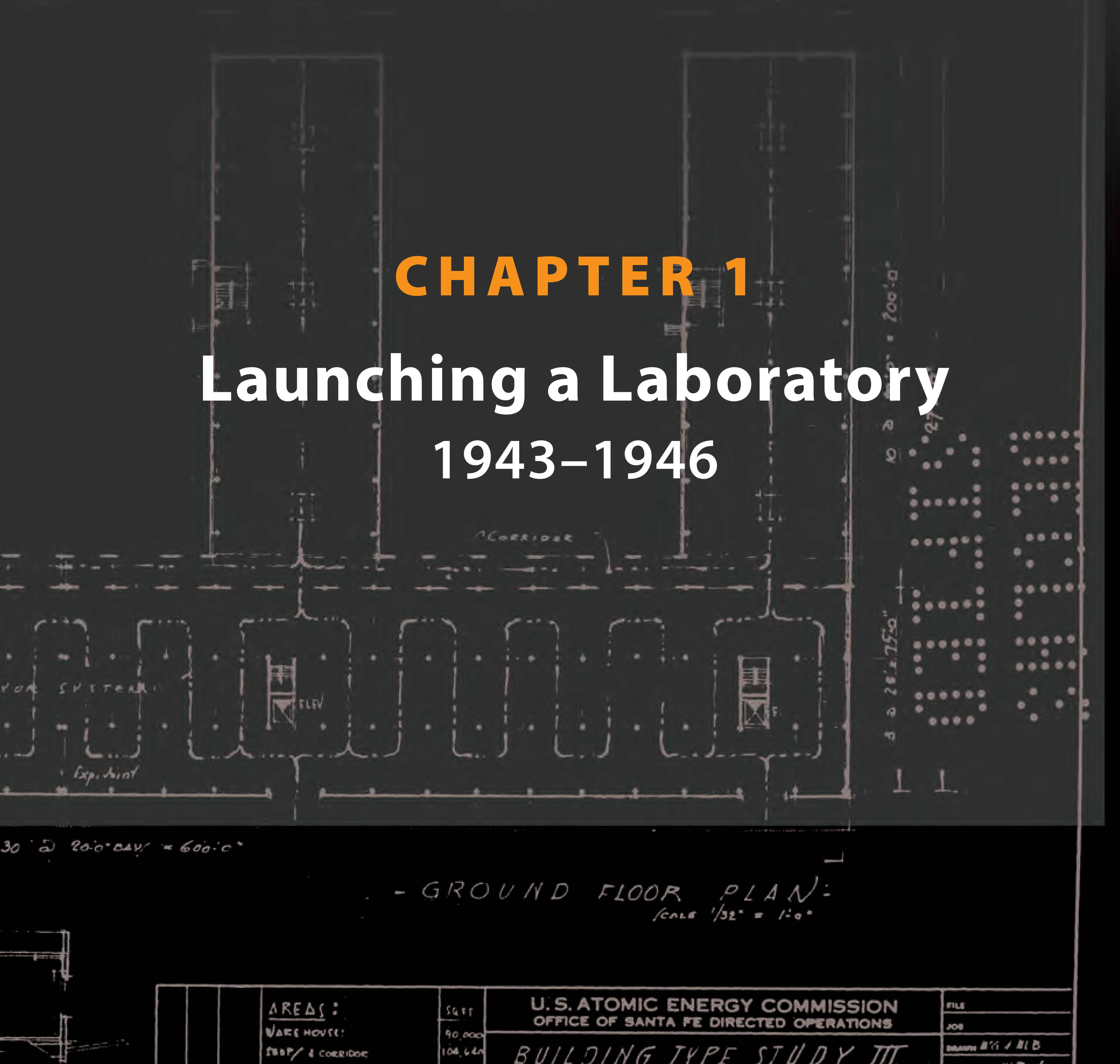

85 MILLION AMERICANS HOLD WAR BONDS

Oppenheimer directly recruited Dorothy McKibbin to work in the Santa Fe Office at 109 East Palace. She was the "Gatekeeper to Los Alamos" and welcomed the incoming scientists and their families. Dorothy was also the lifeline for many of the people already on the Hill.

CHAPTER 1

Launching a Laboratory

1943–1946



The main technical area adjacent to Los Alamos townsite in 1945.[1]

Presidents

Franklin D. Roosevelt (D), 1933–1945
Harry S. Truman (D), 1945–1953

Major Conflicts

World War II, 1941–1945
Cold War, 1945–1991

Federal Oversight

U.S. Army Corps of Engineers,
Manhattan Engineer District, 1942–1946

Laboratory Directors

J. Robert Oppenheimer, 1942–1945
Norris E. Bradbury, 1945–1970

Laboratory Staff

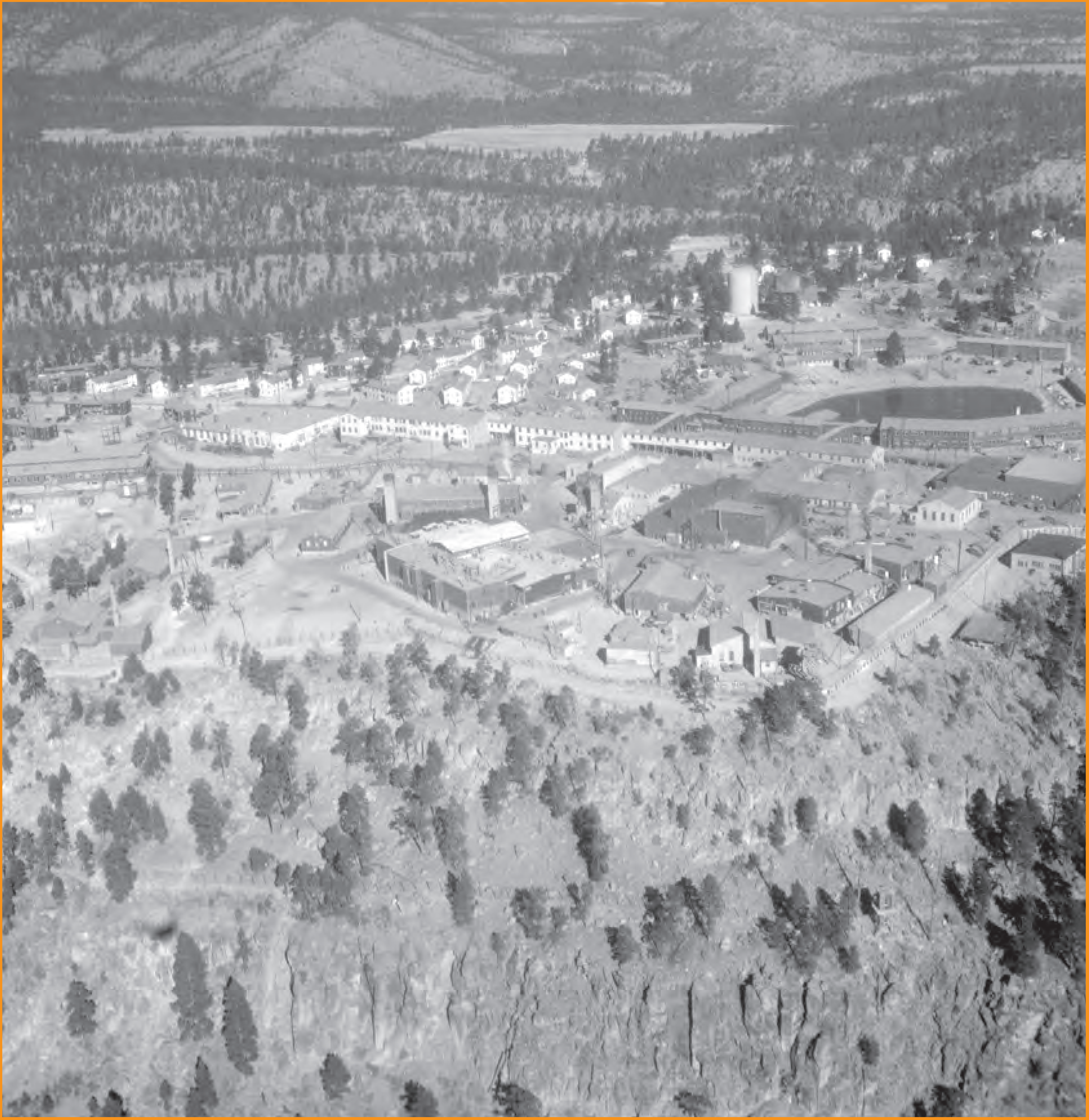
Approximately 1,500 (1943)–
Approximately 10,000 (1946)

Executives over Laboratory Operations

David Hawkins, Arthur L. Hughes,
and Bermis E. Brazier, 1943–1944
David Dow, 1944–1945/1946
Col. Austin W. Betts, 1945–1946
Col. L. E. Seeman, 1945–1946
Col. Austin W. Betts, 1946–1948

Support Contractor

Zia Company, 1946–1986



Los Alamos and the Main Technical Area (TA-01) in 1946 (opposite page; photo from the Los Alamos Historical Society).

REACHING SHANGRI LA

The year 1942 witnessed a heightened acceleration by the United States to develop an atomic weapon. The Manhattan Project had been well underway before the United States' entry into World War II and was initially launched to determine the prospect for successfully developing and deploying atomic weaponry sooner than the Germans. With war raging on two fronts after the attack on Pearl Harbor, the United States ramped up the effort of the Manhattan Project to develop atomic weaponry before the enemy and bring about a quick and decisive victory for the Allied Nations. Manhattan Project personnel brought an intensity to the mission and a deep conviction that their efforts, if timely and successful, would save countless American service members' lives and the lives of millions of people around the globe.

Work to develop an atomic weapon was expected to ramp up; key positions needed to be filled, and additional locations were required. General Leslie R. Groves was tasked with heading up the Manhattan Project, while J. Robert Oppenheimer would lead Project Y—the extraordinary effort to engineer a deployable atomic weapon. Groves understood from the beginning that, although scientific insight and laboratory research would be vital to the Manhattan Engineer District, at its heart it was not a scientific project but a large, far-flung industrial enterprise. Success—in the form of a deliverable bomb before the end of the war—would come only from coordinating and pushing hard on all elements of the complex.[2] The general understood that, although the contributions of the scientists were crucial, theirs was only one of a host of critical components that made up the totality of the Manhattan Project.[3]

This task—a difficult one defined by difficult constraints—required site selection as its first priority. The yet-determined location of Project Y (codenamed Site Y) required addressing several concerns held by Groves primarily, but also by Oppenheimer. Groves insisted on security and safety.[4] Oppenheimer, while in agreement with Groves, also sought certain provisions for the wellbeing of the assembled scientists and support staff.[5] Primary selection factors included availability of rail and air transportation, reliable water supply, amiable climate, physiographical remoteness, and social seclusion.

Ultimately, favorable conditions for the operational success of the Project Y mission propelled Los Alamos, New Mexico, to the top of the list.[6] The mesas around Los Alamos represented an ideal location for a base of operations to develop the world's first atomic weapon. Ample distance from the coastlines offered an undeniable advantage for classified Project Y work.[7] Placement in a remote part of the country provided security, yet also offered the untethered opportunity for scientists to collaborate openly within a compartmentalized structure. Proximity to local Pueblo and Hispano communities provided a sustainable population with numbers to support the looming support required by the scientific endeavors of Project Y.

Favorable conditions for the operational success of the Project Y mission propelled Los Alamos, New Mexico, to the top of the list.

Project Y needed a reliable water resource to ensure successful operations. Although water availability in and around Los Alamos presented a level of concern, initial staffing forecasts led General Groves to believe that the available water supply would be sustainable if the Laboratory followed conservative water-use practices.[8] Water availability would prove to be a reoccurring problem throughout the war years. Today, our Operations Division manages the challenges of ensuring supply distribution to the Laboratory's ever-increasing need for safe and reliable water for a growing population.

The first water tower to supply Los Alamos had a capacity of 250,000 gallons. Not only did the tower provide for the operations of the Laboratory and offer safe drinking water to the community, it also was used as the principal marker when giving directions to various social events held in neighborhood housing.

Although the approach to Los Alamos was much improved, the plateau still offered a rugged and challenging terrain to navigate..

Favorable weather patterns were determined to offer an advantageous outcome to operations.[9] Year-round construction was a prime objective. Northern New Mexico winters can be cold and snowy, especially in decades past; however, the abundant sunshine and clear, sunny days experienced most of the time (even throughout the winter months) on the Pajarito Plateau served to diminish the effects of occasional wintry weather.

Collaboration among physicists, chemists, metallurgists, and engineers ensured that the challenging mission of Project Y succeeded. A trying timeline required that a bomb be ready once usable nuclear materials were obtainable from manufacturing plants across the country. Because of this straining schedule, collaboration was essential, and the adoption of compartmentalization was critical to the success of the project.

Within the main technical area (TA), Oppenheimer was responsible for establishing and organizing the working groups therein,[10] in addition to policy and the administration of security and secrecy between the civilian technical staff and the family members who followed them to Site Y. Oppenheimer decided on four divisions that were directly related to building the weapon. These four divisions were designated Theoretical, Experimental, Chemistry and Metallurgy, and Ordnance. Divisions were further separated into "groups."[11] Oppenheimer established a "governing board" to oversee the divisions.

The divisions set up by Oppenheimer were housed at TA-01. This TA was constructed around Ashley Pond and, at first, efficiently used the close proximity to existing infrastructure of the previous Ranch School.[12] Many of the early staff were housed in existing school buildings, and the earliest housing quarters were constructed on the school grounds. The introductory map for Chapter 1 illustrates the buildup of infrastructure near Ashley Pond during the last days of the Manhattan Project.

As staffing grew and experimental requirements developed, divisions and groups extended outward, past the established boundary of TA-01. Much of this expansion was due to the need for less interference from other experimentation occurring at TA-01, safety considerations from explosives testing, and the development of multiple lines of weapons testing.

As the scientists, their families, and the support staff began settling the mesa top, buildings went up faster than previously imagined. TAs moved well beyond the main TA-01. Housing areas swelled as the number of families moving onto the mesa also swelled, and families grew bigger once they arrived. The Pajarito Plateau upheld its promise to protect Groves's secret project while also sustaining the idea of splendor that Oppenheimer had foreseen. The name Los Alamos was to remain a secret. As a name, Site Y was sterile, secure, and secretive, but to the new inhabitants of the plateau, other names became commonplace. Shangri La was often used to describe Los Alamos in all its mystery and beauty.

While Oppenheimer administered the civilian side, a commanding officer, Gerald R. Tyler, held responsibility over the military personnel. Although a large civilian contingent made up the bulk of Project Y's technical staff, the military supported the project with security to prevent trespass, provide guard duties, and ensure that living conditions in Los Alamos remained suitable for the town's population. Initially, the Laboratory would stand as a civilian institution that was researching and designing an atomic weapon. As design and assembly took precedence, the military would take over, citing the need for greater secrecy and potentially commissioning the once-civilian scientists as military officers. As with Oppenheimer, Tyler reported directly to Groves, yet Groves ultimately snubbed the initial plan of moving Project Y to the military because the effort to maintain secrecy under a civilian administration proved adequate.

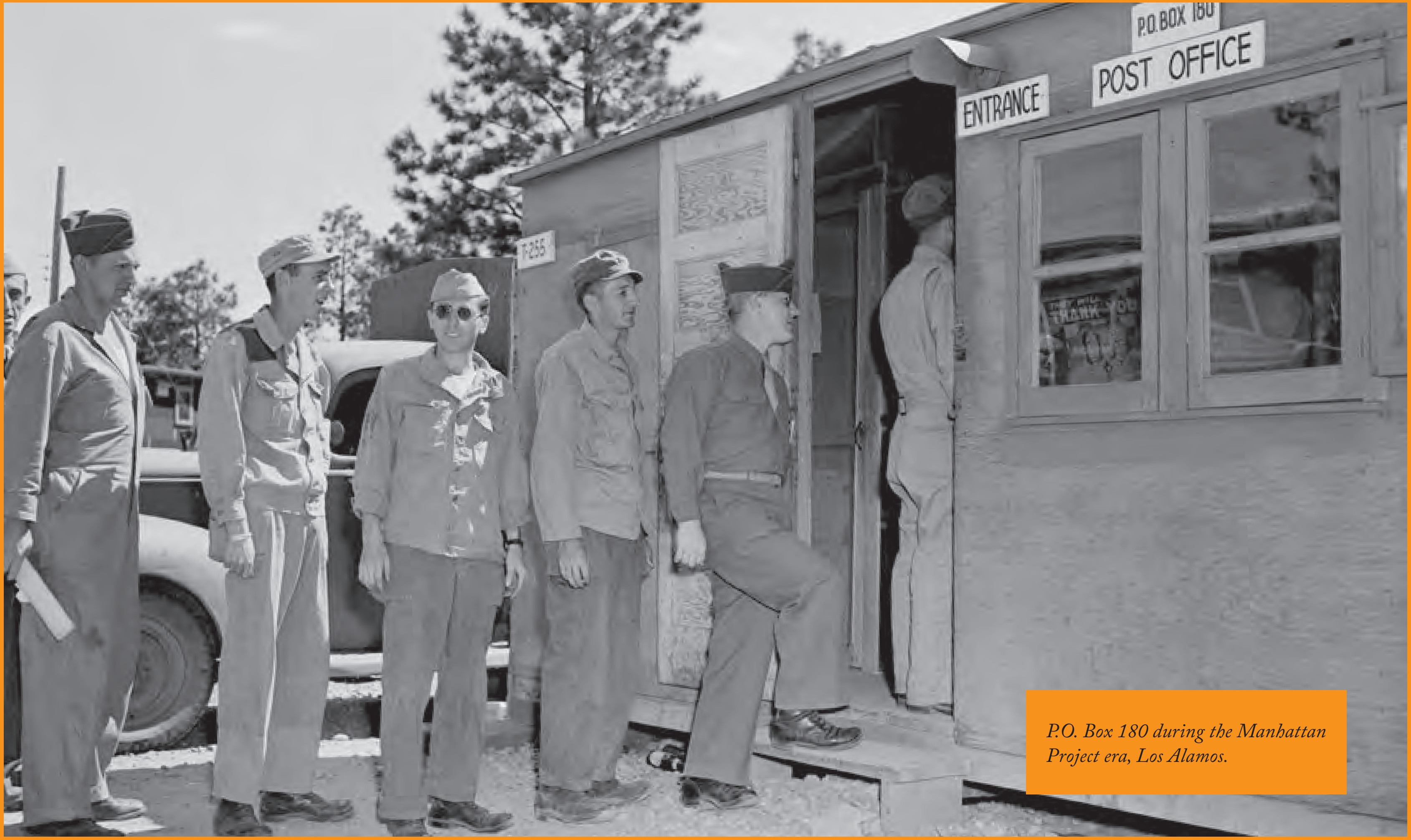
After completion of the bombs and the realization that work at Los Alamos would continue, modernization and expansion of infrastructure occurred within the bounds of available land. Land procurement and expansion were limited due to neighboring federal agency lands (U.S. Forest Service, National Park Service) and sovereign tribal lands. Laboratory operations can expand only within inflexible boundaries and outward only into willing communities.

GROVES AND OPPENHEIMER

Oppenheimer and Groves had a surprisingly congenial relationship. Groves was a hard and fast military man, while Oppenheimer was a quizzical yet confident academic. In any other existence, these two commanding figures of opposing personalities and conflicting qualifications could have faltered. Still, the shared enormity of constructing an atomic weapon and putting an end to WWII inspired the two to persevere. What started out with the decision for Site Y's location ended with the success of the Manhattan Project, nearing culmination in July 1945 at the Trinity Site with the successful detonation of the "Gadget" (pictured below).

Oppenheimer and Groves survey the Trinity site.

Site Y post office in Los Alamos.



P.O. Box 180 during the Manhattan Project era, Los Alamos.

SERVICE	DATE COMMENCED	FIRST OPERATOR
Appliance Store	Late 1946	U.S. Army
Building Maintenance and Repair	1943	U.S. Army through Force Account Crews
Dentist	March 1944	U.S. Army
East Cafeteria	March 1945	U.S. Army
Electric Power Facilities	1943	U.S. Army
Fire Department and Fire Prevention Section	April 1943	U.S. Army
Garbage Disposal	1943	U.S. Army
Heating	1943	U.S. Army
Housing	1943	University of California
Medical Service	March 1943	University of California
Military Educational Facilities	September 1946	U.S. Army
Military Mess	Early 1943	U.S. Army
Motor Transportation Pool and Shop	July 1943	U.S. Army
Natural Gas system	Early 1946	U.S. Army
North Mess	April 1943	U.S. Army
Police Department/Military Police	April 1943	U.S. Army
Regular School System/ Los Alamos High School	Summer of 1943	University of California
Special Engineer Post Exchange	June 1944	U.S. Army
Sewage System	1943	U.S. Army
Tech Post Exchange	September 1943	U.S. Army
Technical Area Steam Plant	1943	U.S. Army
Telephone System	February 1943	U.S. Army
Veterinarian	April 1943	U.S. Army
Women’s Army Corps Mess/ West Cafeteria	Spring 1945	U.S. Army
Water Supply	1943	U.S. Army
West Mess	September 1943	U.S. Army

A FORMIDABLE APPROACH

The Pajarito Plateau lies on the southeast-facing slope of the Jemez Mountains. Long mesas and steep canyon walls steer water and earth down and away to the Rio Grande—a landscape that Groves found ideal for security. In contrast, Oppenheimer appreciated the beauty and sunshine that northern New Mexico afforded.

Operational support bypassed the switchbacks with a reroute along the north edge of the mesa. The route (NM 502, also called "Main Hill Road") is still in use today, and the historic switchbacks offer popular hiking opportunities.

At first, Oppenheimer and Groves projected that Project Y would require only a few hundred scientists and support staff to finish the mission.[13] With this initial estimate, the existing infrastructure and the development of a living area and laboratory space would be sufficient. Oppenheimer began recruiting prominent physicists for Project Y.

Groves not only saw the military eventually leading the effort to build the bomb; early on, he envisioned the recruited scientist's enlisting in the military and falling under Army Corps of Engineers jurisdiction as well as being issued military rank. Oppenheimer initially agreed to this setup but compromised on this requirement after conversations with some of the more needed and influential recruit prospects such as Robert F. Bacher and Isidor I. Rabi, who refused to work at a laboratory run by the military, arguing that science could not flourish within a rigid military structure. Oppenheimer determined that recruitment efforts would also suffer, given the solidarity among the physicists at the time. Groves ended up giving in but did request the services of a special engineering detachment consisting of enlisted personnel.

As a result, recruitment picked up. Oppenheimer used his network of former students and professional associates to help fill the ranks at the Laboratory. Although he was not allowed to tell the recruits about the particularities of the assignment, Oppenheimer's prestige and confirmation that the project, if successful, would end the war led many to accept relocation to Los Alamos virtually "sight unseen."

Within a year of establishing Site Y, the realization hit home that the initial estimate of a few hundred scientists was a drastic miscalculation. Because the incoming scientists were not enlisted and Site Y was so remote, the demand to bring along family members was enormous. By the end of the war, the military had posted approximately 3,000 personnel at Los Alamos.[14] The civilian population amounted to around 2,500 individuals—considerably higher than the few hundred at the start of the project in 1943, which was not part of Groves's initial plan of how staffing at Project Y would progress. The addition of so many families changed the number and function of the required facilities for the townsite. In addition to increased housing that would support family-sized units, residents would also need support infrastructure such as a school and a hospital—a hospital set up not for military personnel but for families. Not only was the size of the staff an underestimate—community demographics played a large part in how the new laboratory would need to be administered.

"LARGEST COLLECTION OF CRACKPOTS EVER SEEN" —GENERAL GROVES

With the site of the new laboratory selected and the personnel organization developing, General Groves would need to find a management entity. J. Robert Oppenheimer hailed from the University of California, which had experience managing scientific laboratories. At this time, Groves and Oppenheimer envisioned Site Y primarily as a scientific laboratory and, to some extent, could have viewed the situation from a very narrow perspective that partially blinded them to the needs of the incoming families.

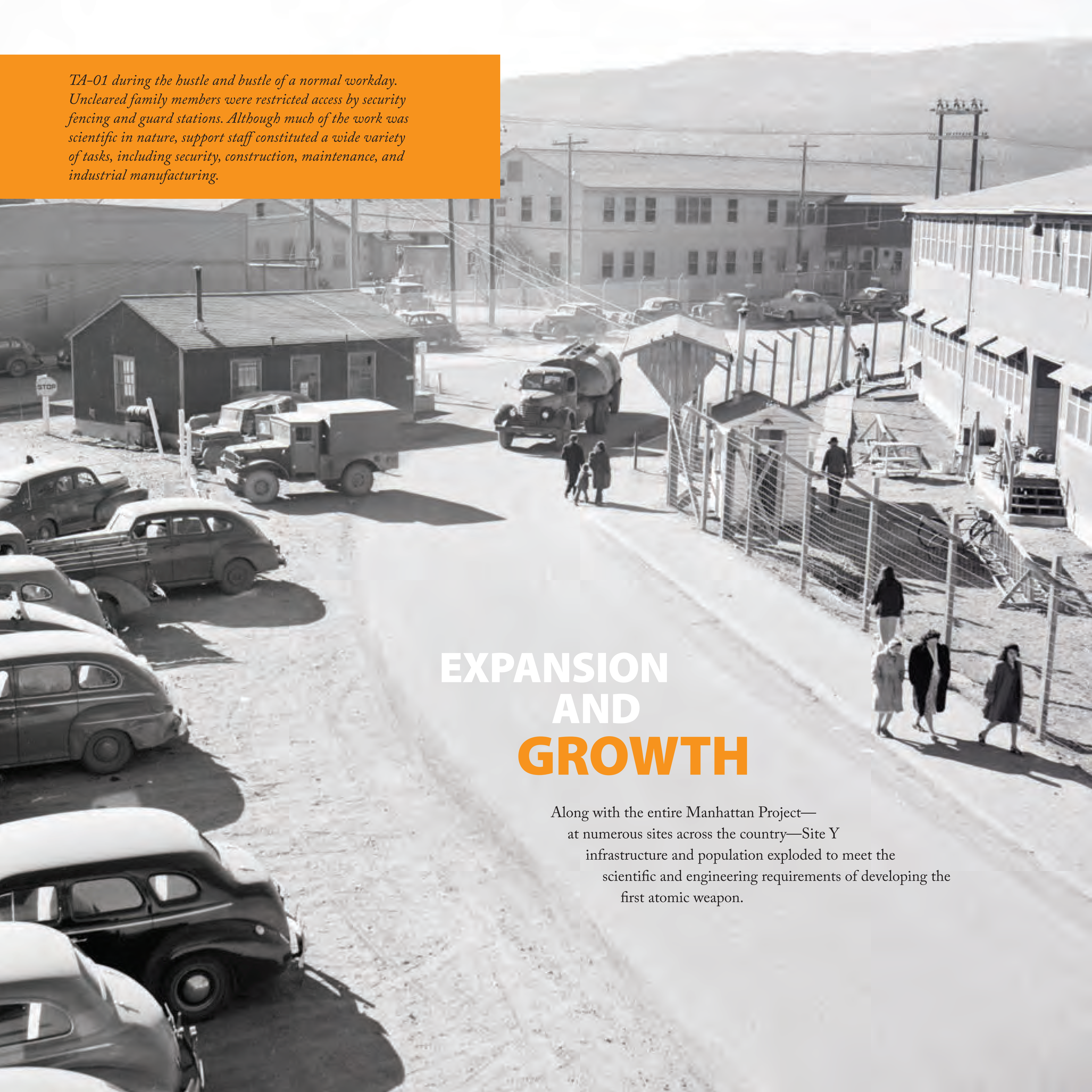
The University of California was selected in April 1943 because Groves needed an entity that was "experienced in research" and "still retained an uncommitted capability to take on work."[15] Many of the universities and related entities across the country were already involved in one way or another with the war effort. Groves believed that the University of California had yet to fully burden itself with war work.[16]

Additionally, Oppenheimer and a few of the prospective recruits hailed from the University of California. This connection surely played a pivotal role in Groves's decision. Oppenheimer's connection with the University of California went back to a 1929 assistant professorship,[17] and Ernest O. Lawrence presented an extremely influential presence with the University of California. Lawrence invented the cyclotron and founded Berkeley's Radiation Laboratory. The University of California's experience with the scientific aspects of the work at Site Y easily fit the defined parameters of the Project Y mission; however, the need for housing and other civilian-type infrastructure on a massive scale was out of its league. The University of California would end up turning to multiple private contractors to help fulfill this need.

The University of California signed a contract with the Manhattan Engineering District on April 20, 1943. The contract was retroactive to January 1, 1943, because work had already occurred and required procurement and financial processing.[18] The mission of Project Y remained a secret to University of California officials who were administering the contract while necessary personnel, supplies, materials, and equipment were procured for the work.

After the war, the University of California expected to end the contract; however, the continued interest in further researching and developing atomic technology and the advent of the Atomic Energy Commission in 1947 led to an extension of the contract in March 1947.[19] This contract remained in effect through 2006, with control being transferred to Los Alamos National Security, LLC. In 2018, a partnership between the Regents of the University of California, Battelle Memorial Institute, and Texas A&M University continued Laboratory operations and helped promote an enhanced culture of safety.

This photo of John von Neumann, Richard Feynman, and Stan Ulam was taken in the entrance patio at Bandelier National Monument.



TA-01 during the hustle and bustle of a normal workday. Uncleared family members were restricted access by security fencing and guard stations. Although much of the work was scientific in nature, support staff constituted a wide variety of tasks, including security, construction, maintenance, and industrial manufacturing.

EXPANSION AND GROWTH

Along with the entire Manhattan Project—at numerous sites across the country—Site Y infrastructure and population exploded to meet the scientific and engineering requirements of developing the first atomic weapon.

Operations personnel, such as machining specialists, contributed an essential and substantive workforce to the mission of the Manhattan Project.

COMPARTMENTALIZATION

Compartmentalization was key to security in Groves's mind. The concept of compartmentalization specific for the Manhattan Project came from Gregory Briet, a nuclear physicist.[20] However, the scientists at Site Y grappled with how to convey and discuss ideas; they were used to open and free dialogue. Oppenheimer realized that compartmentalization could hamper this exchange and took steps to lessen the military rigidity imposed on the scientists, improving morale and the success of the mission.[21]

TOTAL QUALITY MANAGEMENT

Total Quality Management (TQM) was the essential organizational philosophy incorporated by Oppenheimer into the Laboratory's structure since the beginning.[22] TQM was a revolutionary development that stressed not only effective leadership and management but also multidisciplinary teams with efficient information exchange.

In the summer of 1944, the Laboratory underwent a major reorganization in response to the realization that plutonium would not work in the type of bomb that they were developing. Testing of the gun-type bomb indicated that the design would sufficiently set off a chain reaction and subsequent explosion in a uranium core; it would be insufficient for a plutonium core. Because of the projected quantities of refined uranium, it was essential that plutonium be available to produce multiple weapons. Oppenheimer went into crisis mode and reorganized the Laboratory to continue developing and testing the gun device and to emphasize the importance of developing a plutonium-based weapon. TQM was instrumental to the success of this reorganization and the short timeframe when a plutonium-based weapon was developed.[23]

THE WOMEN OF PROJECT Y

Many of the celebrated stories attributed to the Manhattan Project in articles, books, and movies sadly place most, if not all, of the focus on the prodigious and subsequently widely admired men of the project; however, countless women of remarkable talent furthered the achievements generated by the Manhattan Project as a whole and Project Y specifically. Women worked in a variety of skillsets and endeavors to ensure the success of Project Y. These extraordinary women, exceeding 500 by the end of the war, worked in the civilian sector and came to Los Alamos with their husbands; or they worked on Project Y as enlisted personnel in the Women's Army Corps (WAC), excelling in tasks typically assigned to the enlisted men.[24] Much of this dedicated workforce could be found in administrative jobs or in support of operations as maids, laundresses, and telephone operators, among others. Although a vast number of both men and women performed crucial administrative and operational support, a few women worked in the sciences alongside their male counterparts and were able to contribute to the project with degrees and experience in physics, chemistry, biology, and medicine, just to name a few. Because of the prejudices and limited opportunities that many women faced leading up to and during the war, their potential to contribute to the project was tamped down by institutional constraints. The women of Project Y were suppressed and regulated in their prospective achievements to the project. In spite of this institutional disadvantage, historical investigations confirm the importance of women to the success of Project Y and the war effort overall.

Rose Bethe moved to Los Alamos with famed husband, Hans Bethe. She began work at Site Y assigning lodging accommodations to incoming families and solicited military officials on behalf of tenants. Rose advocated for essential building upkeep, managed delivery and maid services, and tirelessly campaigned for additional housing aimed at easing the strain of an ever-growing population. She later worked to wire electronics boards.

Helen Stokes worked in the procurement office where the Laboratory's purchase requests, expedited shipments, and non-technical conveyances were reviewed and processed. As an elected official to the town council, Helen represented the citizens of Los Alamos in most matters concerning the direction of the town and the quality of residential life.

Irma Shuler recruited new employees in her role as assistant personnel director. She conducted interviews and made hiring decisions. Her extraordinary capacity to perform in this role later required three people to do the same job. Toward the end of the Manhattan Project, she married famed explosives chemist George Kistiakowsky.

Frances Dunne (pictured above assembling an explosives test; photo from the Los Alamos Historical Society) exemplifies the value of women to the success of Project Y. Although women were largely deprived of the same prospects to support the mission of the Manhattan Project enjoyed by male scientists and engineers, Frances triumphed as a respected member of the otherwise all-male Explosives Assembly Group. Retained by George Kistiakowsky, group leader and renowned explosives expert, Frances left her position as an aircraft mechanic at Kirtland Air Force Base to work with Kistiakowsky's group. Her skills proved instrumental to the group's development and testing of implosion designs that led to the "Gadget" and "Fat Man" devices. Frances Dunne's distinguished contribution to Project Y on her own merits—in a customarily male role and despite overwhelming socially engrained opposition—heralded a future that led to the Laboratory's prominent female leaders, scientists, and engineers of today.

The McKee flat-topped, prefabricated housing offered Los Alamos residents a little more discretion from their neighbors, but the size left something to be desired. (opposite page).

BUILDING LOS ALAMOS

Bringing in the multitude of scientific personnel and support staff demanded not only laboratory space but also a significant amount of housing and supporting infrastructure—such as schools and hospitals—and utilities to deliver water and electricity to the new town. Stone and Webster provided original plans for supporting the town and the technical area. Oppenheimer and other top officials directly supplied specifications for laboratory buildings initially designed for a working staff of a few hundred. One of the biggest problems with constructing buildings for the technical area was that experiments in progress determined the design and layout of the building under construction, and foundations were often poured before official architecture plans were received.

All in all, by 1946, family-unit housing for 617 families had been constructed.

Housing on the outskirts of the technical area presented its own set of problems. As the primary staff increased, so did the needed support staff and the family members who tagged along. Although Stone and Webster provided the initial plans and was supposed to also provide construction services, the needs of Project Y proved to be too demanding; M. M. Sundt Company was selected by the University of California to construct many of the buildings designed by the first contractor.[25]

The Sundt Company remained the primary construction contractor for the Laboratory until the beginning of 1944, constructing 332 apartments.[26] Following the work completed by the Sundt Company, the J. E. Morgan Company constructed 56 duplexes, known as “Morganville,” during the first 3 months of 1944.[27] Then the Robert E. McKee Company came to Los Alamos to construct “McKeeville,” which consisted of 100 prefabricated houses.[28] All in all, by 1946, family-unit housing for 617 families had been constructed.

The Los Alamos Hospital, pictured here in 1947, was well equipped to handle most of what a small community needed; however, the number of births frequently tested those capabilities.

The Sundt apartments housed numerous families. The close-quartered living tested the politeness of many good neighbors.

KEEPING SITE Y SECURE

As the population and resultant housing increased, security also increased. Military Police made up the security detachment—with 196 enlisted personnel's reporting to a single officer—to guard the main technical area and other sites and to act as fire guard. By 1946, the number of security guards grew to 9 officers, overseeing 486 security staff in 44 separate, 24-hour posts. Military Police retained the bulk of the security work through 1946, and a Motor Patrol Section handled road patrols and traffic violations. In 1947, AEC security guards replaced the Military Police guards.[29]

Security for and among the residents was a constant presence at Site Y. Workers and their families were under continuous watch and were even provided security regulations.[30] Letters to the outside were carefully scrutinized before being sent out, and any incoming mail went to one post office box: P.O. Box 1663, Santa Fe, New Mexico. Telephone usage was also severely regulated. Staff and family members were restricted in their interactions when off The Hill. Professional conversations were limited to the technical areas, but families were still under restrictions regarding their social engagements and photography.[31] Travel from Los Alamos was generally limited to Santa Fe—with farther destinations firmly discouraged—and friends and family members were not allowed to visit the site at all.

Staff wore mandatory security badges around the technical areas. To keep information secure, staff often used codenames. Names of premier and well-known scientists were veiled to hide their true identity and to keep prying ears from gaining further understanding of the work that was occurring at the Laboratory. For example, Enrico Fermi used the surname Farmer when traveling offsite.[32] Other codenames, such as with progress reporting, used popular baseball teams to describe poor outcomes (Chicago Cubs), fair (Brooklyn Dodgers), and good results (Boston Red Sox).

Groves was not only worried about an outside threat but also one from the inside.[33] During the entirety of the Manhattan Project, General Groves sent hundreds of operatives across the country within a counterintelligence corps. This operation—comprising some 500 soldiers alongside detectives, reporters, lawyers, and the like—monitored the workers of the Manhattan Project. Not only did the counterintelligence corps investigate suspected leaks and sabotage—in at least one instance, they came down hard on an individual who was producing and selling counterfeit meal tickets.[34] The threat was real, and with the confirmed test of the first Soviet atomic weapon on August 29, 1949, the United States realized that the Soviet Union had received inside information. In fact, much of the information that the Soviet Union received was given freely, with little or no apprehension.

Security changeover, 1947.

Klaus Fuchs

Klaus Fuchs would later come to personify the fear that initially captured the concern of General Groves when selecting a location for Site Y. Fuchs admitted to suppling the Soviet Union with details that aided their production of an atomic weapon; however, Fuchs's treachery did not stem from an adjacent populace, as initially conceived, but rather from a sympathetic stance for a political ideology. Insider threats remain a serious concern for the successful and secure operations of the Laboratory today.

> "I had therefore, no hesitation in giving all the information I had, even though occasionally I tried to concentrate mainly on giving information about the results of my own work."
>
> — Klaus Fuchs

KEEPING SITE Y SAFE

Security and secrecy were prime objectives for Site Y operations; however, urgency to succeed often placed environmental management and waste management far behind other priorities. Standards were set by the project and did not allow for sufficient oversight by nearby communities. Additionally, project managers implemented hasty solutions to ensure more expedient results, and these solutions ultimately sacrificed the health and safety of personnel. Compartmentalization contributed to this sacrifice by limiting the sharing of sensitive information, safety concerns, and lessons learned; however, significant efforts produced strides in monitoring radiation hazards,[35] with contractors bearing the responsibility of setting standards, procedures, and inspection protocol. In 1942, the Met Lab (short for Metallurgical Laboratory) instituted unprecedented monitoring for radiation hazards by establishing the Chicago Health Division.

… accidents and fatalities did occur due to the fast-paced nature of the work…

Project Y had two separate health service providers during the Manhattan Project, but science was the focus of the University of California and the Army Corps of Engineers. One of the health service providers served the civilian population, and the other served the Laboratory staff. Group Leader Louis Hempelmann, who reported directly to Oppenheimer, led the Los Alamos Health Group.[36] This group was concerned with "special hazards,"[37] which included industrial health safety that required a definition of standards and safe operating procedures and also monitoring and recording.[38] The first year for Hempelmann's group saw a light workload, and with the arrival of plutonium to the Laboratory in 1944, the workload dramatically increased. Before 1944, the health group monitored particle accelerators and other radiation sources, performed blood counts of personnel, documented instrumentation shortages, and developed precautions for uranium poisoning.[39] Once plutonium entered the picture, testing increased significantly regarding this little-known substance.

Methods for biological testing[40] and apparatuses to monitor for exposure took center stage.[41] Laboratory staff were under significant pressure to perform and produce results, which caused concern that accidents were likely to occur at the Laboratory. Plutonium effects produced terrifying effects in bone and kidneys.[42] Furthermore, very little data existed for the short-term effects on the human body—much less for long-term effects measured in decades rather than days, months, or several years. In response, the Laboratory developed ways to determine exposure in the body and plutonium concentration in the air.[43]

The civilian health services provided by the Post Hospital for the community of Los Alamos differed dramatically in scope from Hempelmann's Health Group. Although the Post Hospital provided healthcare for Laboratory workers, that work mostly comprised common injuries and accidents characteristic of normal manufacturing processes. Additionally, one of the most common events at the Post Hospital was childbirth—so common that General Groves was quite dismayed by his lack of control regarding this unexpected circumstance of bringing a bunch of 20- and 30-year-olds together in the middle of nowhere.

Although the Laboratory tried to monitor health effects of staff, accidents and fatalities occurred due to the fast-paced nature of the work and lax safety procedures of the era. Two notorious fatalities occurred due to accidental radiation exposure to Harry Daghlian and Louis Slotin, but non-radiation exposure and construction-related fatalities also occurred. In 1947, the Atomic Energy Commission took over the Manhattan Engineering District.[44] Lessons learned from previous fatalities provided opportunities to learn from mistakes, in hopes of preventing further accidents from claiming lives.

ESTABLISHMENT OF THE MANHATTAN PROJECT NATIONAL HISTORICAL PARK

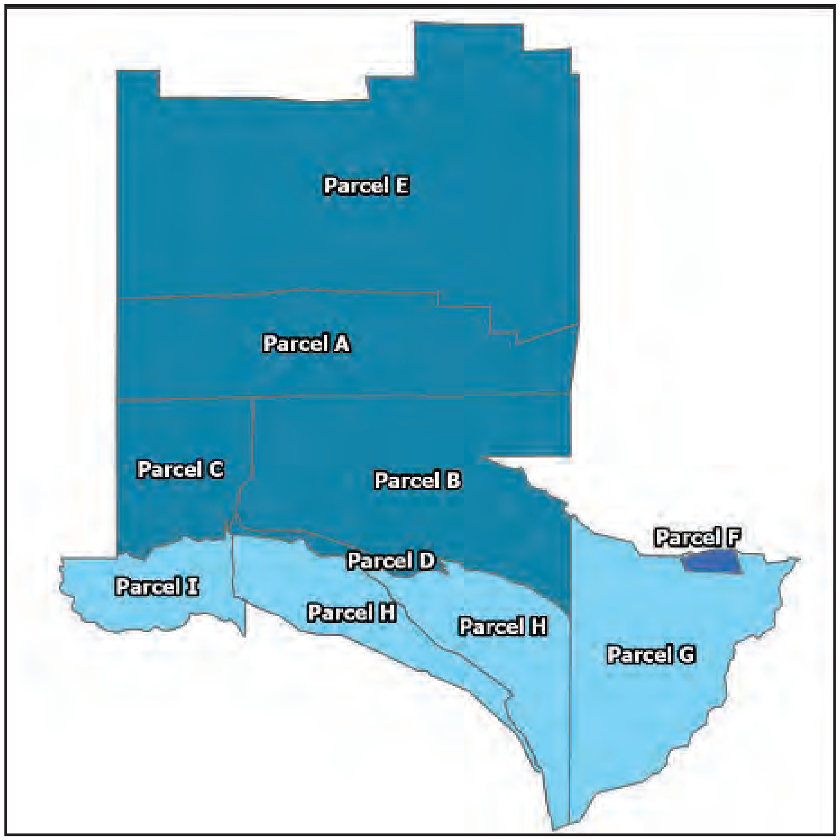
In November 2015, Congress established the Manhattan Project National Historical Park to memorialize the historically significant events of the Manhattan Project. The Los Alamos unit of the park showcases much that has been discussed in this chapter. The Laboratory's Operations Division does much to support these efforts by helping to preserve the extant buildings and providing crucial carrying capacity for the dissemination of knowledge for which the public thirsts.

A park service employee helps lead tours at TA-18, the first Manhattan Project National Historical Park site at the Laboratory to allow limited public access.

An early apparatus used to detect radiation. The Health Group was tasked throughout the Manhattan Project with monitoring potential radiation exposure.

A mock-up of the criticality experiment that caused the death of Louis Slotin on May 30, 1946.

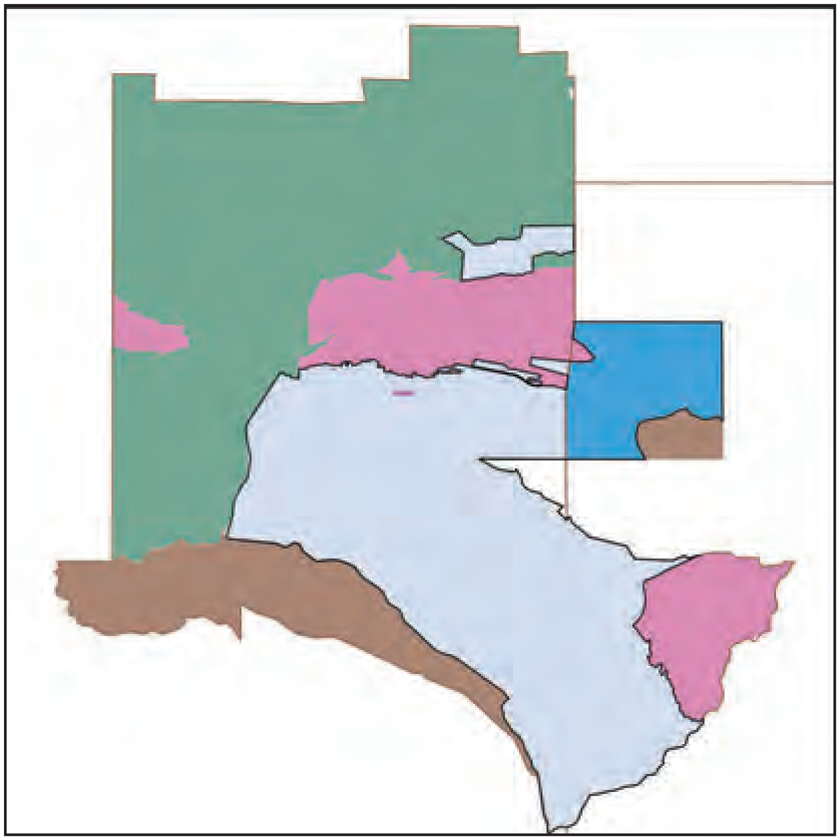
ACQUIRED REAL ESTATE (1943–1948)[45]



🟦 Manhattan Engineer District > Atomic Energy Commission
🟦 Atomic Energy Commission (1947)
🟦 Atomic Energy Commission (1948)

The Manhattan Engineer District acquired Parcels A through E in 1943 and transferred them to the Atomic Energy Commission in 1947. The Atomic Energy Commission acquired Parcel F and Parcels G through I in 1947 and 1948, respectively. The exterior boundaries of all parcels became the incorporated County of Los Alamos in 1949. The area totals approximately 109 square miles.

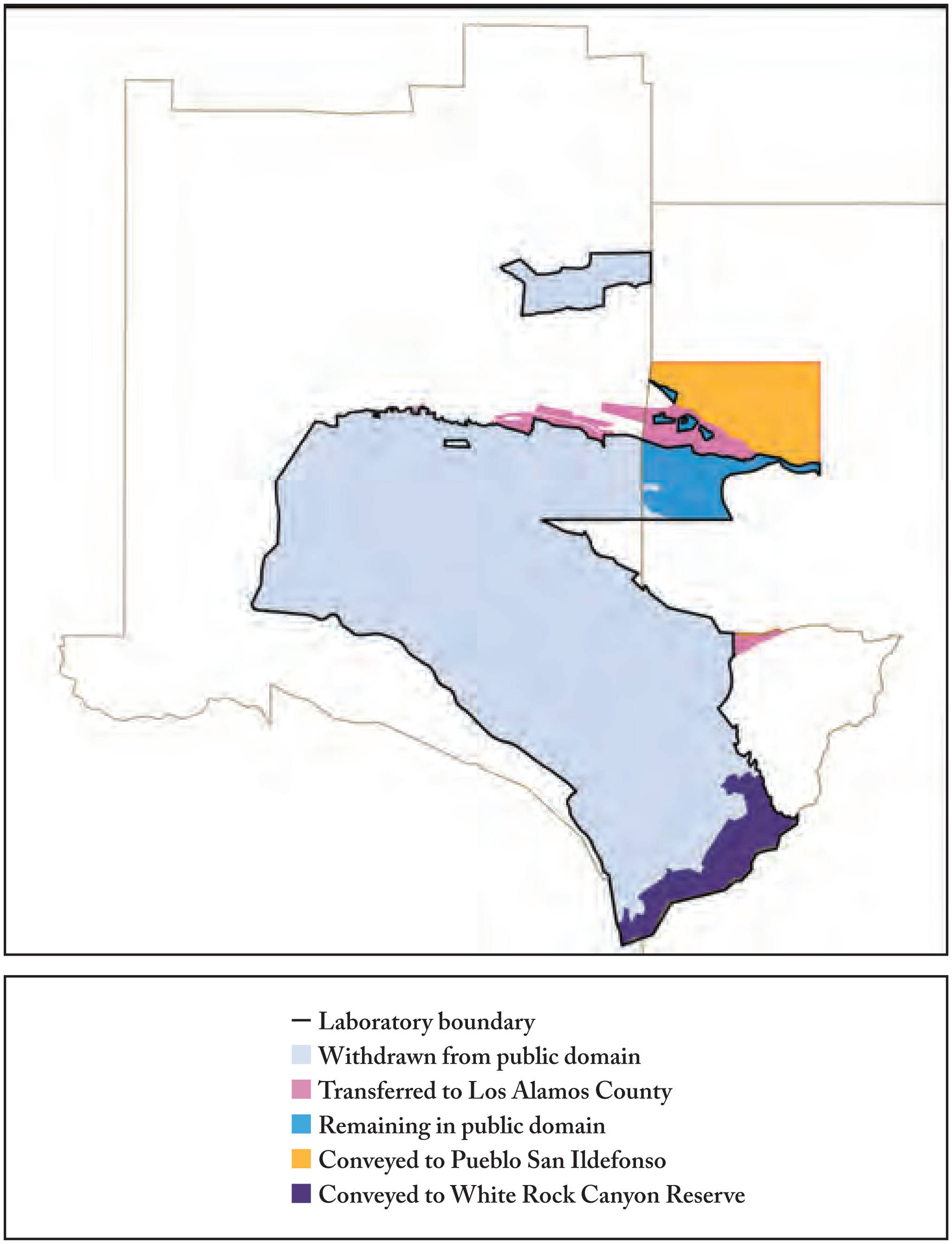
REAL ESTATE ACQUISITIONS AND DISPOSITIONS (1949–1997)[46]



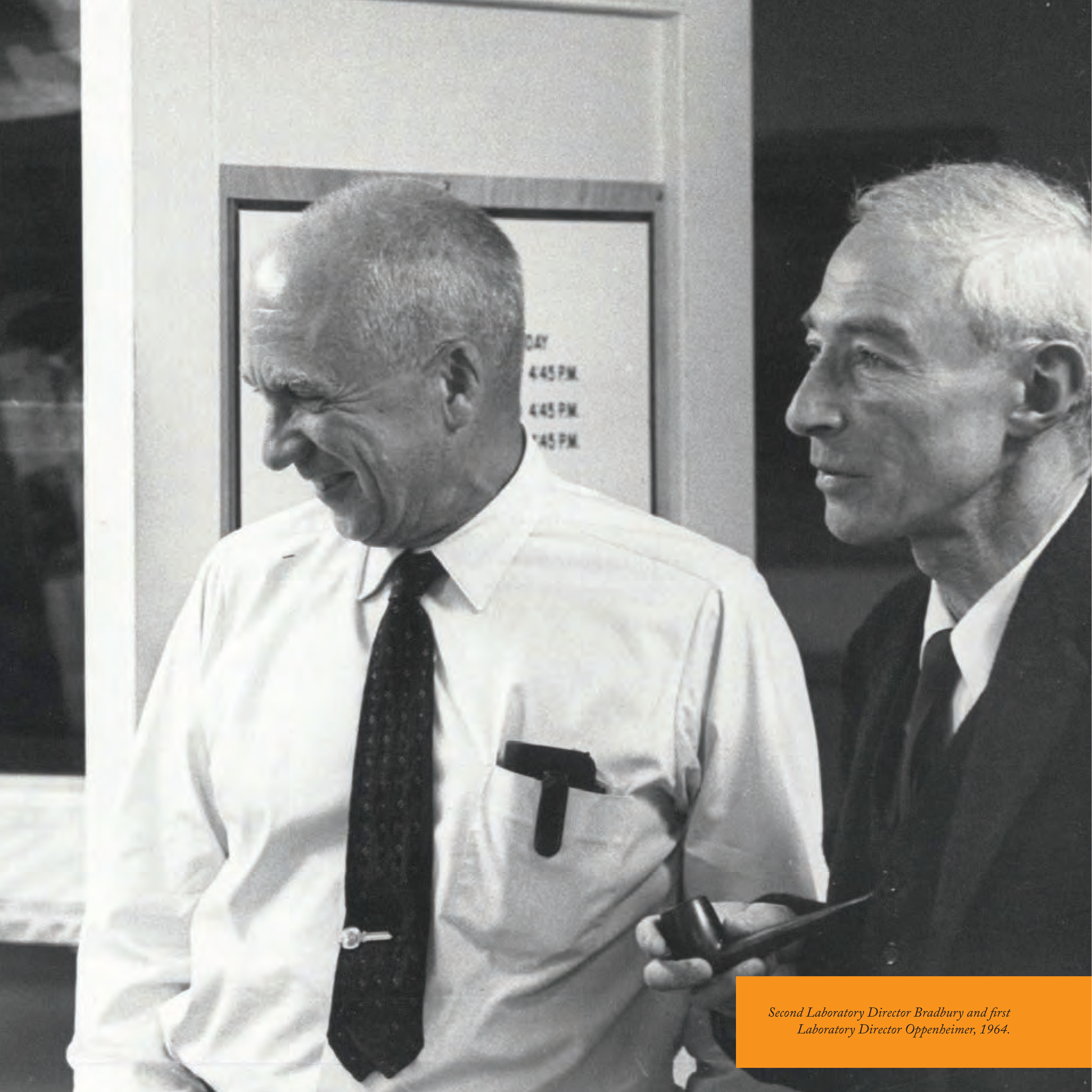
— Laboratory boundary
⬜ Withdrawn from public domain
🟪 Transferred to Los Alamos County
🟦 Conveyed to public domain
🟩 Conveyed to U.S. Forest Service
🟫 Transferred to Bandelier National Monument

The black line represents the bounds of the Laboratory. Light blue areas reflect land withdrawn from public domain for use by the U.S. Atomic Energy Commission (1947–1974), the U.S. Energy Research and Development Administration (1974–1977), and the U.S. Department of Energy (1977–1997). Pink areas show the land that was transferred to Los Alamos County (Los Alamos Ski Club to the left, Los Alamos "townsite" in the middle, and White Rock to the right). The medium blue area identifies land conveyed to the public domain. Green areas display land conveyed to the U.S. Forest Service. Brown areas indicate land transferred to the Bandelier National Monument.

REAL ESTATE ACQUISITIONS AND DISPOSITIONS (1998–2019)[47]



The black line represents the bounds of the Laboratory. Light blue areas reflect land withdrawn from public domain for use by the U.S. Department of Energy. Pink areas show additional land transferred to Los Alamos County. Medium blue areas identify land remaining in the public domain. The orange area displays land conveyed to the Pueblo de San Ildefonso. The purple area represents land conveyed to the White Rock Canyon Reserve.

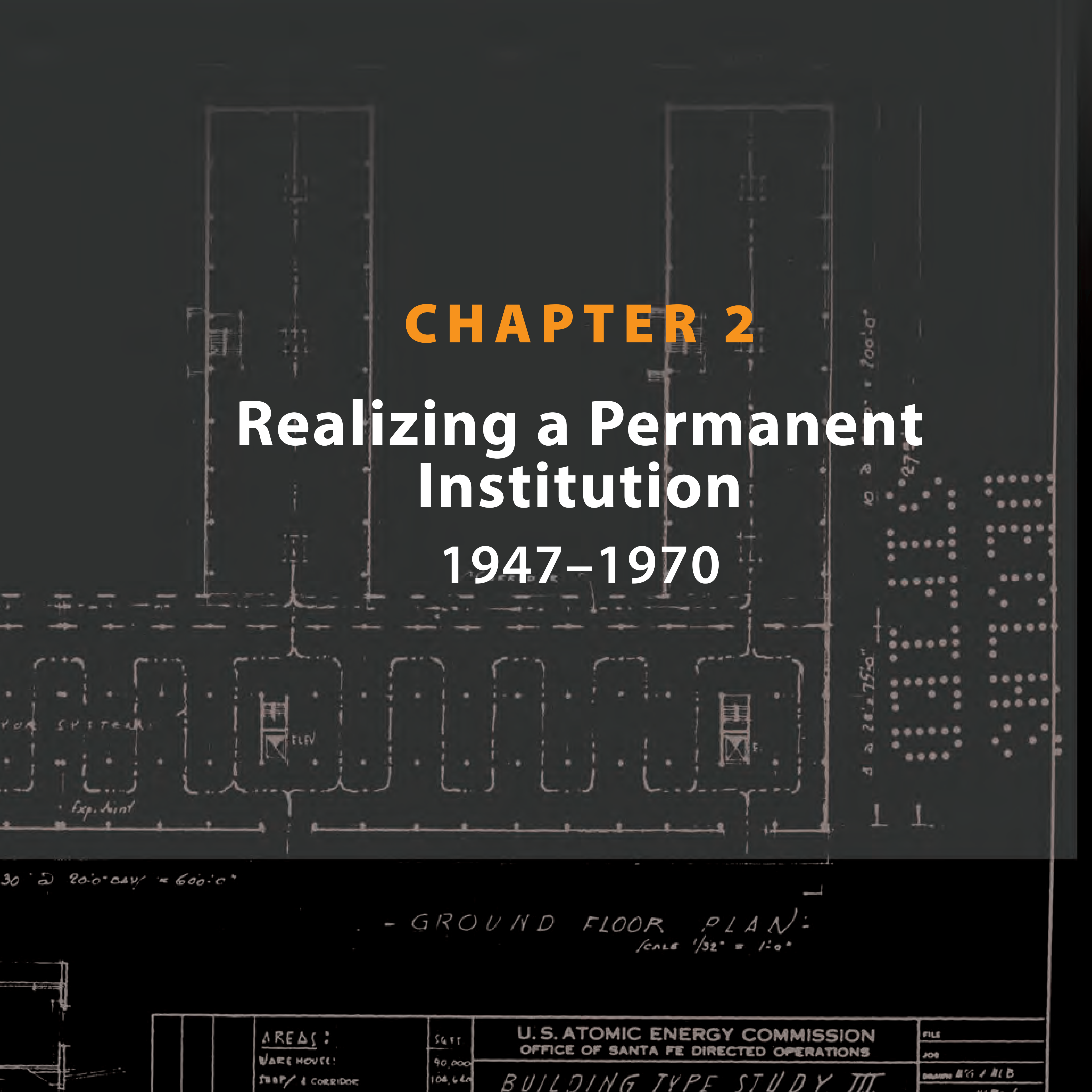


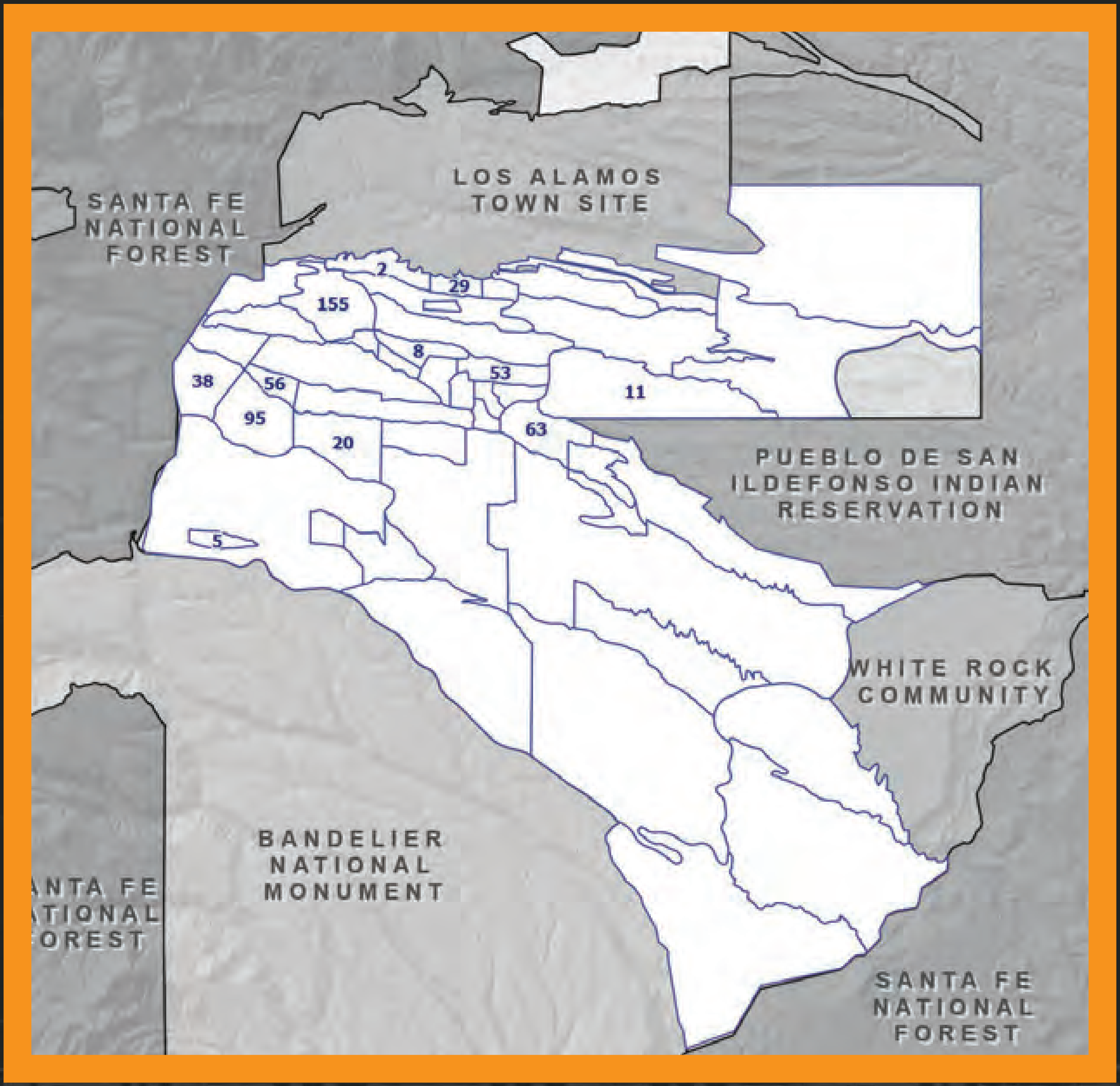
Second Laboratory Director Bradbury and first Laboratory Director Oppenheimer, 1964.

CHAPTER 2

Realizing a Permanent Institution

1947–1970





Facility counts of Los Alamos National Laboratory technical areas in 1965.[48]

Presidents

- Harry S. Truman (D), 1945–1953
- Dwight D. Eisenhower (R), 1953–1961
- John F. Kennedy (D), 1961–1963
- Lyndon B. Johnson (D), 1963–1969
- Richard M. Nixon (R), 1969–1974

Major Conflicts

- Cold War, 1945–1991
- Korean War, 1950–1953
- Vietnam War, 1965–1973

Treaties

- North Atlantic Treaty Organization formed, 1949
- Limited Test Ban Treaty, 1963
- Outer Space Treaty, 1967
- Treaty on the Non-Proliferation of Nuclear Weapons, 1970

Laboratory Budget ($K)

$44,484 (1954)–$140,980 (1970)

Laboratory Staff

4,508 (1947)–4,428 (1970)

Federal Oversight

U.S. Atomic Energy Commission, 1947–1974

Federal Managers[a]

- Elmo R. Morgan, 1951
- Ralph P. Johnson, 1951–1952
- Frank C. DiLuzio, 1952–1956
- Paul A. Wilson, 1956–1961
- John J. Burke, 1961–1962
- Charles C. Campbell, 1962–1967
- Herman E. Rosser, 1967
- H. Jack Blackwell, 1968–1974

Laboratory Director

Norris E. Bradbury, 1945–1970

Executives over Laboratory Operations

- Col. Austin W. Betts, 1946–1948
- Robert M. Kimball, 1948–1950
- Henry R. Hoyt, 1950–1970
- Raemer Schreiber, 1962–1972

Support Contractor

Zia Company, 1946–1986

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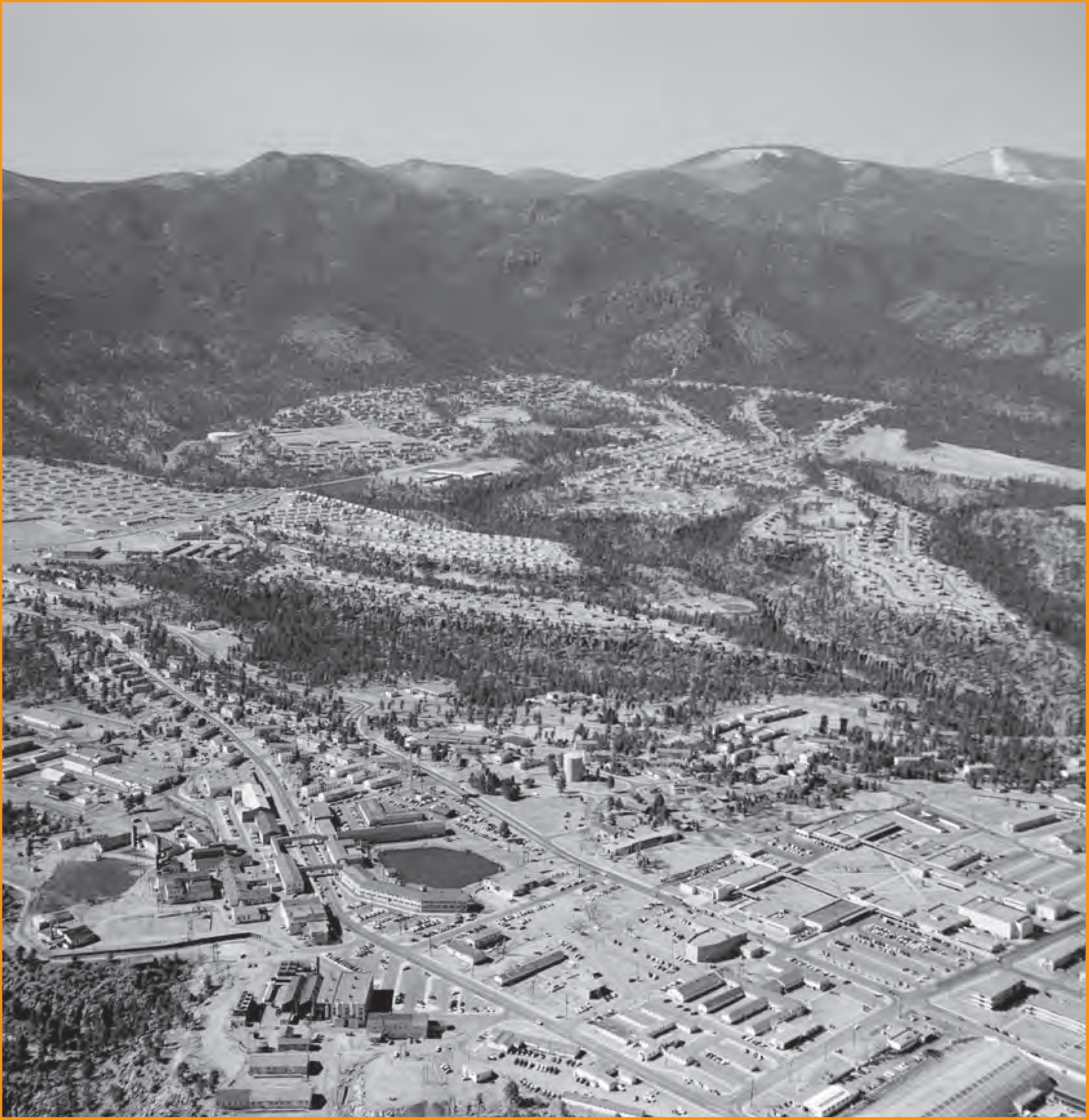
[a] The Atomic Energy Commission established a Los Alamos field office on June 18, 1951, which provided exclusive federal oversight of the Laboratory.



Oblique aerial of TA-01 (foreground) and the community of Los Alamos, 1955 (opposite page).

NURTURING A NASCENT ORGANIZATION

At the end of World War II, the Laboratory's future was extremely uncertain because staff had fulfilled its "one and only mission" to develop an atomic bomb.[49] After the war, the campus stood in great disrepair, and approximately half of the Laboratory's staff left Los Alamos to return to their pre-war lives.[50] As recalled in 1954, "Laboratory equipment, although excellent, was housed in cramped, inadequate complexes of wooden buildings and served by an increasingly inadequate utility system," and the townsite lacked the necessary housing and commercial infrastructure.[51] Some stability was established with the appointment in October 1945 of Norris E. Bradbury as interim director upon J. Robert Oppenheimer's departure.[52] Accepting the position on condition for 6 months, Bradbury stayed at the helm for 25 years.[53] Director Bradbury had a vision for the Laboratory and established its future with a continued focus on weapons research. By right-sizing programs, he ensured that the land base could accommodate the work and civilians could administer it.[54]

Los Alamos Laboratory's focus was the development of atomic weapons, which required ... a permanent community.

At the end of 1945, the United States had two nuclear weapons in its stockpile.[55] The first nuclear test series, Operation Crossroads, occurred in June–July 1946 at Bikini Atoll in the Pacific Ocean.[56] The Operation Crossroads program provided the Laboratory with a new objective; the program focused on testing the destructive power of the atomic bomb against naval vessels. Rebuilding the Laboratory's infrastructure and intellect began in January 1946, when Groves implored Director Bradbury to keep the Laboratory consequential, thereby inaugurating a longstanding tactic.[57] Evidently, "inheriting a solid staff helped him [Bradbury] through the transition years, which included times with no water, very little pavement, lots of mud, and not enough housing."[58] The procurement of a permanent water supply began in March 1946, with the commencement of a $750,000 water-acquisition project using valley wells that tapped into the Rio Grande aquifer.[59]

The United States Congress quelled the uncertainty of the Laboratory's future when they passed the Atomic Energy Act in August 1946.[60] This legislation validated that the United States wanted to maintain a nuclear research laboratory.[61] Notably, the Atomic Energy Act of 1946 transferred the control of atomic energy from the military to the civilian Atomic Energy Commission.[62] In an effort to increase the United States' production capacity of nuclear weapons, the Atomic Energy Commission initiated an expansion of the entire nuclear weapons complex.[63]

In this new framework, the Los Alamos Laboratory's focus was the development of atomic weapons, which required the immediate establishment of a robust campus and a permanent community.[64] The former required the construction of new, dedicated technical areas and scientific facilities and the development of dependable power and water supplies. By September 1947, the decision was made to move the Laboratory's primary functions to South Mesa (present-day TA-03) and subsequently demolish the Main Technical Area (TA-01) immediately adjacent to the Los Alamos townsite.[65]

In December 1947, Associated Architects-Engineers, led by W. C. Kruger, developed a 5-year campus plan that articulated Director Bradbury's vision for reconstruction of the technical area.[66] The campus plan provided a general site plan of present-day TA-03, studied access

Car stuck in the mud, February 1948.

Construction of Omega Bridge over Los Alamos Canyon, 1951.

roads, included drawings of building types, and estimated construction costs. Primary considerations in preparing the plan were to

> group related facilities to simplify operations;
>
> provide adequate room for expansion;
>
> segregate administrative, warehouse, maintenance, and laboratory functions;
>
> provide ease of access to all elements;
>
> maximize security for technical operations;
>
> prohibit security from impeding on routine administrative and warehouse functions;
>
> minimize interference with existing activities; and
>
> construct a road along the north side of South Mesa.

To facilitate Director Bradbury's vision, Associated Architects-Engineers assigned a research team that consisted of an architect and an engineer for each division. Working with the division leader and division staff, the teams assessed space and utility requirements, observed the division's processes, and evaluated area and equipment needs. The team then developed "an ideal mode of operation under ideal conditions in a new laboratory."[67] Through the input gathered from the research teams, Associated Architects-Engineers developed a set of standard schemes, establishing guidelines for modular designs and a master plan.[68]

The construction of a bridge across Los Alamos Canyon was critical to moving the Laboratory because the canyon separated the Main Technical Area from South Mesa. The Atomic Energy Commission awarded the construction contract in May 1950, and the bridge opened in August 1951.[69] Between 1947 and 1951, the Laboratory established more than 12 technical areas and hundreds of facilities on the other side of Los Alamos Canyon, away from the townsite. Plans for the South Mesa access road (present-day Truck Route) and a power plant were also underway. By 1954, the Atomic Energy Commission invested more than $127 million in technical facilities at Los Alamos Scientific Laboratory.[70]

As the Atomic Energy Commission was established, Director Bradbury began rebuilding the Laboratory's intellect. He established research and development priorities, initiated new projects, and hired the appropriate staff to accomplish mission objectives. To remain germane and attract first-rate scientists, Director Bradbury expanded the Laboratory's weapons-research programs and extended their reach. Cooperating primarily with universities, the Laboratory established student fellowships, postdoctoral appointments, and consultant agreements.[71] Director Bradbury began "building his ideal Laboratory" and convinced the Atomic Energy Commission and the University of California of his plans.[72]

The Atomic Energy Commission and Director Bradbury knew that mission success was dependent on Los Alamos's being a nice place to live. Without an attractive community, they could not expect to keep high-quality staff, students, and consultants in town. The military camp had to be transformed into a traditional community that included housing, schools, municipal services, and medical facilities.[73] Director Bradbury took an active interest in this effort, spending much of his time dealing with domestic crises.[74] It has been said, "He lived as though he were killing snakes every minute of the day."[75] In March 1948, the Atomic Energy Commission announced a 5-year community master plan worth $65.5 million. By 1954, the Commission had invested more than $121 million in community and general-use facilities in Los Alamos.[76]

Director Bradbury established the Laboratory's model to remain consequential, explaining in 1963 that, to succeed, the Laboratory had to exist for a purpose, have a definitiveness and uniqueness of purpose, and have good staff.[77] He noted, "We had very specific, tangible objectives and we were well supported in Washington."[78] Between 1945 and 1967, during Director Bradbury's tenure, the nation's stockpile grew from 2 to 31,255 weapons, and the United States conducted more than 500 nuclear tests.[79] To both maintain a thriving weapons program and ensure the permanence of the Laboratory, Director Bradbury diversified the weapons-research mission as much as possible.[80]

In 1968 during the Laboratory's 25th anniversary, Director Bradbury was awarded the Atomic Energy Commission's citation, in part, for "his

SETTING THE STANDARD

In December 1947, Associated Architects-Engineers proposed architectural and structural standards for new facilities at the Laboratory.[85]

ADMINISTRATIVE BUILDING

Type A: Rectangular plan, five stories high with a service tower
Type B: Rectangular in plan and numerous stories high with services in the center
Type C: U-shaped in plan with a three-story main building and two-story wings
Type D: Rectangular in plan and one story high with separate wings for each department

LABORATORY

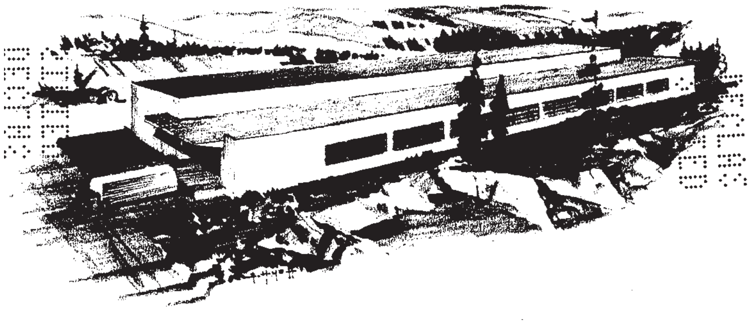
Type A: Two-story-high laboratory and office combination
Type B: Three-story sets of laboratories and offices
Type C: One-story-high laboratory with utilities in the attic

SHOPS AND WAREHOUSES

Type A: Three-story-high shops and warehouse combination with freight elevator
Type B: Main warehouse with separate wings for shops

UTILITY BUILDINGS

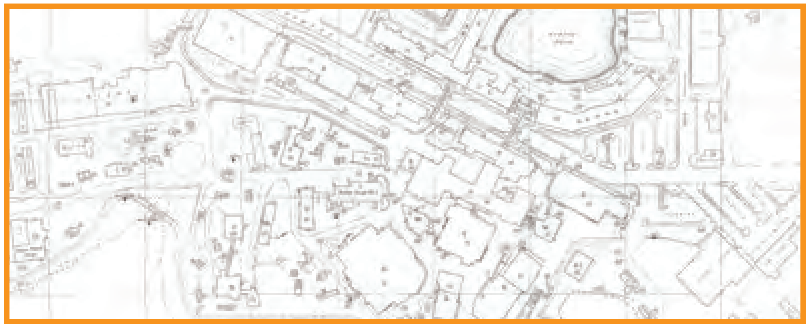
Type A Powerhouse: Housed four 5,000-horsepower diesel generators
Type B Firehouse: Sited on a corner lot with two wings for personnel quarters



Design for Shop and Warehouse type A, by Associated Architects-Engineers, Los Alamos, New Mexico.

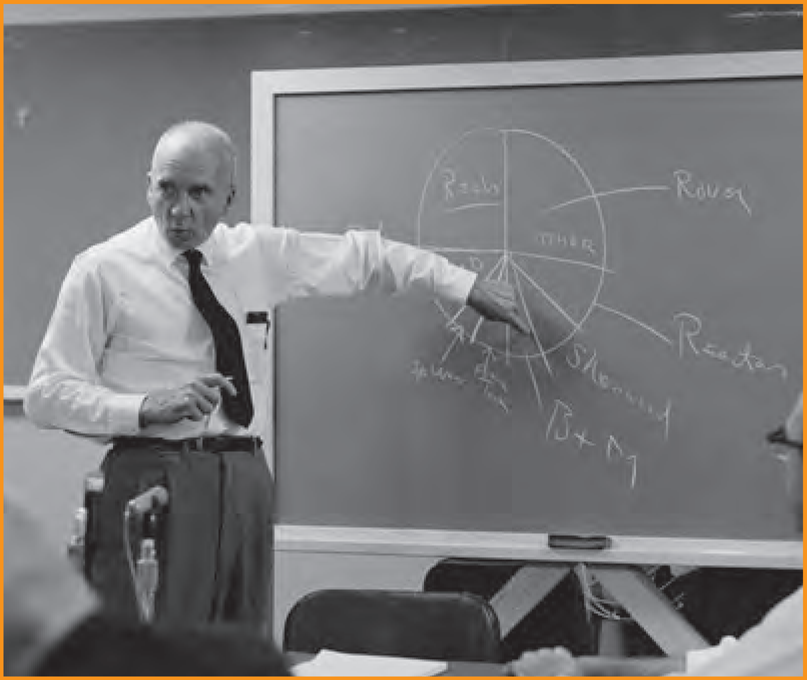
accomplishments as a scientist and administrator in translating basic concepts into practical instruments of national security and peacetime national goals" and "his courageous and imaginative leadership after World War II in transforming a temporary wartime installation into an outstanding modern center for research and development."[81] Senior Laboratory Historian Alan B. Carr noted that Norris E. Bradbury is considered the father of the modern federal Laboratory.[82]

Today, we face many of the same operational challenges that Director Bradbury faced in the late 1940s. As the Laboratory expands its programs—namely the pit-production mission—the need is increasing for more regional housing, high-quality staff, reliable power, and mission-essential infrastructure. In 2021, the Laboratory developed a comprehensive Campus Master Plan that established a vision for the future.[83] With aims similar to those of the Associated Architects-Engineers in 1947, the Laboratory is meeting the increased demand for staff and space by adopting modular construction, expanding parking capacity, and increasing telework options. The Laboratory Agenda for fiscal year 2022 seeks to improve talent acquisition plans, double the rate of hiring, increase procurement volume, innovate subcontracting, expand construction and engineering capacity, and improve the review and approval processes.[84] Meeting the Laboratory's energy needs will be accomplished through investments in long-term, power-purchase agreements. Comprehensive facility-based planning ensures that upcoming expansions will be supported by maintenance and operations staff and activities, including criticality safety, waste management, security, and environmental permitting. To succeed, the Laboratory must continue to execute sustained operations that are reliable and responsive to mission needs.



Portion of the Main Technical Area in 1951, before the Laboratory was relocated.

Omega Bridge over Los Alamos Canyon, 1959.



Director Bradbury discusses the Laboratory's budget in July 1963.

TRANSFERRING OVERSIGHT TO CIVILIANS

Appointed by the President, the civilian Atomic Energy Commission took over control of atomic energy from the military in August 1946.[90] President Harry S. Truman signed Executive Order 9816 in tandem and, on January 1, 1947, conveyed the assets of the Manhattan Engineer District to the newly appointed commission.[91] Transitioning responsibility from the military to the Atomic Energy Commission was not immediate because the military continued to oversee the Laboratory at least through March 1947.[92]

In general, the Atomic Energy Commission pursued a policy of decentralization.[93] As part of this management philosophy, they continued with contractor-operated facilities even though the Atomic Energy Act of 1946 allowed them to use federal employees. In 1947, they established the Office of Santa Fe Directed Operations (later known as the Santa Fe Operations Office) in Los Alamos.[94] The Commission established a Los Alamos Field Office in 1951 and moved its regional office to Albuquerque.[95] The Atomic Energy Commission renewed the University of California's contract to operate the Laboratory and Zia Company's contract for Laboratory maintenance and townsite operations.[96]

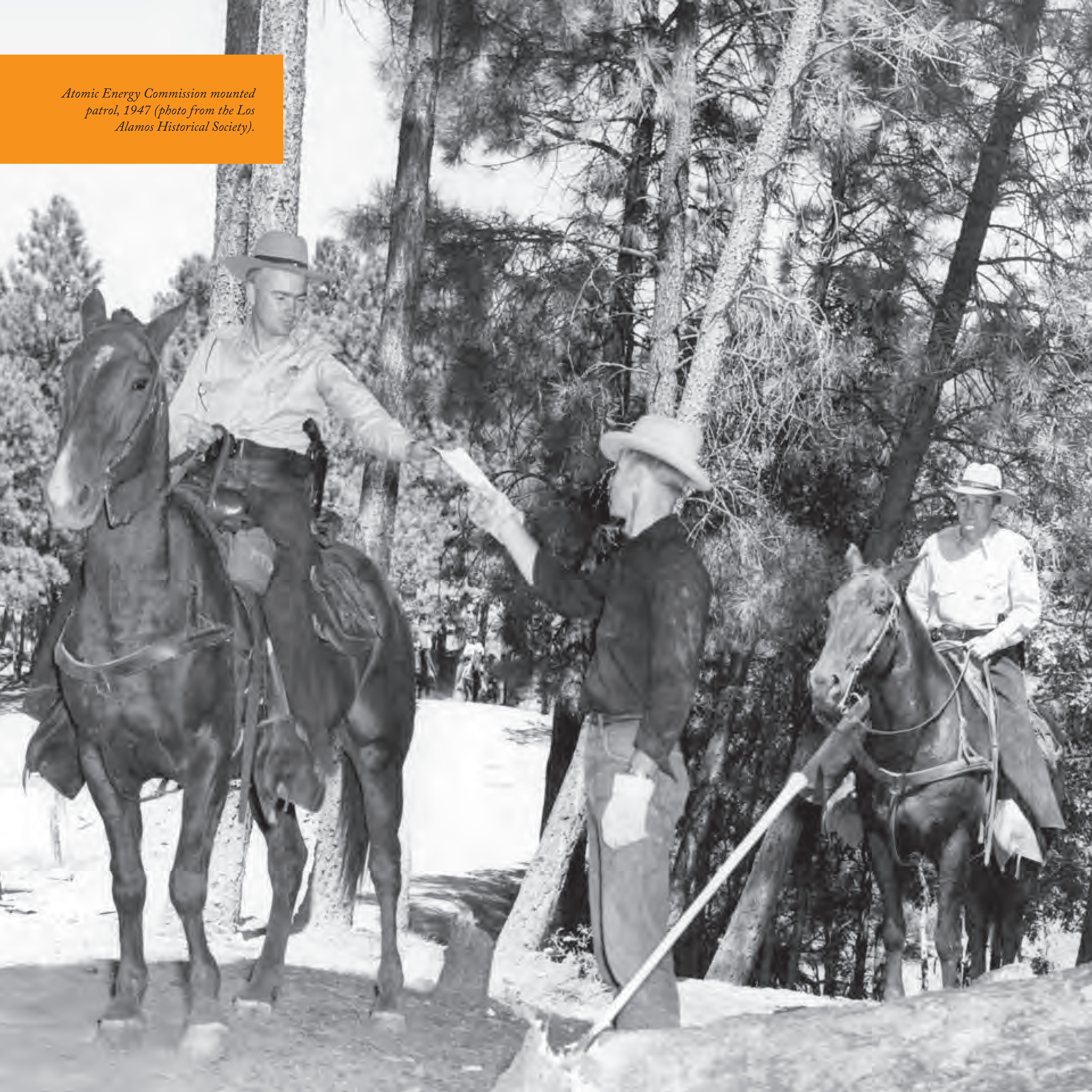
Los Alamos was a "company town," and the Zia Company operated it.

The Zia Company—not to be confused with the U.S. Army Corps of Engineers Albuquerque District's Zia Project or Zia Area Office[97]—was founded in April 1946.[98] At the command of the Manhattan Engineer District, general contractor Robert E. McKee established the Zia Company as a subsidiary to provide support services to the Laboratory after World War II.[99] Under a cost-plus-fixed-fee contract, the Zia Company performed maintenance and operations services for both the Laboratory and the Los Alamos townsite.[100] These services included support of a $127-million Laboratory construction program and a $121-million community master plan.[101] Although the cost of construction was typically more expensive in Los Alamos because of its isolated location, two decisions kept costs down. First, the Atomic Energy Commission employed competitive bidding and second, they built a construction camp in White Rock so that smaller companies could bid on the work.[102]

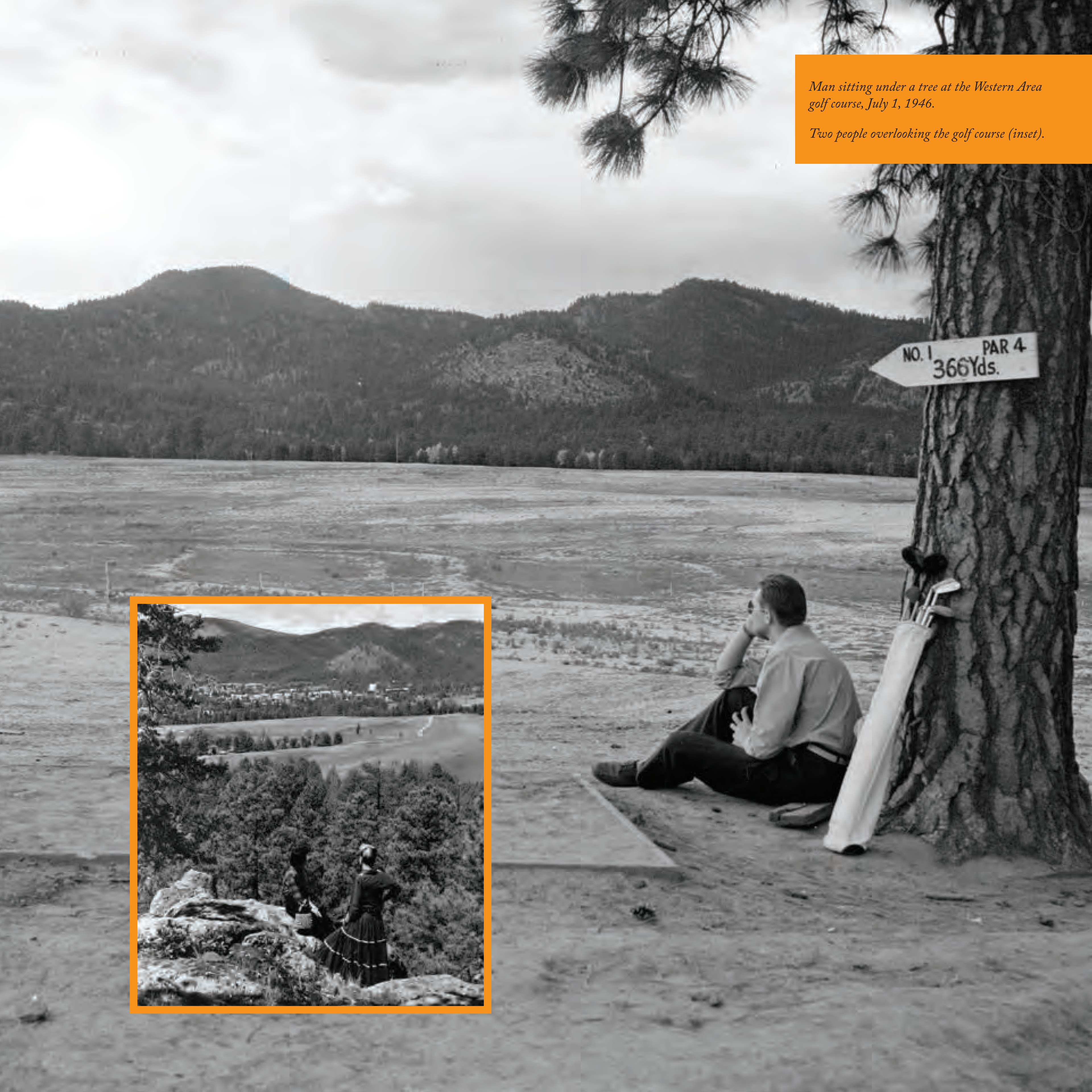
The Zia Company was heavily involved in implementing the Atomic Energy Commission's priorities for the Laboratory: stabilize and revitalize the Laboratory and develop a community "satisfactory to the scientists."[103] Notably, when the Zia Company took over maintenance and support operations, "the utilities for the technical and community areas were both a maze and a mess."[104] The Zia Company managed all utilities and environmental services in Los Alamos (electricity, water, natural gas, steam, garbage, and sewage); ran the town bus system and the Laboratory taxi; maintained all of the roads; and provided architectural and engineering services.[105]

The expediency of the wartime effort to develop the atomic bomb left the Laboratory with crowded complexes, temporary buildings, and cramped spaces.[106] The Zia Company provided supply procurement and storage, cost and property accounting, fleet management, janitorial services, "gadgeteering," and facility maintenance.[107]

Los Alamos was a "company town," and the Zia Company operated it: lodging, cafeterias, radio station, newspaper, veterinary hospital, community hospital, and schools. They managed and maintained all community buildings and housing, collected rental and utilities payments, and kept up parks. Because the Atomic Energy Commission paid for commercial



Atomic Energy Commission mounted patrol, 1947 (photo from the Los Alamos Historical Society).



Man sitting under a tree at the Western Area golf course, July 1, 1946.

Two people overlooking the golf course (inset).

LEADERS IN OPERATIONS

JANE HAMILTON HALL

Jane Hall began in the Laboratory’s weapons division in 1946, co-led the Clementine reactor project, and was promoted to assistant director by Director Bradbury in 1955. Born on June 13, 1915, Jane Elizabeth Hamilton grew up in Denver, Colorado. She married physicist David B. Hall in 1939, had two children, and earned a doctorate in physics in 1942 from the University of Chicago. Before moving to Los Alamos in November 1945, the couple had worked at Chicago’s Metallurgical Laboratory and at Hanford. Throughout her career, colleagues admired Jane for both her great scientific ability and exceptional management skills. The Atomic Energy Commission awarded Hall the AEC Citation for outstanding service to the nation upon her retirement in June 1970.[86] Jane Hall is presently honored with a conference room named after her—the first one named after a woman at the Laboratory—in the Radiological Laboratory/Utility/Office Building (or RLUOB),[87] and an award in her name is given to teams or organizations that have “demonstrated continued improvement in safety/security processes or performance.”[88]

HENRY REESE HOYT

Henry Hoyt began as a senior Laboratory administrator in 1946 and was promoted by Director Bradbury to assistant director for administration in 1950. In this position, Hoyt coordinated fiscal, procurement, property, personnel, and miscellaneous administrative activities. Born on December 5, 1902, in New York City, he received an associate degree in business in 1924 from Harvard College. He and his wife, Keziah (or Kay), had three children, and Hoyt served on the home front in the U.S. Air Force from 1942 to 1945. In addition to his Laboratory duties, Hoyt charitably gave back to his Santa Fe community. He served as president of the International Folk Art Foundation and was a member of its board of trustees. Additionally, he was a member of the board of managers for the School of American Research. Hoyt retired on October 31, 1970, and received a certificate of appreciation for his valuable service from Director Agnew.[89]

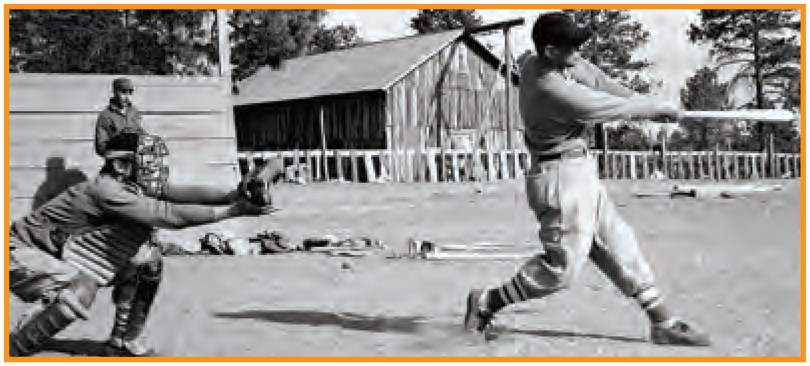
Atomic Energy Commission Office of Santa Fe Directed Operations, Los Alamos, 1947 (photo from the Los Alamos Historical Society).

Zia service station.

buildings, they limited the types and number of businesses allowed to operate. For example, of the 33 business types in Los Alamos in 1952, only food stores, cafeterias, barber shops, service stations, jewelers, movie theaters, and drugstores numbered more than one.[108] Through the contracting of private concessionaires, the Zia Company eventually delegated the operation of commercial enterprises.[109] The state educational system appropriated schools administration in 1949, and Los Alamos Medical Center, Inc., took over hospital management in 1950.[110]

Undoubtedly, the Atomic Energy Commission was fortunate to inherit the Zia Company.[111] The work required at the Laboratory provided for a Zia Company payroll of 1,400 staff by 1954[112] and included skilled and unskilled craftpersons from local unions, whom the Zia Company kept exhaustively trained. The Zia Company spent 60 percent of its resources in support of Laboratory operations and 40 percent on the townsite. After sustaining Laboratory operations for 40 years, the Zia Company lost its contract to Pan Am World Services in 1986.[113] An outside contractor provided support services to the Laboratory until 2008, when the Laboratory brought the functions in-house.[114] Made possible by reinvesting funds previously allocated for the state's gross-receipts tax, this structural change allowed the Laboratory to build a maintenance organization that ensures mission operations to this day.[115]

As noted in a 1954 Laboratory report about the state of Los Alamos, "There were few amenities of normal American life other than those provided by the residents themselves, but these inconveniences were accepted by civilian and military residents alike as part of their contribution to winning the war."[116] Although it took time for residents to assume greater responsibility for their community, they eventually created boards of trustees, associations, clubs, committees, and organizations.[117] Notably for residents, the last outdoor toilet disappeared in 1949, citizens were allowed to vote in 1950, the security switchboard for home phones

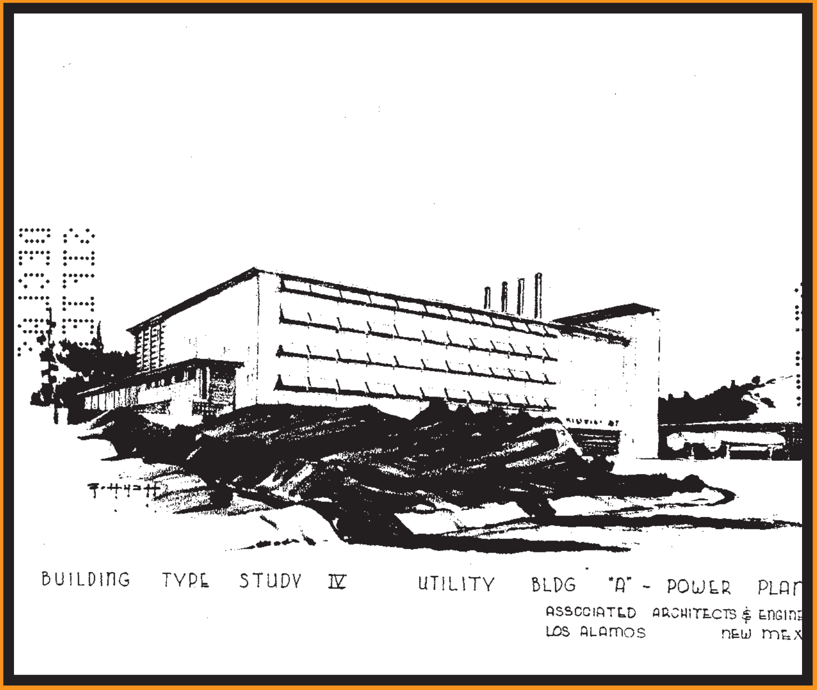


The community of Los Alamos put great emphasis on indoor and outdoor recreation and its associated facilities. It's a hit, April 22, 1947.

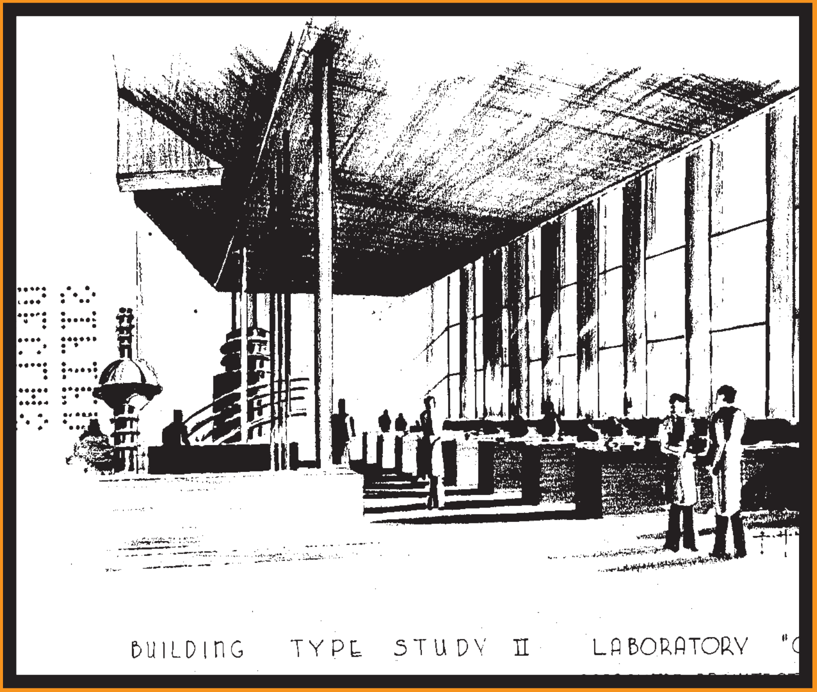
was removed in 1954, the town opened up to the public in 1957, and private homes were built in 1959.[118] Today, the County of Los Alamos is governed by a council with the support of boards and commissions.

Contrary to their maintenance and operations outsourcing, the Atomic Energy Commission conducted their own security.[119] They established the AEC Security Service (later known as the AEC Protective Force), made up of federal employees. AEC Security Service personnel wholly replaced the U.S. Army Military Police by mid-November 1947.[120] The Atomic Energy Commission also established a fire department and community police force.[121] The community founded a best-in-class Civil Defense Organization, overseen by the Los Alamos Field Office's Chief of Health and Safety when off-duty.[122] The Laboratory's security service comprised federal employees from 1946 to 1984, at which time the Laboratory secured a protective force contractor.[123]

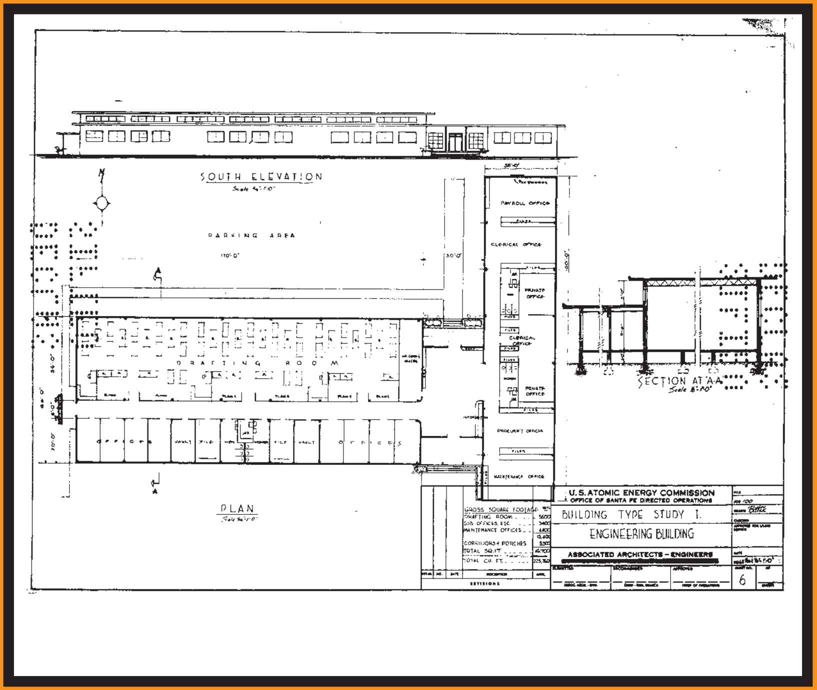
Ceremony for the U.S. Army transfer of security responsibility to the Atomic Energy Commission in 1947.



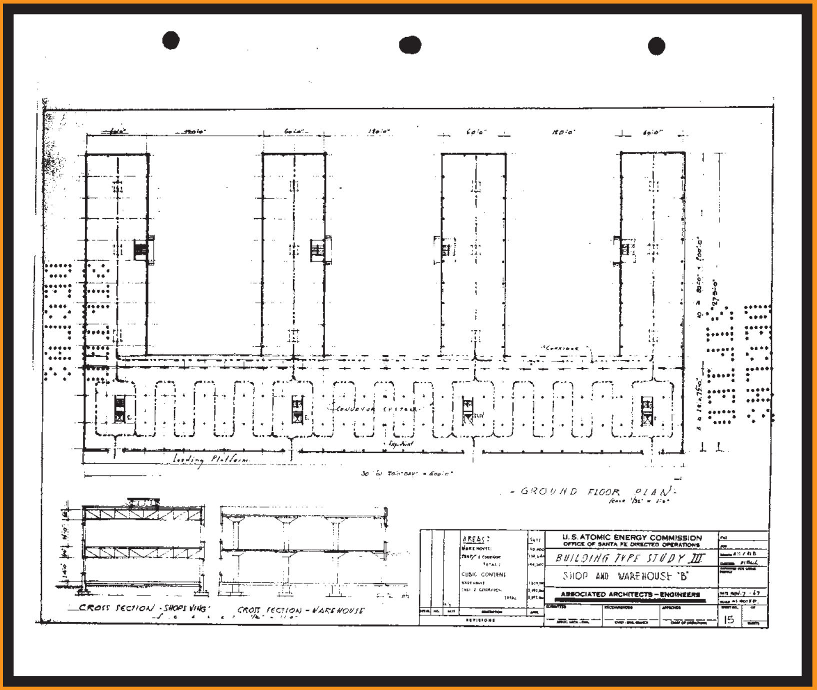
Design for Utility Building type A, by Associated Architects–Engineers, Los Alamos, New Mexico.



Design for Laboratory type C, by Associated Architects–Engineers, Los Alamos, New Mexico.



Design for Engineering Building, by Associated Architects–Engineers, Los Alamos, New Mexico.



Design for Shop and Warehouse type B, by Associated Architects–Engineers, Los Alamos, New Mexico.

Stretch engineer's maintenance console, 1961 (opposite page).

DIVERSIFYING MISSION THROUGH PARTNERSHIPS

The Laboratory's post–World War II mission was to continue to research and develop nuclear weapons. Bradbury had a plan for the Laboratory's future before the Atomic Energy Commission was even established.[125] To quell the staff exodus and keep the Laboratory relevant, Director Bradbury developed new technical research programs.[126] Expanding beyond basic nuclear research, they included physics, chemistry, and metallurgy.[127] Fortunately, the scientists found Bradbury's diversified programs challenging and rewarding, and the Laboratory prospered with new partnerships.[128]

In 1954, some interested Laboratory scientists formed a study group to explore the feasibility of a nuclear-powered rocket, unofficially starting Project Rover.[129] To investigate the technological principles, the Atomic Energy Commission began a demonstration program at the Laboratory in 1955. The Laboratory established a Nuclear Rocket Propulsion (N) Division, led by Raemer Schreiber, to support the program.[130] Initially collaborating with the U.S. Air Force and the University of California's Radiation Laboratory at Livermore, the newly founded National Aeronautics and Space Administration joined the project in 1958.[131] In 1961, as the space race began, President John F. Kennedy inaugurated the Project Rover program.[132] Project Rover was discontinued in January 1973 because of growing concerns about the overall cost of the space program, and national priorities had changed.[133] Considered a success, Project Rover, at its peak, was the second largest program at the Laboratory, engaging many divisions and utilizing various facilities.[134] Importantly, subsequent deep-space missions greatly benefited from technology developed during Project Rover, and the Laboratory continues to collaborate closely with the National Aeronautics and Space Administration.

Since helping to originate the field in high-performance computing, the Laboratory has always been at the forefront to develop new and better systems.[135] The Laboratory designed computers and augmented systems with commercial units until it began working with industry to design new computers in 1956.[136] The Laboratory collaborated with IBM for 5 years to co-design the first transistorized computer, Stretch (or the IBM 7030).[137] Keen to continue partnerships and knowledge sharing, the Laboratory was a founding member of the IBM SHARE user group, establishing relationships with other scientific computing centers such as RAND and MITRE.[138] In 1966, the Laboratory collaborated with the Control Data Corporation to develop the CDC 6600, the first remotely operated system.[139] Another computing partner was the University of New Mexico. The Laboratory remains on the cutting edge of supercomputing—the primary tool for ensuring the safety and reliability of the nation's nuclear stockpile.[140]

Project Rover, at its peak, was the second largest program at the Laboratory.

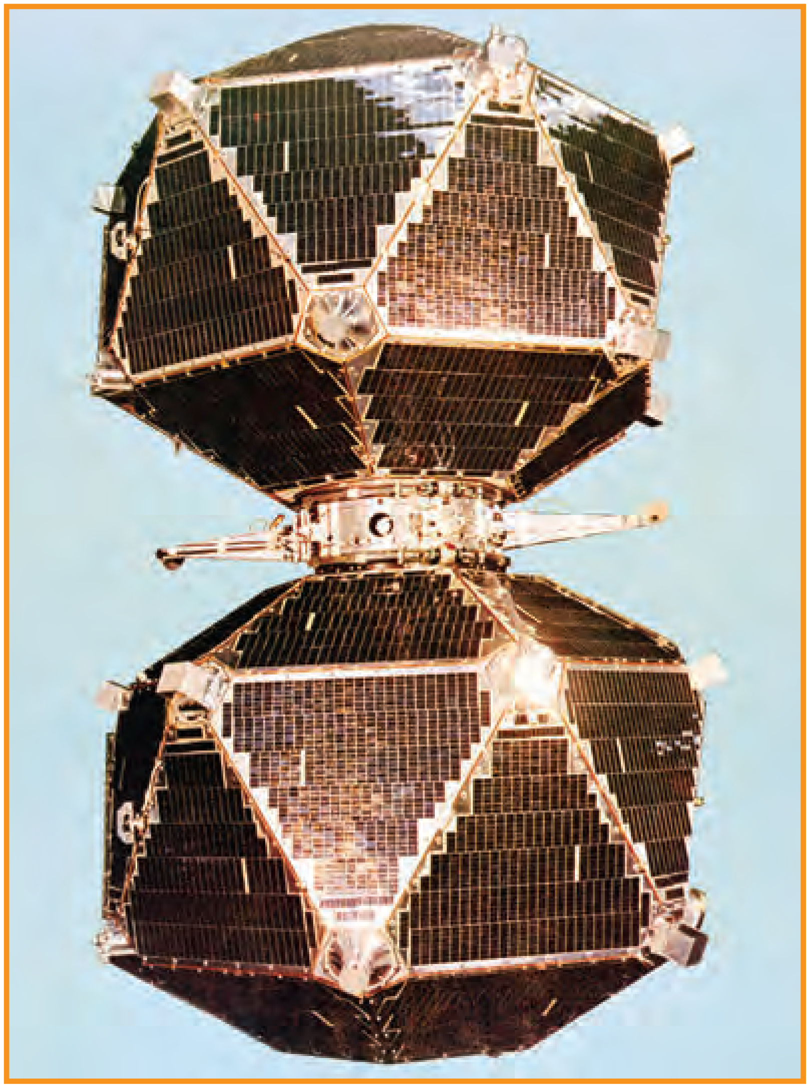
In 1958, the Advanced Research Projects Agency developed a "watchman" project in response to the launch of the Sputnik satellite by the Soviet Union.[141] The Los Alamos Scientific Laboratory and Sandia Laboratory were funded in 1959 to research technologies for monitoring nuclear explosions around the world.[142] Developing into the Vela satellite Program, the project involved primarily the P-1, P-4, and W-7 groups at the Laboratory; the Atomic Energy Commission; the U.S. Air Force; and the Advanced Research Projects Agency (present-day DARPA).[143] The Laboratory developed detection instrument systems for nuclear explosions within the earth's atmosphere and in space.[144] Ten days after the signing of the Nuclear Test Ban Treaty on October 7, 1963, the United States launched Vela 1 and 2 to conduct nuclear surveillance.[145] In total, the United States launched six pair of Vela satellites between 1963 and 1969 and made

numerous cosmic discoveries along the way.[146] The Laboratory continues to support satellite-based nonproliferation programs.

Markedly, President Dwight D. Eisenhower's Atoms for Peace proposal and the Atomic Energy Act of 1954 shifted the trajectory of nuclear energy and opened up new opportunities for partnerships. The former promoted the international management of nuclear energy and its peaceful uses, and the latter allowed the sharing of technical and scientific nuclear information with the foreign nations.[147] Significantly, in 1960, the Atomic Energy Commission endorsed the collaboration of laboratories with other federal agencies in nonnuclear research.[148] They recognized that "the strong capabilities of the laboratories are not the exclusive resources of the atomic energy field; they are held in trust for the nation as a whole."[149] Applying technology to peaceful uses, the Laboratory participated in the Plowshare series of nuclear testing and directed Project Sherwood. Plowshare explored the feasibility of using nuclear explosions for excavation, natural gas exploration, and earth moving.[150] Project Sherwood comprised the Laboratory's research on controlled thermonuclear (fusion) reactors that could produce an essentially inexhaustible source of energy.[151]

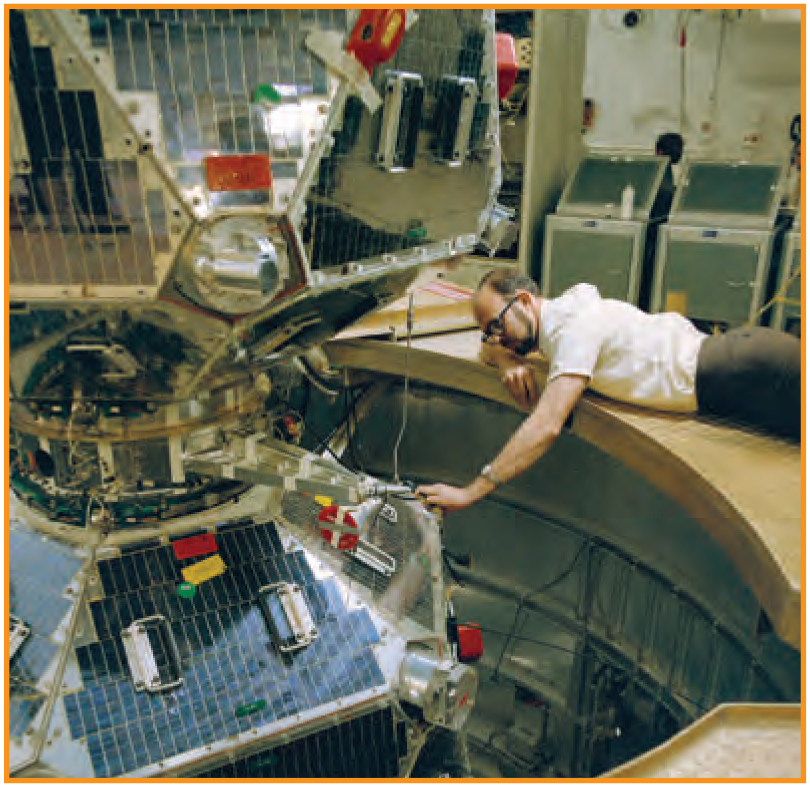
Director Bradbury's plan to transition the Laboratory from one project (developing an atomic bomb) to many projects (technical research to integrate physics, chemistry, and metallurgy) created a sustainable future for the Laboratory. The effort required funding from the Atomic Energy Commission; construction, maintenance, and operations support from the Zia Company; innovative proposals from the staff; and a means to attract high-quality scientists and engineers. Bradbury initiated the wide-ranging cooperation with universities and colleges that the Laboratory enjoys today. His strategy included developing dynamic consultant agreements, making numerous postdoctoral appointments, and creating student fellowships.[152] Director Bradbury's tactics were the predecessors of the Laboratory's current robust student pipelines in the fields of science and operations.

Today, establishing and improving community relations is a core part of the Laboratory's mission. The Laboratory's management and operations contractor, Triad National Security, LLC (Triad), believes that it ensures effective and successful operations and enhances the economic viability of surrounding communities.[153] Building on Director Bradbury's achievements, the Laboratory has increased its partnerships with academic institutions and developed new relationships with trade organizations. Recognizing that technological and process improvements drive efficiency,



Developed in 1962, the Laboratory-designed Vela satellites were named from the Spanish word velar, meaning "to watch."

improved talent pipelines focus on the critical skills currently needed, such as construction and craft trades, radiation protection, engineering machining, and mechanical engineering.[154] To address stewardship concerns, the Laboratory has increased its regional and community dialogue and partnerships,[155] which include Laboratory leadership's being more visible in the community by serving on boards of directors and attending board meetings. The Laboratory is also focused on improving relationships with regional tribes. As such, the Laboratory established a Tribal Working Group and presents high-profile projects to the All Pueblo Council of Governors. Triad has increased philanthropy in northern New Mexico by investing $7 million since November 2018. As part of improving the Laboratory's culture, "Community involvement and engagement [is] expected of everyone across the organization."[156]

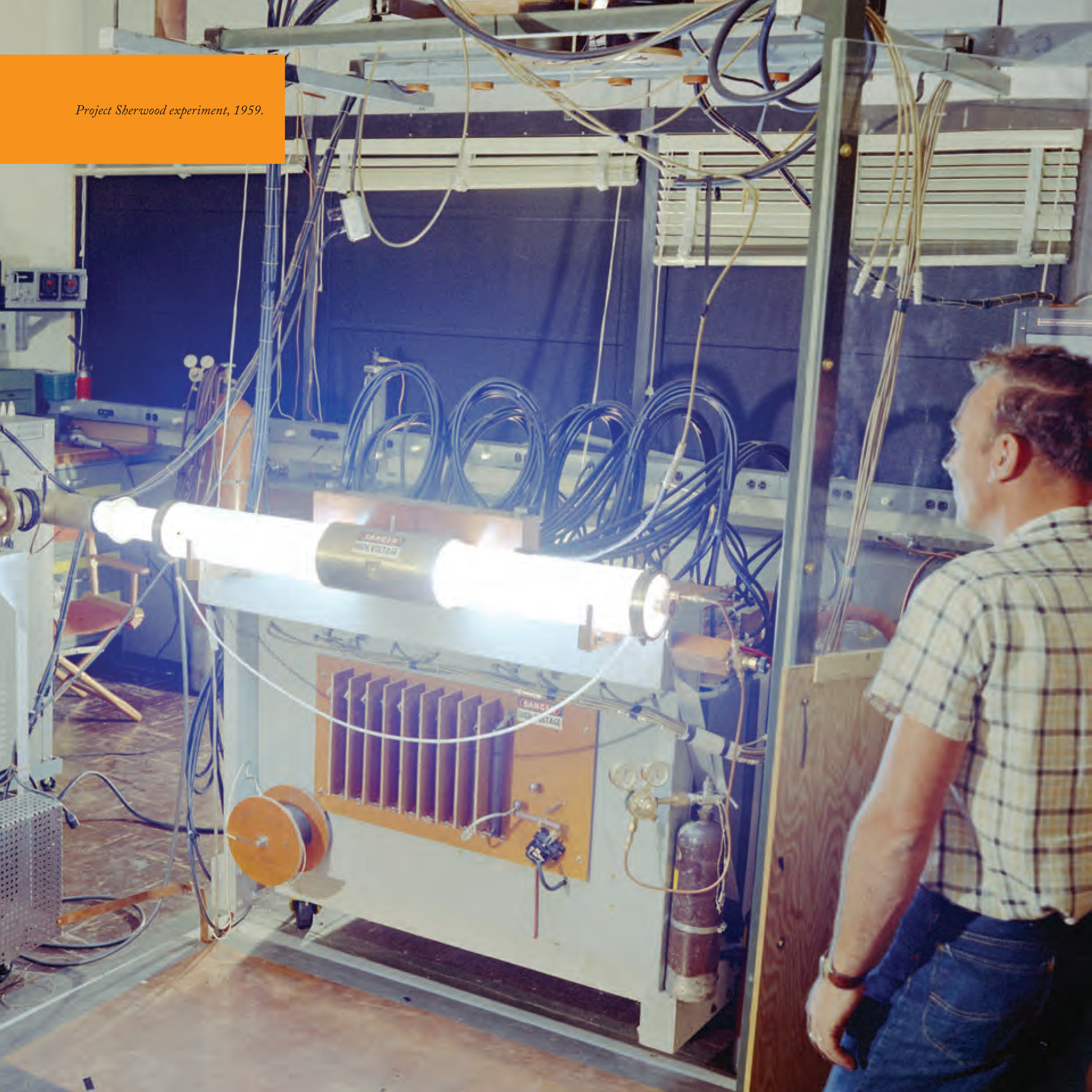


Vela satellite assembly at Cape Canaveral, April 1970.

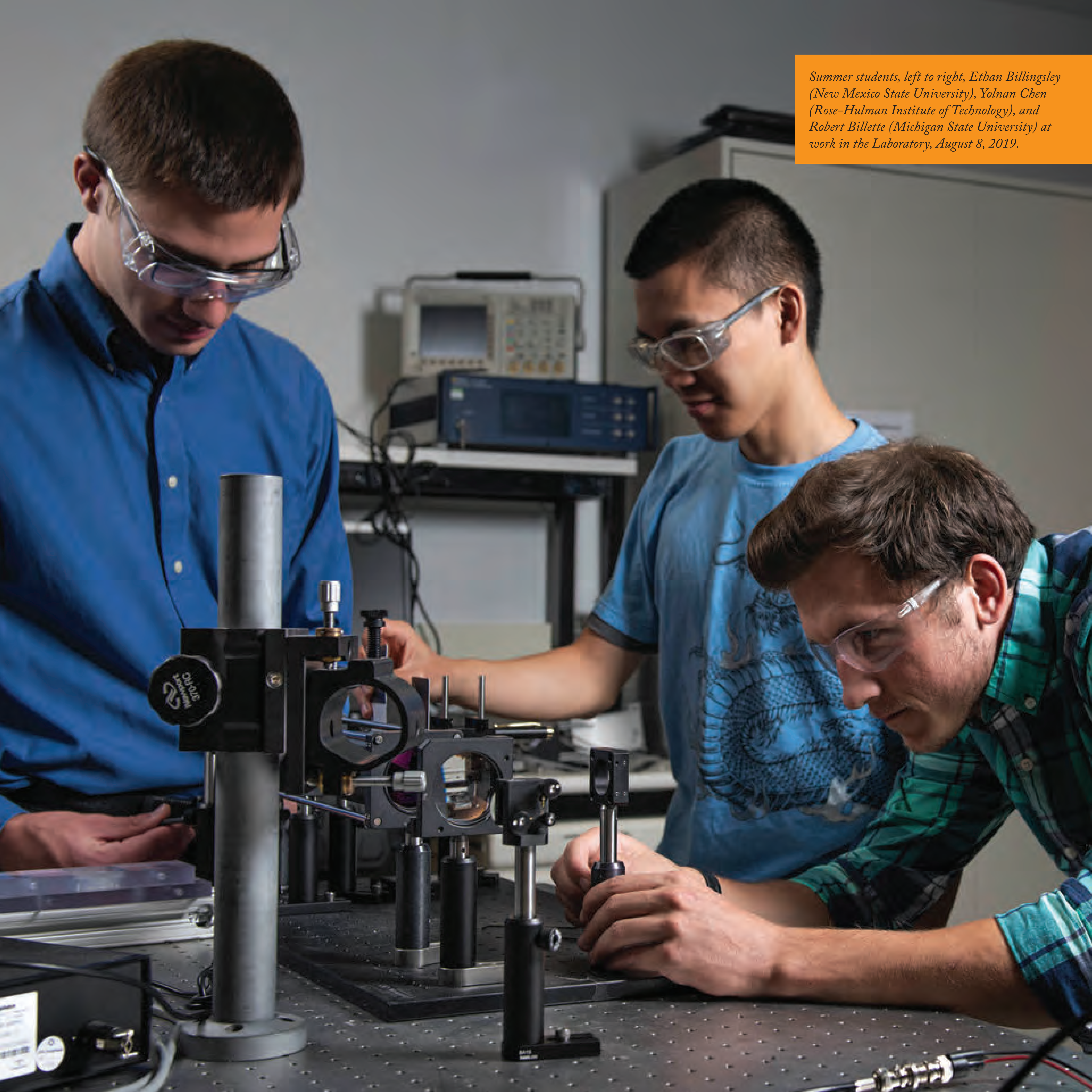
EAST GATE SECURITY STATION

East Gate, Back Gate, and Sandia Gate served as public security checkpoints along public access points during the early-Cold War era. The East Gate checkpoint included a tower, a pass office, and a covered vehicle inspection station. Constructed in 1948 by W. C. Kruger and Associates, the checkpoint served the townsite and the Laboratory until 1957, when the townsite was opened up to the public. The location of the tower offered excellent views of traffic along State Road 502 and increased the visibility of physical security to the public.[124]

East Gate Security Station.



Project Sherwood experiment, 1959.



Summer students, left to right, Ethan Billingsley (New Mexico State University), Yolnan Chen (Rose-Hulman Institute of Technology), and Robert Billette (Michigan State University) at work in the Laboratory, August 8, 2019.

PROTECTING THE WORKFORCE

Unfortunately, the Laboratory's health, medical, and safety services were in as much upheaval as the rest of the Laboratory after World War II.[157] In response, Director Bradbury called for the development of a health physics program and championed the continuing research of radiation effects.[158] Notably, Chemistry and Metallurgy Division Leader Eric Jette was an early advocate for a Health Division at the Laboratory, even sending Director Bradbury a memo in 1946 requesting its establishment and providing an organizational chart.[159] Expanding on the health and safety efforts of the Manhattan Project, the Laboratory established an independent Health (H) Division in May 1947, with Louis H. Hempelmann as its Division Leader and Wright H. Langham as his alternate.[160] The new division—even its research group—was a service organization to the Laboratory, with the aim of maintaining the health and safety of workers. Notably, biomedical research began in the laboratory in support of worker safety of those engaged in handling plutonium.[161]

Biomedical research was born out of necessity during the Manhattan Project.

By 1948, the Health Division formed a trainee program and occupational health, radiological safety, radiobiology, industrial health, and safety groups.[162] In 1949, new Health Division Leader Thomas L. Shipman created the Industrial Hygiene (H-5) and Bio-Medical Research (H-4) groups. At the Laboratory, biomedical research was born out of necessity during the Manhattan Project as an essential support group to the weapons program.[163] However, by the late 1940s, the Health Division had made numerous contributions to the general body of biomedical knowledge, which gained its independence as an important field of study like physics, chemistry, and metallurgy.

From the Manhattan Engineer District, the Atomic Energy Commission received a "comprehensive accident prevention and health program" within the complex.[164] However, the physical state of equipment and facilities across the complex varied. As such, the Atomic Energy Commission established the Safety and Industrial Health Advisory Board in August 1947 to provide an independent assessment. The resulting report established, "Los Alamos, with the worst record in the complex, had not been subject to health and safety control from headquarters,"[165] and changes ensued.

Health Division Leader Shipman noted in 1950, "Gradually and inevitably the concept of 'health' broadened as it was realized that general matters of physical and mental well-being were matters of importance in the relationship between the worker and the work he was doing."[166] Planned in conjunction and intentionally sited next to each other, the Los Alamos Hospital opened in January 1952, and the Laboratory's Health Research Laboratory—home to the Health Division—opened in October 1953.[167] Although the two organizations were closely cooperating before their relocation, the importance of this continued collaboration was noted aptly by Dr. Shipman, ". . . there now exists the very healthy realization that we all have a common aim, that a person cannot have one part of his health on one side of a fence and one part on the other."[168]

Director Bradbury also oversaw the establishment of facilities and procedures for remote handling of fissile materials following the Manhattan Project–era criticality accidents.[169] These new guidelines prioritized personnel safety while safeguarding fissile material. Moreover, Laboratory management had to approve a detailed set of operating procedures for each experiment. The new operating philosophy included designating an individual to monitor the safety of the experiment.[170] Significantly, the Laboratory has always been on the cutting edge of


The aftermath of the high-explosives accident that killed Candelario Esquibel on June 26, 1956.

criticality safety and criticality experiments. Work conducted by the Laboratory and others forms “the basis for all criticality safety calculations in our nuclear facilities.”[171]

Between 1947 and 1970, the Laboratory experienced 12 fatal accidents.[172] The first of these occurred in 1954, when a Laboratory worker died of an electrocution while stationed in the Pacific. In 1956, the first fatal high-explosives accident occurred. Subsequently, the Laboratory’s GMX Division formed the Explosives Sensitivity Committee, which was responsible for “reviewing available sensitivity data and approving the use of new compounds and formulations . . .”[173] By 1980, this committee reported straight to the Laboratory Director.[174] Two additional high-explosives accidents killed six Laboratory workers in 1959, bringing about the preparation of standard operating procedures for all explosives operations.[175] Changes to existing practices included the addition of some remote-control drilling, the installation of blast doors to machining bays, a 50-pound weight limit on explosives to be burned, and the use of specially designed containers to transport explosives.[176]

A December 1958 criticality accident led to the death of one Laboratory worker in 1959.[177] Before the Laboratory restarted operations at the site, they installed new and better equipment, implemented improved sampling techniques, and emphasized compliance with procedures.[178] Most criticality accidents worldwide occurred between 1950 and 1970, during the early era of the Cold War; after 1970, the criticality accident rate decreased by 90 percent.[179] Three additional fatalities occurred in 1961: a fall, an asphyxiation, and a vehicle accident.[180]

During the early–Cold War era, the Laboratory’s health, medical, and safety programs evolved and expanded to keep up with the pace, quantity, and diversity of research occurring on site. The Laboratory made operational changes after incidents to lessen the chances of reoccurrence. The Health Division created radiation-counting machines, developed bioassay procedures, and invented protective gear and monitoring equipment (such as thermoluminescent dosimeters [or TLDs] used at the Laboratory today). The Laboratory’s occupational health program promoted physical, mental, and social well-being at work. An understanding of potential hazards and their effects, exposure limits, effective controls, and efficacious treatments matured hastily during the early–Cold War period.[181]

WHO KEPT THE LAB SAFE?

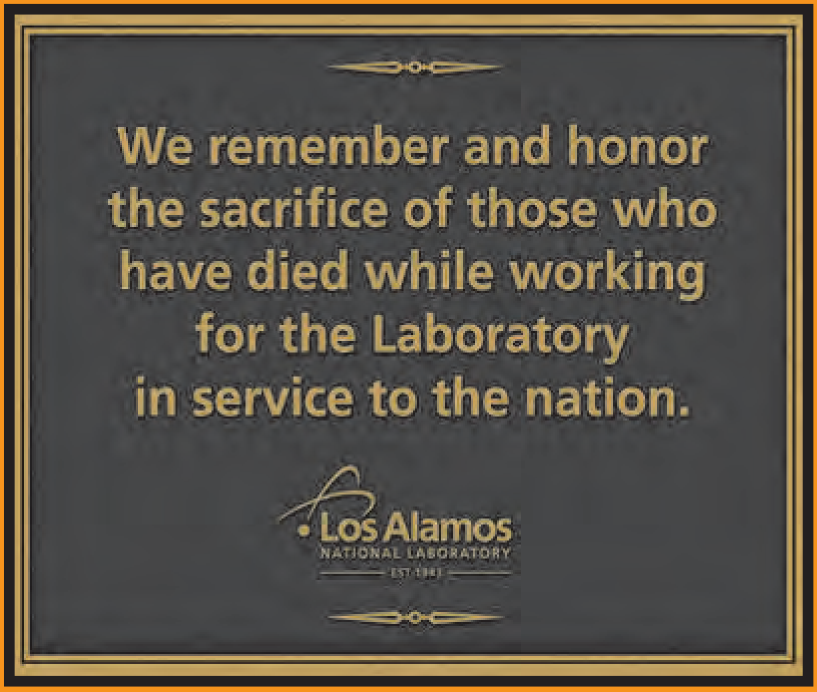
Roy Reider, "LASL's Mr. Safety," served as the Safety group leader in the Health Division from August 1948 through his retirement in February 1977 and as the Laboratory's safety director from 1954 to 1971.[183] Born in Dobbs Ferry, New York, on August 13, 1914, Reider acquired a degree in Chemical Engineering at Rensselaer Polytechnic Institute in New York. Before taking the Laboratory job in 1948, he was a safety engineer for an insurance company and a safety superintendent at a major explosives firm in Wisconsin. An active member in the community, he enjoyed public speaking and gave up to 10 lectures per month, both internal and external to the Laboratory, on a variety of subjects. As a leading safety expert in the nuclear field, Reider believed in helping, not hindering, the mission of the Laboratory, as asserted by Health Division Leader Shipman. Reider understood that there was no "absolute safety in a scientific laboratory" but that eliminating all risk would impede progress.[184] Reider hated safety slogans and posters and advocated for each division to make their own safety standard operating procedures and rules because safety is specific and rests with the workers and their immediate supervisor. With most injuries in the nuclear industry associated with strains, falls, tool mishaps, fires, and chemical accidents, Reider emphasized, "It's not always the obvious hazards that cause the accidents."[185] In 1964, the Atomic Energy Commission presented an Award of Honor to the Laboratory for operating 3,373,000 person-hours without a disabling injury. "It was the longest accident-free period in the Laboratory's history."[186] As of 1965, Safety Director Reider had reduced the Laboratory's accident rate by 50 percent from what it was during the Manhattan Project.

This profile is based on an article by David Sundberg in a 1965 issue of *The Atom*.[182]

Safety Group Leader Roy Reider, January 9, 1974.

The aftermath of the high-explosives accident that killed José Cordova, Sevedeo Luján, Escolastico Martinez, and Leopoldo Pacheco on October 14, 1959 (above left, above right).

The aftermath of the high-explosives accident that killed Leo Guerin and Ray Means on February 24, 1959.



We remember and honor
the sacrifice of those who
have died while working
for the Laboratory
in service to the nation.

Los Alamos
NATIONAL LABORATORY
EST 1943

The Laboratory also honors the service of four others who died between 1954 and 1961. Robert England died of an electrocution in 1954. In 1961, Clarence McInturff died from a fall, Wyndle Frazier died from asphyxiation, and Homer Gittings died from a motor-vehicle accident.

PROTECTING WORKERS AGAINST HAZARDOUS AEROSOLS

Notably, the Laboratory played a leading role in the identification, understanding, and protection of workers against radioactive aerosols.[191] It began in 1948, when the Laboratory hired Harry F. Schulte to start a program of industrial hygiene and to "correct some of the ventilating 'atrocities.'"[192] By the 1950s, the Industrial Hygiene Group, led by Schulte, was measuring particulate matter from nuclear testing; addressing ventilation problems associated with tritium activities; and collecting and analyzing air samples associated with beryllium, lithium, plutonium, and uranium operations.[193] Schulte and H-5 Alternate Group Leader Edwin C. Hyatt, dissatisfied with the unspecialized respirators used by personnel who were working with plutonium, brought about improved respirator design and testing in the late 1950s and through the 1960s.[194] Harry J. Ettinger assumed the role in the late 1960s, becoming the H-5 group leader in the 1970s.[195] He studied aerosols of burning fissile materials, tested filter media, and surveyed techniques employed to define respirable dust. The latter led to the identification of the LASL Conference Curve (or Los Alamos Curve) to "provide a basis for defining 'respirable dust' and lung deposition."[196] Still used today, this Laboratory breakthrough "led to significant advancements and application of respiratory protection."[197]

The Health Research Laboratory under construction on the right, with the Los Alamos Hospital (present-day Los Alamos Medical Center) on the left, June 15, 1953.

CECIL KELLEY CRITICALITY ACCIDENT

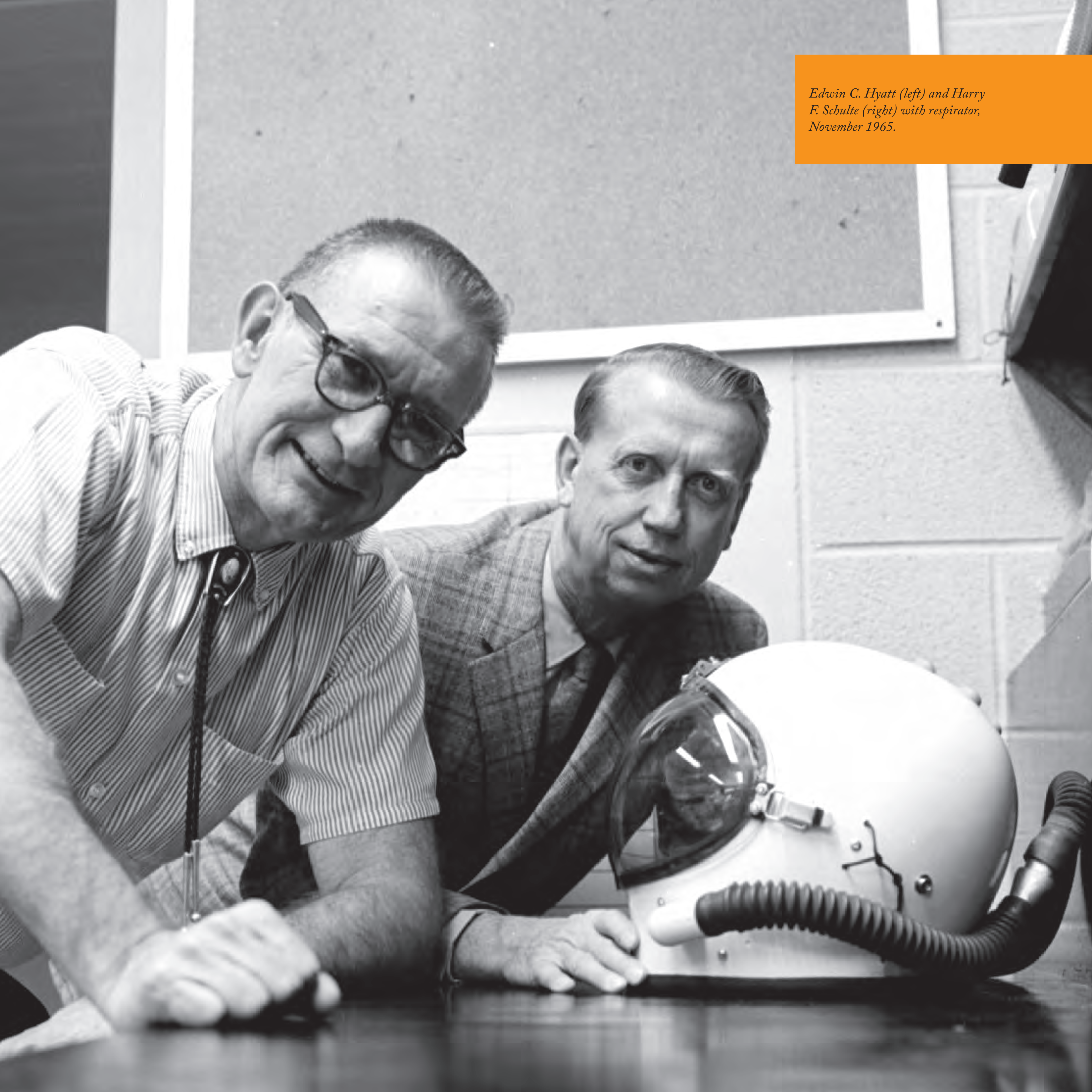
In January 1959, Cecil Kelley died from radiation exposure that he received during a criticality accident in December 1958. Kelley was an experienced plutonium-processing operator, and on December 30, he turned on the stirrer of a large mixing tank. Unbeknownst to him, the solution in the tank contained higher-than-normal levels of plutonium. When the liquid formed a whirlpool in the tank, the plutonium-containing layer congealed and went critical. Lasting 200 microseconds, the event released a large pulse of neutrons and gamma radiation. Falling or being knocked off of his observation ladder and becoming disoriented, Kelley turned the stirrer off and then back on and then left the building. Coworkers found Kelley outside stating, “I’m burning up! I’m burning up!”[199] The nature of his injuries was not understood for nearly 20 minutes, and Kelley died after a grueling 35 hours. The radiation dose has been estimated at “900 rad from fast neutrons and 3,000 to 4,000 rad from gamma rays, giving 3,900 to 4,900 rad.”[200] Significantly, “Kelley’s tragic death became an opportunity to determine certain factors crucial to the protection of workers.”[201] Upon collection and analysis of Kelley’s tissues, the Laboratory initiated the Los Alamos Human Tissue Analysis Program.[202] For many years, this program served as an indicator of the effectiveness of the Laboratory’s workforce-exposure-protection efforts.

This event summary is based on an article that appeared in a 1995 issue of *Los Alamos Science* that focused on radiation protection and the human radiation experiments.[198]

THERMOLUMINESCENT DOSIMETER

In 1962, the Low-Level Counting Section of the Laboratory’s Health Division began the development of a TLD with an operating range of 100 mrad to 2,000 rad.[187] Basing their investigations on previous studies (1953–1962) that used thermoluminescent materials to measure an absorbed dose, the team envisioned radiobiology and health-physics applications for the device.[188] By 1966, Laboratory staff were using TLDs at Nevada Test Site sampling stations during Project Rover testing.[189] Laboratory field experiments in 1975 traced levels of radioactivity in the vicinity of the Laboratory and the Trinity test site by implanting rodents with TLDs.[190] These early instruments are the predecessors of the TLDs that many Laboratory staff use today.

Respirator testing by workers of the H-5 Industrial Hygiene Group in the Health Research Laboratory, November 1965.



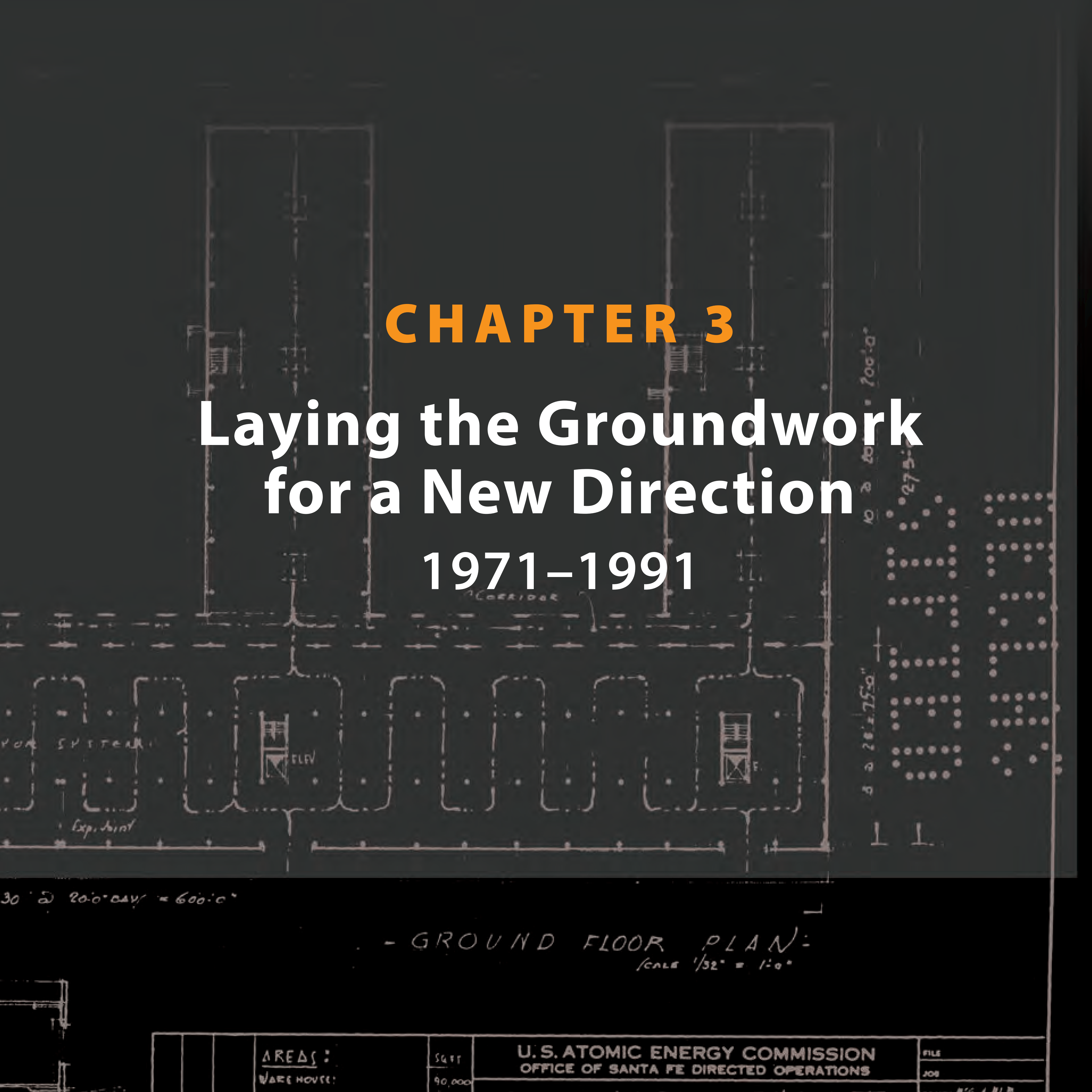
Edwin C. Hyatt (left) and Harry F. Schulte (right) with respirator, November 1965.

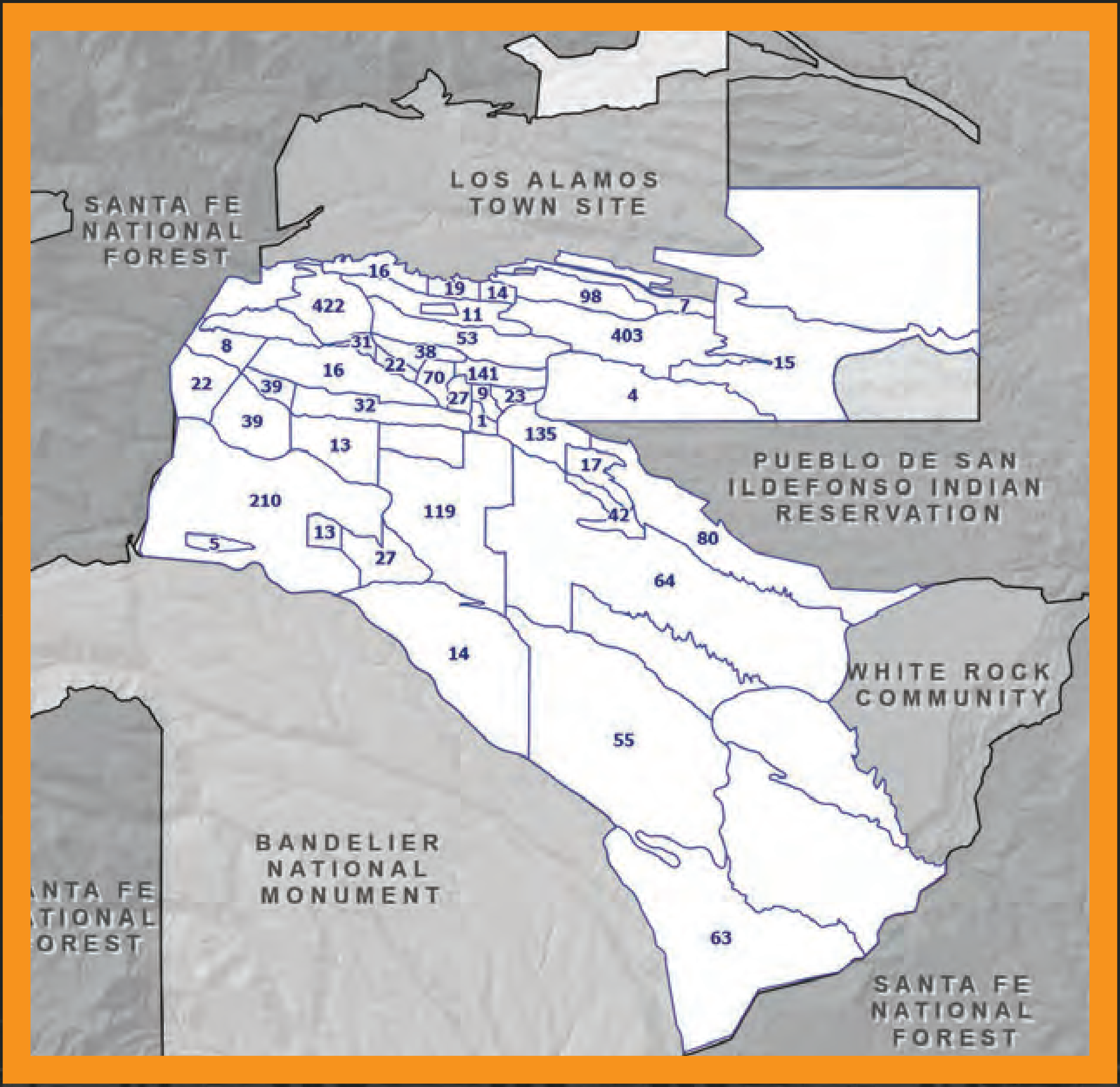
Researchers celebrate in the control room after Los Alamos Meson Physics Facility (LAMPF) obtained its first full-energy beam in 1972.

CHAPTER 3

Laying the Groundwork for a New Direction

1971–1991





Facility Counts of Los Alamos National Laboratory Technical Areas in 1991.[203]

Presidents

Richard M. Nixon (R), 1969–1974
Gerald R. Ford (R), 1974–1977
James Earl Carter (D), 1977–1981
Ronald Reagan (R), 1981–1989
George Bush (R), 1989–1993

Major Conflicts

Cold War, 1945–1991
Gulf War, 1990–1991

Treaties

Seabed Arms Control Treaty, 1971
Anti-Ballistic Missile Treaty, 1972–2002
Strategic Arms Limitation Treaty I, 1972
Strategic Arms Limitation Treaty II[a]
Intermediate-Range Nuclear Forces Treaty, 1988–2019
Threshold Test Ban Treaty, 1990
Treaty on Underground Nuclear Explosions for Peaceful Purposes, 1990

Laboratory Budget ($K)

$130,852 (1971)–$1,037,619 (1991)

Federal Oversight

U.S. Atomic Energy Commission, 1947–1974
U.S. Energy Research and Development Administration, 1974–1977
U.S. Department of Energy, 1977–Present

Federal Managers

H. Jack Blackwell, 1968–1974
Kenneth R. Braziel, 1974–1981
Harold E. Valencia, 1981–1989
Jack E. Tillman, 1989–1990
Jerry L. Bellows, 1991–1994

Laboratory Directors

Harold M. Agnew, 1970–1979
Robert N. Thorn (acting), 1979
Donald M. Kerr, 1979–1985
Robert N. Thorn (acting), 1985–1986
Siegfried S. Hecker, 1986–1997

Laboratory Staff

4,168 (1971)–7,523 (1991)

Executives over Laboratory Operations

Raemer Schreiber, 1962–1974
Charles I. Browne, 1974–1983
Christopher S. Adams, Jr., 1983–1986
Robert W. Selden, 1984–1986
James F. Jackson, 1985–1998
Allen Joseph Tiedman, 1986–1994

Support Contractors

Zia Company, 1946–1986
Pan Am World Services, 1986–1989
Johnson Controls World Services, 1989–1997

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[a] This treaty was never entered into force.

An early aerial view taken of LAMPF (opposite page).

A FUTURE BEYOND WEAPONS—A MULTIPROGRAM NATIONAL LABORATORY

Since the Laboratory's inception, it had focused mostly on weapons design and science used—if not exclusively, then very indirectly—for nuclear weapons. The Laboratory was a world leader in nuclear science. During the 1960s, the Laboratory began to engage in non-weapons projects such as those associated with nuclear energy, reactor research, and Project Rover.[204] Although the Laboratory grew steadily during this period, changes were on the horizon.[205] The nuclear science gap closed because other national laboratories had taken leaps forward, and scientific centers in Europe were close behind.[206] Partly to blame was the aging employee base. The many great scientists who had seen the Laboratory grow from infancy were now retiring.[207] Additionally, as relations between the Soviet Union and the United States improved, the future of weapons work became uncertain, and a few national security projects were terminated.[208]

LAMPF would become a crowning achievement of the era.

The Laboratory needed to attract new minds, which physicist Louis Rosen—a Manhattan Project pioneer—called instrumental to its future. When Harold Agnew became Laboratory Director in 1971, the Laboratory progressed into a period of transition.[209] Rosen said, "A laboratory is, in first approximation, made up not of hardware and computers and buildings but of people—dedicated, competent people, well educated in the activities that you want to pursue but, more important, inspired by the magnitude of their ignorance."[210] Although Director Bradbury had begun to broaden the research done at the Laboratory during his tenure, the work still hewed closely to the idea that the Laboratory was, first and foremost, a weapons laboratory.

By the beginning of the 1970s, several projects set the Laboratory on a course for change. The idea was to expand the type of science possible at the Laboratory, especially with world-class equipment that would attract world-class talent.[211] By 1973, the epitome of these projects was the Los Alamos Meson Physics Facility (LAMPF), whose task was to study atomic nuclei and nuclear reactions. LAMPF would be used to study nuclear science applicable for weapons, but it would also become important for understanding nuclear reactors at the time of growing concern about the world's energy sources. It would become a crowning achievement of the era. With an estimated cost of $47,142,000, it would be one of the most expensive nuclear scientific research facilities to date. The chosen location was Mesita de Los Alamos, a small mesa to the east of the main Laboratory site. Because this mesa was also the site of many pre-Columbian Native American settlements, Laboratory archaeologists carefully preserved the artifacts. In 1972, LAMPF produced the first 800 MeV of protons, and in August 1973, the Laboratory had produced its first mesons.[212] LAMPF was officially named the Clinton P. Anderson Meson Physics Facility, in dedication to the senator's support.[213]

LAMPF, and the experiments that followed, led to many breakthroughs. For example, after running the accelerator, scientists knew the target area would become so radioactive that it would be harmful for any human to repair the machine if needed. So Laboratory scientists developed a device, similar to a robotic arm, that could work in the target area remotely. Scientists also developed the side-coupled linear accelerator structure, which was later adopted by industry around the world for radiation therapy.[214] And on July 30, 1974, the Laboratory shipped a small bottle that contained radioisotopes for medical research to the Veterans Administration Hospital in Denver. The Laboratory opened LAMPF as a national user facility and the first "open" scientific facility


Team working on LAMPF high-resolution proton spectrometer.


Visitors inside LAMPF.

at the Laboratory.[215] This effort allowed nuclear and particle physicists across the country—and the globe—to visit the Laboratory and study the basic properties of nuclear forces, the bonds that hold elements together on Earth and in space. As Rosen and Bradbury desired, the Laboratory once again became an international draw for nuclear scientists.

Although much of the early and late 1970s was a period of diversification at the Laboratory, this period also saw the onset of the energy crisis and environmental crises. The United States experienced consequences from the political chaos in the Middle East, tumult in pricing policies by the Organization of Petroleum Exporting Countries nations, and associated transport disruptions.[216] This persistent turmoil resulted in limited supplies of coal, oil, and gas; price increases; and power brownouts along the Atlantic coast.[217] Concurrently, environmental degradation in the United States was increasingly tied to energy-related technologies, such as refinery operations, drilling accidents, off-shore oil spills, transportation of fuels, and production of electricity.[218] An outcome was the consideration of "more environmentally-[sic] benign alternative fuels" by the public.[219] Dialogues encompassed the associated research and development and the general reduction of pollutants in waterways, landfills, and the atmosphere.[220]

In the energy field, the Laboratory focused on magnetic fusion and geothermal energy—large complex research programs.[221] With government support in 1973, the Hot Dry Rock project, which had started as a pursuit of curiosity in geothermal energy, became a program that would succeed in generating 10 gigawatts of energy and inspiring many countries to start their own geothermal programs. Other non-weapons undertakings supported nuclear medicine, genetic studies, NASA collaborations, and superconducting research.

As the end of the 1970s neared, the Laboratory also opened the Plutonium Facility, which would grow into a massive complex called TA-55.[222] Scientists during the Manhattan Project had used D Site, which looked like a large barn, to process plutonium for the core of nuclear weapons. Then the Laboratory built DP West, which became active in 1945 and remained in use until 1978.[223] The Plutonium Facility would be state of the art—160,000 square feet across three floors, which included 70,000

Modular home at the Laboratory, demonstrating Laboratory-developed solar collector panels in 1976. Scientists hoped to show enough of an energy savings that the nation would consider installing them on all modular and mobile homes built each year (below).

square feet of processing space, 450 gloveboxes to handle plutonium, and a host of safety technology such as air sensors and a specialized venting system.[224] For such an endeavor, the planning and construction of the facility moved quickly, with the idea originating in 1969 and the first plutonium shipment being received less than 10 years later. Even today, it is the nation's newest, most modern plutonium facility.[225]

The TA-55 Plutonium Facility was constructed to survive 200-mile-per-hour winds, as well as any likely earthquake, because the work done there involves handling dangerous metals and caustic chemicals. Scientists recover plutonium from decommissioned weapons, process plutonium for disposal or to burn as mixed oxide fuel, recycle plutonium, and refine and remove impurities from plutonium. Today, the work at the Plutonium Facility supports some of the Laboratory's most fundamental, mission-related programs—stockpile stewardship, materials disposition, nuclear forensics, nuclear counter-terrorism, and nuclear energy.

The three endeavors (LAMPF, the Hot Dry Rock project, and TA-55) and the technology held inside represented a pivotal shift for the Laboratory. No longer would the Laboratory rest solely on the laurels of being the first to develop a nuclear bomb. It was now a first-class research facility—one that would draw weapons designers and scientists of all stripes. The Laboratory had diversified quickly and became a multipurpose national laboratory.[226] By 1980, the Laboratory doubled its staff to 7,000; professionals accounted for 35 percent, and half of them held doctorate degrees. The operating budget in fiscal year 1980 totaled $395 million, and only half of this amount was allocated to defense programs.[227]

POWER OF DIVISION LEADERS

Begun by Director Bradbury and expanded by Director Harold Agnew, diversification of Laboratory activities involved research and development beyond weapons, resulting in new programmatic divisions. Following the Manhattan Project organizational structure, new division leaders reported directly to the Laboratory Director.

From 1950 to 1970, major non-weapons programs included

> controlled thermonuclear reactors (magnetic fusion),
> advanced nuclear reactors,
> the nuclear rocket program (Project Rover),
> the Vela project,
> the subterrene tool and the Hot Dry Rock project,
> laser fusion and laser isotope separation,
> solar energy, and
> the tritium system test assembly.

The 1970s was an age of decentralization when division leaders and project heads wielded much power. The Laboratory grew steadily, and major non-weapons projects came online. Though these programs were well conceived and led by competent and respected scientists and engineers, the reporting structure became progressively less effective. The diversity of programs led to a diversity of funding mechanisms, which resulted in increased authority and independence of divisions. Laboratory management often received program approval requests after divisions had already negotiated program objectives and content with their federal partners. This risk was significant for the organization, especially when these programs were terminated abruptly. The situation changed when the Department of Energy took responsibility, and their policy of decentralization diminished the power of division leaders. As explained by WX Division Leader J. J. Wechsler, "Division leaders were very strong in the Lab. One who felt strongly something should be done could make it happen. Now he can propose it, but it has to go through a rigorous review."[247]

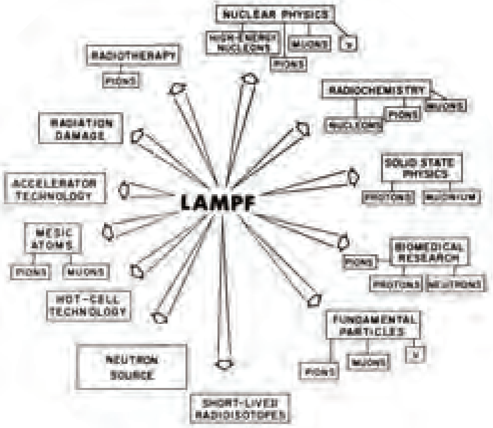
This synopsis was based on a 1997 report by Edward F. Hammel titled "*Los Alamos Scientific Laboratory Energy-Related History, Research, Managerial Reorganization Proposals, Actions Taken, and Results 1945–1979.*"[246]

Donald M. Kerr became Laboratory Director in 1979. He called for accountability, with the aim to streamline operations and reduce costs.[228] Changing the Laboratory's management structure from a vertical model that served weapons research and development, Director Kerr instituted a hybrid form of "matrix" management, which aligned with a multipurpose national laboratory.[229] His matrix management structure included two kinds of line authority: program managers oversaw projects, and disciplinary (or functional) managers oversaw staff and managed facilities.[230] The former negotiated with the latter for manpower and resources.[231] This structure allowed the Laboratory to harness talent at every level and created a Laboratory that Director Kerr called "relatively well integrated" and avoided "the pejorative sense of regimented." [232]

Regrettably, the matrix system "sowed confusion in the everyday tasks of evaluating work, giving promotions, and settling disputes." [233] While programs with concrete goals thrived, individuals suffered. After an initial period of discomfort, staff aligned with the new structure, and it was accepted in support of the Laboratory's multipurpose mission areas.[234] Director Kerr's tenure saw the creation of three new research centers: the Institute for Geophysics and Planetary Physics, the Center for Nonlinear Studies, and the Center for Materials Science. The greatest accomplishment of these new institutions was the employment of scientists from outside the Laboratory. He shared, "They're attempts to bring a focus to research areas of great interest to the lab that don't fit within the normal organizational mode."[235]

In 1986, the Laboratory began another period of diversification when Siegfried S. Hecker became Laboratory Director. He guided the Laboratory through the paradigm shift caused by the nuclear testing moratorium and the potential of a complete testing ban.[236] Laboratory scientists had to develop experiments, other than nuclear testing, to manage the nation's weapons stockpile.[237] Under Director Hecker's leadership, the Laboratory developed science-based stockpile stewardship, which focused on computer modeling, non-nuclear testing, and additional weapons surveillance.[238]

To reduce the risk of nuclear weapons to the world, the Laboratory engaged in a mission of stockpile stewardship, stockpile support, nuclear-materials management, non- and counter-proliferation, and environmental legacy management (including environmental cleanup).[239] Using science-based stockpile stewardship, the Laboratory conducted above-ground, non-nuclear experiments that employed hydrodynamic testing and big-flash X-ray machines.[240] Stockpile management required the Laboratory to be clever, by identifying cheaper alternatives for weapons manufacture or re-manufacture and ensuring a steady supply of tritium.[241] In support of nuclear-materials management, the Laboratory developed technological solutions to reduce the material stockpile and extract energy in the process.[242] In the nuclear non-proliferation and counter-proliferation arena, the Laboratory assisted Russian officials in securing their plutonium and highly enriched uranium.[243] As Russian society collapsed, the security of Russian fissile nuclear materials became precarious.[244] During this period, the Laboratory also began to understand all aspects of cleaning up the environment and safely and securely storing waste in the long term.[245] Hecker's term saw the expansion of the Laboratory's scientific, computational, and experimental capabilities to address challenges in weapons research and development.

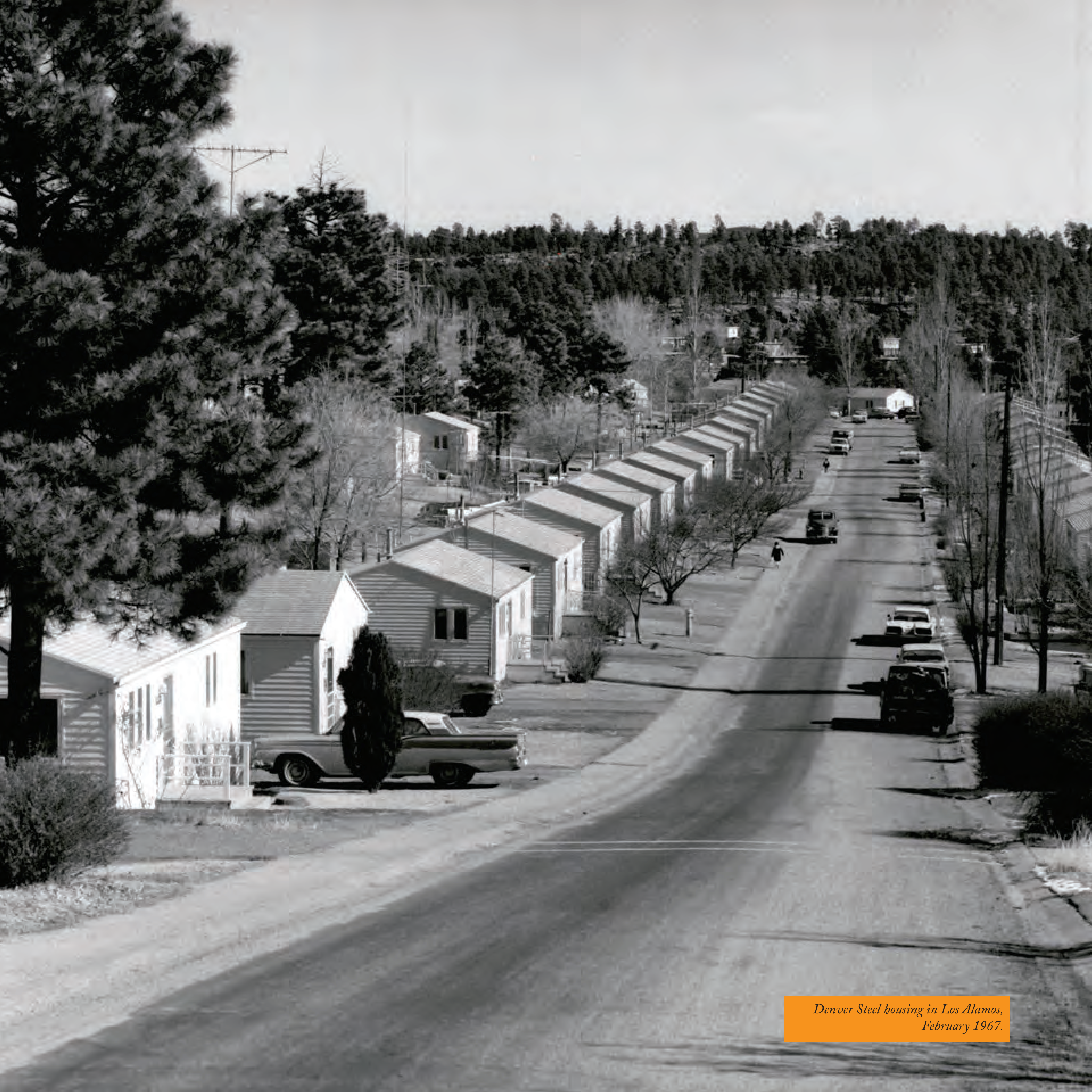


A diagram shows the varied research that scientists hoped could be accomplished by LAMPF (above).

A piece of nuclear material from Russia. Large quantities of nuclear material were vulnerable following the breakup of the Soviet Union (opposite page).

At the Los Alamos Survival–Mortality (or SUMO) site, a piñon tree and a juniper tree are enclosed in an acrylic chamber that simulates the effects of climate change, 1990.

The Fenton Hill site for the Hot Dry Rock project, which had a fairly small footprint, was one of the first government-funded experiments to channel a large amount of geothermal energy.



Denver Steel housing in Los Alamos, February 1967.

INCREASED HOUSING DEMAND

Program diversification of the 1970s also necessitated an increase in Laboratory staff, which drove up demand and prices for housing located within Los Alamos County. County population—composed of Los Alamos and White Rock, a wartime construction camp—reached almost 20,000 by the end of the decade. Conspicuously, the composition of county residents was mostly Laboratory staff, many Laboratory retirees, and some relatives. It was not unheard of for parents and relatives of Laboratory staff to visit the county, fall in love with it, and settle down. As time passed, the number of second-generation employees increased, and some county residents even chose to commute from other northern New Mexico communities.[248]

Residential neighborhoods in Los Alamos (above).

Morley Safer, 60 Minutes correspondent, interviews Laboratory Director Kerr (opposite page).

BEGINNING A STRATEGIC PLANNING PROCESS

The Atomic Energy Commission established a Long Range Planning Committee, and the Laboratory's response to a request for information in 1974 became DIR-2345. This document, "Los Alamos Long-Range Planning through Fiscal Year 1981," comprised information from fiscal year 1975 and projections through 1981.[249] It was the first comprehensive site plan that detailed the Laboratory's technical history, accomplishments, expenditures, and goals. Commencing annual workshops to discuss the institutional planning process, the national laboratories held their first one in 1978.

A Laboratory alumnus, Director Kerr worked in the Washington, D.C., office of the fledging Department of Energy for 3 years before he returned to the Laboratory to become its director in 1979. During this time, he partook in the endeavor to align the national laboratories with headquarters and make them more accountable. To achieve this goal, the Department of Energy selected long-term planning as its management tool. This approach provided an opportunity for each laboratory to distinguish itself to headquarters by characterizing its capabilities and objectives.[250] Distinctly, the institutional planning process became an important factor in the research and development endeavors of multiprogram national laboratories.[251]

Laboratory Director Kerr.

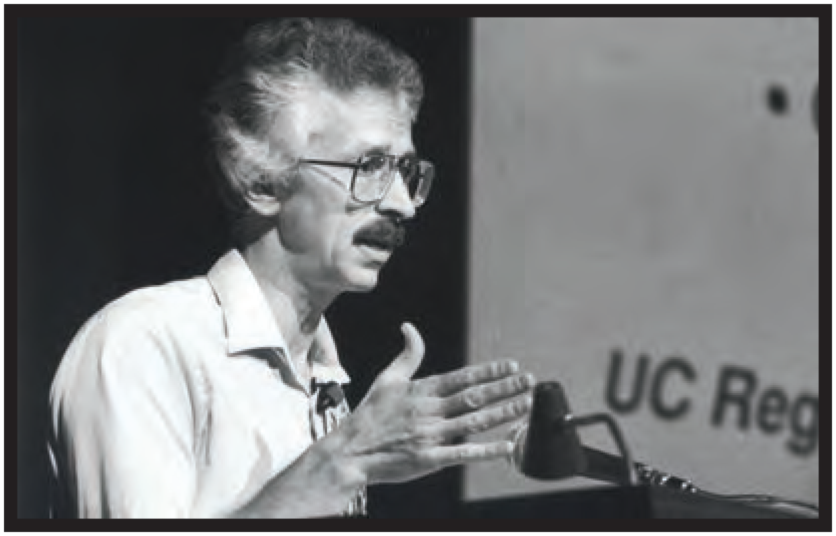
GOVERNANCE AND OVERSIGHT CHANGES

The Manhattan Project introduced the government-owned, contractor-operated, or GOCO, model of governance. Laboratory Director Siegfried Hecker called it "an enlightened system of governance."[252] According to Director Hecker, it was an admission by the federal government that they struggled to attract the best and brightest and to administer a complex organization efficiently. The engagement with the University of California provided a way for the organization to get out from under some government regulations and to maintain some agility. In 1995, Director Hecker stated, "But this system has eroded steadily over 50 years and has rapidly declined in the last 6 years."[253]

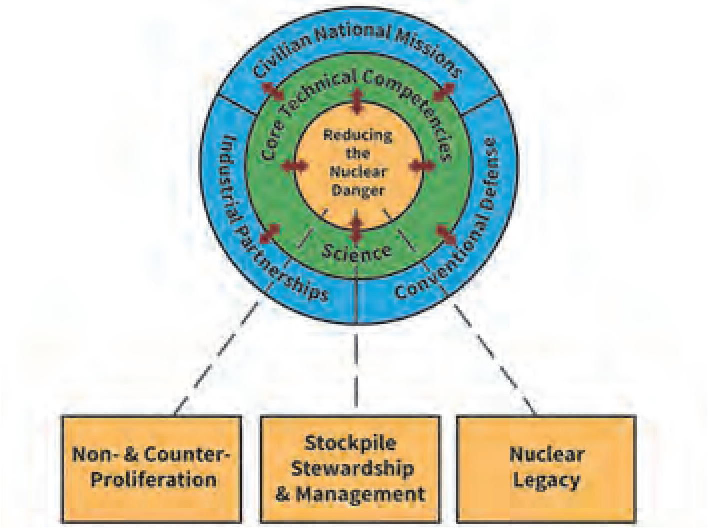
Thinking about a resolution, Director Hecker pointed to the work of Robert Galvin, chairman of Motorola, who recently revived their competitiveness and subsequently headed up a task force for the Department of Energy.[254] The resulting report, "Alternative Futures for the Department of Energy National Laboratories," also known as the Galvin Report, recommended that the Department of Energy make changes in its governance of the national laboratories regardless of each laboratory's mission.[255] Observed governance problems included "a counterproductive federal system of operation" and "multiple symptoms of institutional stress."[256] These problems included rising overhead costs, poor morale, gross inefficiencies, excessive internal focus, institutional fragmentation, and poor management systems. Scathingly, the task force wrote, "it is hard to reach any conclusion other than the current system of governance of these laboratories is broken and should be replaced with a bold alternative." [257] The creation of a not-for-profit research and development corporation is one model outlined by the task force, wherein the Department of Energy becomes the Laboratory's customer.

Laboratory Director Hecker briefs President Clinton during his first visit to Los Alamos, 1993.

The creation of a not-for-profit research and development corporation is one model outlined by the task force, wherein the Department of Energy becomes the Laboratory's customer.



Laboratory Director Siegfried Hecker.



Director Hecker's bullseye chart.

JAMES (JIM) F. JACKSON

Jim Jackson served as the deputy director from 1985 to 1998 and "was very involved in all aspects of the operations of the Laboratory."[258] Born on August 15, 1939, in Ogden, Utah, he married Joan Borger in 1960, and they had four children together. He acquired his master's degree in nuclear engineering from the Massachusetts Institute of Technology and began his professional career as a research engineer at Atomic International in 1962. Jackson worked as a research assistant at the University of California-Los Angeles while he attained a PhD in engineering in 1969. Subsequently, he worked as a nuclear engineer at Argonne National Laboratory and served as an associate professor of engineering and as an engineering consultant.[259] Jackson began his career at the Laboratory in June 1976 as the leader of the Reactor Systems, Theory, and Methods Group in the Nuclear Safeguards, Reactor Safety, and Technology (R) Division.[260] In 1977, he moved to the Energy (Q) Division, where he held numerous leadership positions until 1983. At this time, Jackson became the Personnel Administration (PA) division leader under Director Kerr. Jackson was highly regarded as a leader and an engineer; he received the Los Alamos National Laboratory Distinguished Performance Award in 1981, the Department of Energy's E. O. Lawrence Award in 1983, and was elected to the National Academy of Engineering in 1991.[261]

THE ERA OF ENVIRONMENTAL RECKONING

During the Manhattan Project, the topmost priorities for scientists and the government were first, to build an atomic bomb, and second, to keep this project secret. The government built sprawling complexes across the nation that would help accomplish this goal.

But once World War II ended, the Cold War began, and the nation was again in a state of constant weapons production. As a result, emphasis was placed on keeping workers safe, but no unifying regulations were adopted across the nation's labs and weapons facilities, which worked not only with radioactive elements such as plutonium, but also with a vast array of chemicals used to build weapons. [262] Again, the priority was placed on speed and technological development.

> **Loose environmental oversight was, in part, caused by the emphasis on speedy production.**

The remote location of the Laboratory meant that any accidents or release of chemicals would be far from any public centers,[263] so at the Laboratory, radioactive material was buried underground on the Pajarito Plateau.[264] Chemicals such as chromium, which was used at the Laboratory's non-nuclear power plant as a corrosion inhibitor, were commonly flushed into the canyons from 1956 to 1972.[265] It would eventually penetrate the rock layers and later seep into the regional aquifer beneath Sandia and Mortandad Canyons. The Laboratory had developed a medical section as early as 1943, though this effort focused on employee health and researching the risks of radiological exposure.[266] Scientists and health workers took air and water samples to detect radioactive contamination. The Laboratory also conducted environmental surveys, though these were done with the immediate future in mind.

"Health and safety, however, received higher priority than waste or environmental concerns," read one report, "because this could put workers and public directly at risk and made sense from the perspective of cost-benefit analysis."[267]

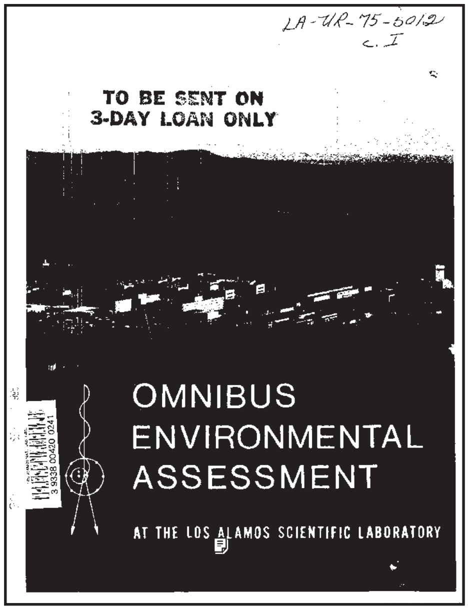
The loose environmental oversight was, in part, caused by the emphasis on speedy production. But it was also an organizational issue. The Laboratory regulated itself for the most part, meaning that no outside public authorities reviewed developments behind the fence, ranging from facility construction to waste management.[268] The need for tight security and control of classified information also hindered cooperation between federal regulatory authorities.

This self-regulation began to change in the early 1970s. In the decade prior, a growing movement among the public emphasized environmental conservation and, on April 22, 1970, the world celebrated the first Earth Day. That year Congress stood up the Environmental Protection Agency, and it also passed the National Environmental Policy Act, which required all federal agencies to consider the adverse effects of their actions upon the environment.[269]

At the time, the nation's laboratories were overseen by the Atomic Energy Commission, which fought this new law, saying that it conflicted with the Atomic Energy Act. (This conflict would lead, 14 years later, to a federal court decision that ruled in favor of increased federal oversight.) In the following years, Congress passed a series of laws aimed at placing more environmental regulations on private and public entities, including national laboratories. These regulations included the Clean Air Act; the Clean Water Act; the Resource Conservation and Recovery Act; and the Comprehensive Environmental Response, Compensation, and Liability Act.

By 1974, the Atomic Energy Commission had been dealt a series of public setbacks concerning its handling of hazardous waste. Congress dismantled the agency, replacing it in 1974 with the Energy Research and Development Administration and the Nuclear Regulatory Commission.[270] Three years later, the Department of Energy was formed; an agency with a cabinet-level position that brought together two programmatic focuses: defense technologies that included the design, construction, and testing of nuclear weapons; and a swath of energy-related programs deployed within numerous federal agencies.[271] As part of the new focus on environmental cleanup, Congress also established the Environmental Management agency within the Department of Energy.

At the Laboratory, these new regulations meant a more transparent accounting of its environmental impact, which included yearly site-wide reports.[272] The intent of this document, read one early report, is to "keep information on environmental quality available to the public" and "principally serves the purpose of providing public documentation of data on environmental quality and conditions in the vicinity of the Laboratory."[273]



Cover of an early environmental report, mandated by National Environmental Policy Act, that assessed environmental impacts of the Laboratory.

These reports, at first composed by the Environmental Studies Group, published the results of a wide range of potential environmental impacts, including radioactivity in the air, ground, and surface waters; and chemical presence in groundwater. Although it would undergo numerous name changes over

CREATION OF THE ENERGY RESEARCH AND DEVELOPMENT ADMINISTRATION

On October 11, 1974, President Gerald R. Ford signed the Energy Reorganization Act, which abolished the Atomic Energy Commission.[280] The U.S. Congress created the law in response to the energy crisis and the need for more domestic sources of energy. During a year of study, the unique capabilities of the weapons research laboratories were considered, and the laboratories were placed under the Energy Research and Development Administration instead of the Department of Defense. The Energy Research and Development Administration amassed, for the first time, all major research and development programs for all forms of energy in one organization; other energy-related programs were dispersed to the Nuclear Regulatory Commission and an Energy Resources Council. President Ford appointed Robert C. Seamans, Jr., as the first head of the Energy Research and Development Administration. Developing the country's first national energy plan, *Creating Energy Choices for the Future*, Seamans outlined short-, mid-, and long-term programs to support research into coal plants, research reactors, liquid fuels from coal and shale, energy conservation, solar energy, and fusion and breeder reactors. His plan "called for an early demonstration of the technical feasibility of new energy systems with built-in environmental and safety controls."[281]

The push for environmental oversight led to numerous changes in the agencies that oversaw the Laboratory in the 1970s and 1980s. Seen here are the seals of the Atomic Energy Commission, which later became the Energy Research & Development Administration and then the Department of Energy.

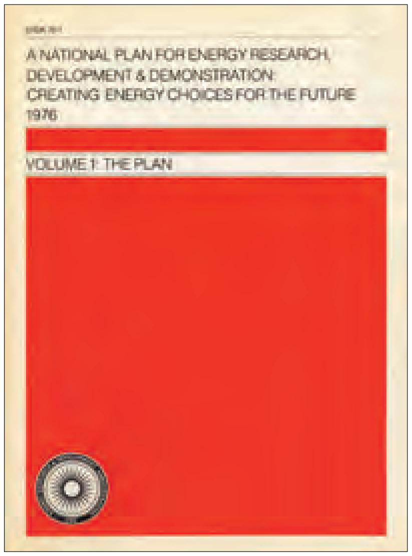
the years, today this wide-ranging report on the state of the environment in and surrounding Los Alamos is called the Annual Site Environmental Report.

As part of National Environmental Policy Act (or NEPA) requirements, the Laboratory also retroactively evaluated legacy waste practices, including storage of radioactive waste, to analyze how past practices had impacted the environment. This effort included monitoring past and current waste burial sites and evaluating the risk posed to the environment, as well as how to store these materials more safely.[274] This activity was no small task. As a 1975 environmental report read, "The variety of wastes that must be treated necessitates a continuing program of research and development, which additionally contribute [sic] to solving world-wide problems of safely handling radioactive wastes."[275] In its effort on this path, the Laboratory would pioneer many new practices that would later be adopted by the radioactive waste management industry, including ion exchange, reverse osmosis, and evaporation.

Environmental remediation would become a main focus of each national laboratory. By 1990, environmental cleanup accounted for about 20 percent of the Laboratory's budget. And by 1995, the Department of Energy had spent $23 billion to identify, characterize, manage, and remediate waste across its weapons sites and facilities.[276]

Today, environmental safety has become an integral facet in how the Laboratory operates, and employees work diligently to correct the mistakes of the past.[277] Some of the most industrious cleanup efforts have included overhauling how radioactive waste is stored at the Laboratory, facility improvements that reduce air contamination, massive energy-use improvements, cleaning up DP Road where legacy waste was stored, and treating water that was contaminated by releasing chromium into the canyons.

This last effort has been a major undertaking. The Laboratory has drilled 30 monitoring, extraction, and injection wells to treat the chromium plume.[278] These wells pump contaminated water to the surface, where it is treated at a plant, then reinjected back into the earth. It is a complicated, costly process—one that evidences that the Laboratory is effectively restoring the environment. As Danny Katzman, groundwater remediation manager for a Laboratory environmental contractor, said, "The combination of extraction, treatment, and injection has resulted in a significant reduction in the extent of hexavalent chromium contamination along that boundary, where sampling results from a key monitoring well have shown a consistent drop in chromium levels."[279]



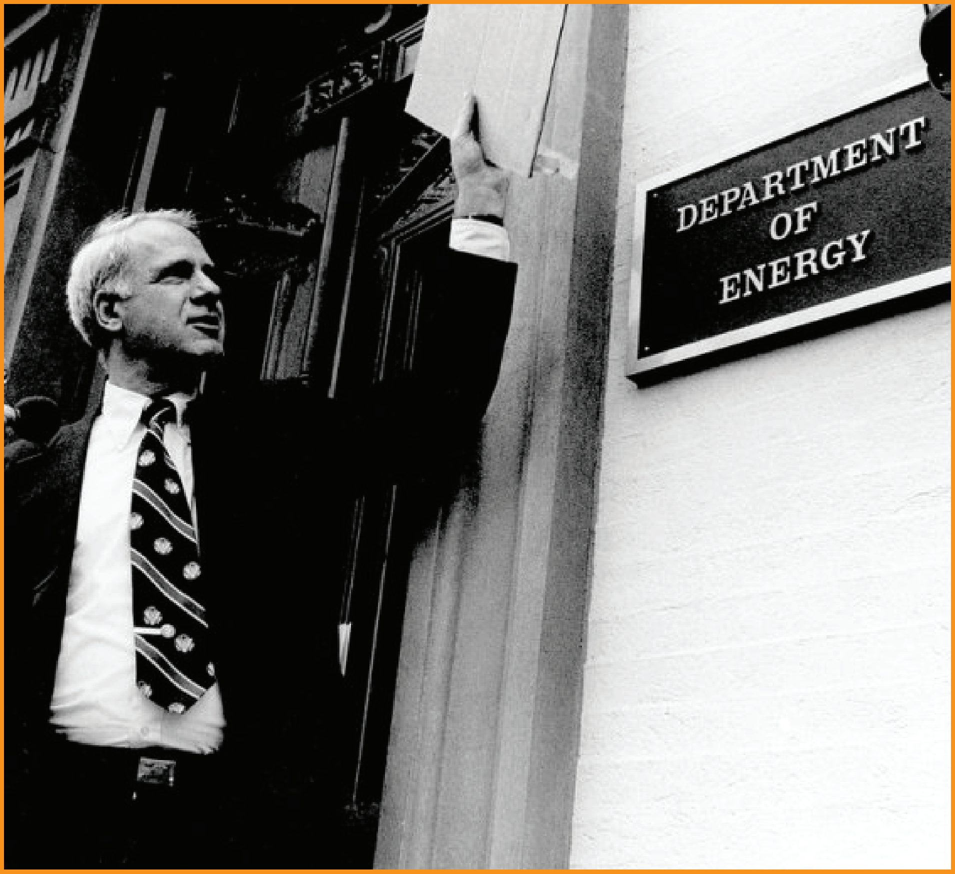
A NATIONAL PLAN FOR ENERGY RESEARCH,
DEVELOPMENT & DEMONSTRATION:
CREATING ENERGY CHOICES FOR THE FUTURE
1976

VOLUME 1: THE PLAN

A National Plan for Energy Research, Development, and Demonstration, 1976.

Injection and extraction wells greatly reduced the spread of a chromium plume.

Overview of the Fenton Hill site, where the Hot Dry Rock project investigated geothermal energy.



DECENTRALIZED MANAGEMENT OF LABORATORIES

The Atomic Energy Commission practiced a policy of decentralization and managed the weapons laboratories in a permissive manner.[282] Striving to establish some regularity across the national laboratories, the Energy Research and Development Administration focused on the consistency of management, planning, and accountability. Secretary of Energy James R. Schlesinger, the first secretary under the new Department of Energy, developed a plan for decentralization. With headquarters responsible for making policy and developing budgets, the field offices were responsible for implementation. His approach entailed more rigorous reporting and longer-term planning. One critic of the strategy, WX Division Leader J. J. Wechsler, foretold, “Such accountability squelches any technology with a long-term payoff.”[283]

MAKING SAFE AND HEALTHY WORKING CONDITIONS

The Occupational Safety and Health Act (OSHA) of 1970 was enacted on April 28, 1971.[284] The law was created "to ensure safe and healthful working conditions for workers by setting and enforcing standards and by providing training, outreach, education, and assistance."[285] A bit ahead of its time on understanding the importance of worker health and safety, the Laboratory had already completed a new Occupational Health Laboratory in TA-59.[286] The Health Division moved in two of its groups, H-5 and H-8, in March 1966. At that time, the H-5 Industrial Hygiene Group was focused on how air contamination and pollution affected workers, and the H-8 Field Test Studies Group was investigating health and safety issues associated with radioactivity from reactor tests and operations at the Nuclear Reactor Development Station in Nevada.

The Laboratory had been conducting research on occupational exposures for years.

Although the Occupational Safety and Health Act initially excluded federal agencies, such as the Atomic Energy Commission, a subsequent executive order brought them under the act.[287] The Atomic Energy Commission moved quickly to bring its sites into compliance with the new law.[288] Comprising five division/group leaders, the Laboratory established an Occupational Safety and Health program. Spending more than 15,000 person-hours, the Laboratory, the Zia Company, and the Atomic Energy Commission conducted an assessment to identify variances in their policies and practices from the new law. Conspicuously, numerous Laboratory groups developed health and safety manuals between 1969 and 1979. The early 1980s saw a proliferation of Laboratory-wide health and safety guides, controls, and appraisal systems.

By 1972, the Health Division doubled the H-5 Industrial Hygiene Group's staff and added $500,000 to its budget. As noted by journalist Barbara Storms, "This happy state of affluence is the result of recent interagency agreements between the Atomic Energy Commission and the National Institute for Occupational Safety and Health (NIOSH) for projects in fields in which H-5 is the nation's recognized authority."[289] Although these initiatives were a result of the Occupational Health and Safety Act of 1970, the Laboratory had been conducting research on occupational exposures and establishing standards for years. For example, by the end of 1973, the Laboratory's H-5 Industrial Hygiene Group had trained more than 250 persons from the Atomic Energy Commission complex; the Department of Health, Education and Welfare; and the Department of Labor on how to bring respirator programs into compliance with federal regulations.[290] In 1975, Laboratory instructors took this training course on the road to Denver, Colorado; Chicago, Illinois; and Pittsburgh, Pennsylvania.[291]

The Energy Reorganization Act of 1974 abolished the Atomic Energy Commission and transferred responsibilities to the Nuclear Regulatory Commission and the Energy Research and Development Administration.[292] The latter assumed responsibility for the Laboratory. In 1977, the Department of Energy Organization Act of 1977 eliminated the Energy Research and Development Administration and conveyed responsibilities and assets to the Department of Energy.[293] An internal review of the complex conducted in the mid-1980s by the Department of Energy—called the Kane Report—determined that environment, safety, and health (or ES&H) programs had little authority and were generally ignored unless a crisis occurred. Importantly, Kane wrote that the Department of Energy's operations were in no way unsafe or jeopardizing the general public; "Rather, the danger was that the Department might not know it if there was a safety or health problem."[294]

Secretary of Energy John S. Herrington took action, and in 1985, he established an Office of Environment, Safety and Health and more than doubled its proposed funding to support new initiatives.[295] In light of the environmental crisis at the Rocky Flats Plant in Colorado—the nation's site for pit production—and to address concerns expressed by the U.S. Congress, new Secretary of Energy Admiral James D. Watkins announced the formation of environmental "tiger teams" in 1989 to "perform compliance assessments" within the complex.[296] The tiger team sent to the Laboratory conducted a health and safety assessment on plutonium and enriched uranium facilities, nuclear reactors, other critical facilities, tritium operations, and accelerators.[297] Team members reviewed safety and health program performance within the following technical areas: organization and administration, quality verification, operations, maintenance, training and certification, auxiliary systems, emergency preparedness, technical support, packaging and transportation, nuclear criticality safety, security/safety interface, experimental activities, site/facility safety, radiological protection, personnel protection, worker safety and health (OSHA) compliance, fire protection, aviation safety, explosives safety, natural phenomena, and medical services. Published in 1991, the results of the assessment were mixed.[298]


Protective gloveboxes.

The assessment affirmed that Laboratory senior management had started making changes—consistent with initiatives established by the Secretary of Energy—that were enhancing performance in environment, safety, and health.[299]

However, much more work was needed because Laboratory staff were still working based on their own

POWER AND WATER

The Laboratory and Los Alamos County have a long-standing partnership in the public works domain, as shared by Andy Erickson, Utilities and Institutional Facilities division leader.[303] With the assistance of the Laboratory, Los Alamos County became a municipal entity and power provider in approximately 1985 and was the first county in the state to do so.

This ingenious move allowed the Laboratory and the county to pool all electric resources to serve both their community and the Laboratory and to purchase and deliver power from the wholesale market.

The Laboratory now contracts with the county for power, and together they determine their own power future, including the purchase of carbon-free or carbon-neutral options. Since the beginning, the Laboratory's administrators—the Manhattan Engineer District, the Atomic Energy Commission, the Energy Research and Development Administration, and the Department of Energy—owned and operated the water system and infrastructure and associated water rights. In the late 1990s, the Department of Energy transferred all water production infrastructure to Los Alamos County, who took over water administration and stood up a water system. Subsequently, the Department of Energy leased its water rights for Los Alamos County to use, which allows Los Alamos County to manage all of the water rights together to serve both their communities and the Laboratory.

As revealed by Erickson, the division is always looking for the intersection between Laboratory research and infrastructure. He wants to "do things that use the Laboratory's infrastructure to help advance scientific research." [304]

Laboratory industrial hygienists conduct research on respiratory protection and personal protective clothing, 1980.

A Laboratory scientist wears appropriate personal protective clothing during a Helios laser system experiment, ca. 1979.

perception of health and safety rather than established Laboratory policy. The assessment noted staffing shortages of health and safety personnel in both higher and lower levels of management. Laboratory safety review committees were not providing independent assessments of programs or experiments. Seventy-four percent of the identified issues "indicate noncompliance with DOE mandatory requirements as a major issue."[300] More direction to staff was required to affect change, and the Laboratory's organizational structure had to "clearly establish the responsibility and authority of organizational units and to set accountability for performance in the ES&H functions."[301] The assessment team identified that "a change in the safety culture at LANL is beginning."[302]

Today, the Laboratory is totally committed to excellence in safety, security, environmental compliance, and quality. It is integral to the work we do and how we do it.

Andy Erickson (left), Scott Backhaus (center), and Loren Toole (right) standing at the power plant for the solar smart grid in Los Alamos, August 25, 2010. The Laboratory, Los Alamos County, Japan's New Energy and Industrial Technology Development Organization, and the State of New Mexico collaborated to develop a smart grid.

THE DEADLIEST DAY

Wright H. Langham, Assistant Health Division Leader and H-4 Group Leader.

After a full decade of no fatal accidents, the Laboratory lost 13 workers during the 1970s.[305] There were two airplane crashes, an electrocution in 1974, an asphyxiation in 1978, and two vehicle accidents in 1979. The Laboratory's deadliest day was May 19, 1972, when eight employees died in an airplane accident at the Albuquerque International Airport.[306] Wright Langham, Johnnie Gallegos, Bruce Bean, Richard Niethammer, William Frye, John Gill, Don Larson, and Eugene Teatum perished when their Beechcraft Queen Air crashed and caught fire shortly after takeoff.[307] Ross Aviation pilot Richard Zettel, also killed, tried to make an emergency landing, but during this critical phase of flight, it was unsuccessful.[308] The investigation showed that the probable cause of the accident was the inadvertent opening of the forward cargo door during takeoff, causing both the door and cargo to impact the left propeller.[309]

"WE'RE MORE THAN JUST DELIVERY BOYS."

The SP-4 Shipping, Receiving, and Warehousing Group was the Laboratory's trucking company in the 1970s.[310] With expert truck drivers and freight handlers, this group packaged, loaded, and delivered 7,000 cargo shipments per year and received 60,000. Shipments included items such as mules, monkeys, "hot boxes," steel shielding, radioactive materials, scientific equipment, high explosives, concrete slabs, and dangerous chemicals, just to name a few. In addition to the peculiarities of transporting freight associated with a nuclear weapons research institution, truck drivers had to be familiar with all Department of Transportation, State of New Mexico, Energy Research and Development Administration, and Laboratory rules and regulations. All employees received safety training in the handling and transportation of both common and unusual materials. One of eight semitrailer truck drivers for the SP-4 Group, José "Tony" Trujillo won first place in 1976 in the New Mexico State Truck Safety Roadeo in Albuquerque. In 1977, the group comprised 50 highly trained men and women and 50 pieces of equipment, and group leadership had a combined total of 60 years with the Laboratory.

This profile was based on an article in a 1977 issue of *The Atom*.[311]

Tony Trujillo drives a Laboratory semitrailer truck east on State Highway 502.

Trujillo loads a shipment into a Laboratory semitrailer truck, 1976.

BUILDING PRIVATE PARTNERSHIPS

With a new suite of technology and facilities at the Laboratory, the work being done there began to attract the attention of private industry. This goal was achieved by a shift in direction under Bradbury, which opened up research to weapons-adjacent topics. Under third Laboratory Director Harold M. Agnew, for the first time, the Laboratory began to institute the programs necessary to forge partnerships that could lead to breakthroughs that would benefit not only national security but also American industry.

Partnerships would become a fundamental part of the Laboratory.

The first such partnerships were facilitated by the Technology Transfer Office, established in 1975. Once the Laboratory developed new technology, then received a patent for this work, the Technology Transfer Office worked with the Department of Energy to license the technology by advertising the licensing opportunity.[312] If a company was interested, the Department of Energy could issue a non-exclusive license for the technology.[313]

This area of interest was not new. From 1940 to 1975 in at least 40 Congressional hearings and reports, Congress had discussed the topic of whether it was right to allow private industry to license publicly funded research. No consensus could be reached, but by the late 1970s, Congress shifted its stance, giving way to the idea that the public would greatly benefit from private partnerships with the national laboratories and that private industry could spark new innovation. To codify this belief, in 1980, Congress passed the Bayh-Dole Act; later it passed the Stevenson-Wydler Technology Innovation Act.[314] These laws allowed universities, nonprofit institutions, small businesses, and federal laboratories to issue exclusive licenses for patents of their inventions.

"The Bayh-Dole and Stevenson-Wydler Acts were intended to increase the rate at which new technologies are commercialized," noted a Laboratory report celebrating 25 years of technology transfer, "and to facilitate inventor involvement in technology development requiring research institutions to take an active approach to the protection and management of their innovations."[315]

As the program grew, the Laboratory established the Technology Transfer Division, which connected work being done at the Laboratory to private industry. In 1989, the program had been so successful that the Department of Energy established the Cooperative Research and Development Agreements program, a formalized process that allowed the Laboratory to more directly benefit from its partnerships. These collaborations would become a fundamental part of the Laboratory, starting relationships with some of the world's largest corporations. By 1993, Director Hecker celebrated the success of the Technology Transfer Office by upholding it as one of the projects that would direct the Laboratory into the "next 50 years."[316]

"Industry not only gets a match for their R&D dollars but also buys into the Laboratory's capabilities," Hecker wrote. "Moreover, our experience demonstrates that the agreements can address each of the three high priority areas for government assistance" in developing "pathbreaking, strategic, and infrastructural technologies."[317]

The collaborations that Hecker touted included Xerox, to develop "new paradigms in computing, along the lines of the lattice Boltzmann technique that we developed for solving nonlinear differential equations." Other collaborations included working with Lockheed to remove uranium and plutonium from soil; developing processing chips with Cray Research; and projects with Exxon, DuPont, MediGene, and many other leaders in private industry.[318]

The Laboratory's work in nanoscience also led to more efficient solar panels and superconducting cables to decrease power loss.[319] Scientists also developed some of the most accurate climate models, later used by the international climate modeling community as part of the Intergovernmental Panel on Climate Change Assessment that would win a Nobel Peace Prize.

Through the Cooperative Research and Development Agreements program, the Laboratory brought in tens of millions of dollars per year, which was cycled into research and development programs that allowed for further research in non-weapons fields. A portion of this funding also went to the scientists who had developed the new technology, incentivizing more innovations.[320]

Not all projects focused on private industry. One of the more ambitious and well-known programs would result from a collaboration between the Laboratory and Harvard University's School of Public Health. Laboratory researcher Bette Korber worked with the university's AIDS Institute, which held a global repository of HIV proteins sequence data and drug-resistant mutations.[321] A similar project led the Laboratory to collaborate with Emory University on a project focused on how HIV avoids the effects of T cells, the immune system response that targets foreign cells for destruction within the body.[322] This work spawned a variety of developments, such as computer-based, disease-modeling software, and ultimately led to the first human trial of an HIV vaccine.[323] This research might have been deemed too tangential to the Laboratory's mission in prior decades, but these new partnerships became an important source of funding for work indirectly related to national security and attracted a new generation of students and scientists who wanted to participate in the research being done at the Laboratory.

Some had begun to believe that the Laboratory was no longer special in its research; however, a path had been laid by the massive construction projects of the early 1970s—first with LAMPF, and then with the expansion of capabilities offered by the Plutonium Facility and the Hot Dry Rock project. Now, decades later, the idea of making the Laboratory, once again, a world-class scientific institution is being realized.

OFFICE OF COMMERCIALIZATION

The first head of the Energy Research and Development Administration, Robert C. Seamans, Jr., developed the country's first national energy plan. Allocating $4 million in the first year to commercial projects, the agency subsidized solar water and solar heating demonstration projects across the country. In January 1976, Seamans founded the Office of Commercialization within the organization. His hope was that the Energy Research and Development Administration could more effectively share with industry any new energy technologies so they could get out into the marketplace. As enabled by Seamans's plan, "industry was expected to take the initiative in the commercialization process while the federal government played a supportive role by identifying major problems and implementing steps to overcome them."[324]

Dr. Robert Channing Seamans, Jr., also former Secretary of the Air Force.

In the fall of 1991, a tiger team inspects the nuclear complex as part of more than 130 audits at the Laboratory over a span of 7 weeks.

LABORATORY RECORDS CENTER AND ARCHIVES

Since its beginning, the Laboratory has generated hardcopy records that have required retention, either due to government regulations or for their historical significance. These records included "memos, letters, administrative documents, payroll records, medical charts and X-ray films, scientific notebooks, maps, photographs, and reports."[325] In 1948, the Laboratory hired Walter Bramlett to oversee these records. He advocated for one bay in a newly built warehouse and made it work until 1956, when he assessed the space as too small. To resolve this issue, the Laboratory gave him the entire building, which subsequently became a "vault" within a secure area. Bramlett retired in 1982 as the head of the Records Center.[326] Curiously, he removed all of the records about himself before leaving.

Begun as an idea in 1975 and established as a permanent institution in 1981, the Archives collected, catalogued, and maintained the historically important records, and the Records Center continued to house the business records.[327] Lillian Hoddeson advised the Laboratory of the need for an archives because she directed the pilot project to write a technical history of Project Y. She required the many documents that had been tucked away in the files of numerous divisions for her project and began "tracking them down, organizing them, and conducting interviews."[328] The first archivist was Nancy Zachariasen, a librarian. Assisting her was Director Kerr's wife, Alison Kerr, who held a degree in library science with an emphasis in manuscripts and archives. Shortly thereafter, Zachariasen left, and Kerr took her place. Subsequently, Kerr hired Roger Meade to backfill her position when she left in 1985.

For a more detailed history of these institutions, please refer to the *History of the Los Alamos National Security Research Center Collections* by Michael P. Bernardin and Alan B. Carr.[329]

Walter Bramlett (center) enjoying his retirement party in the Records Center, 1982.

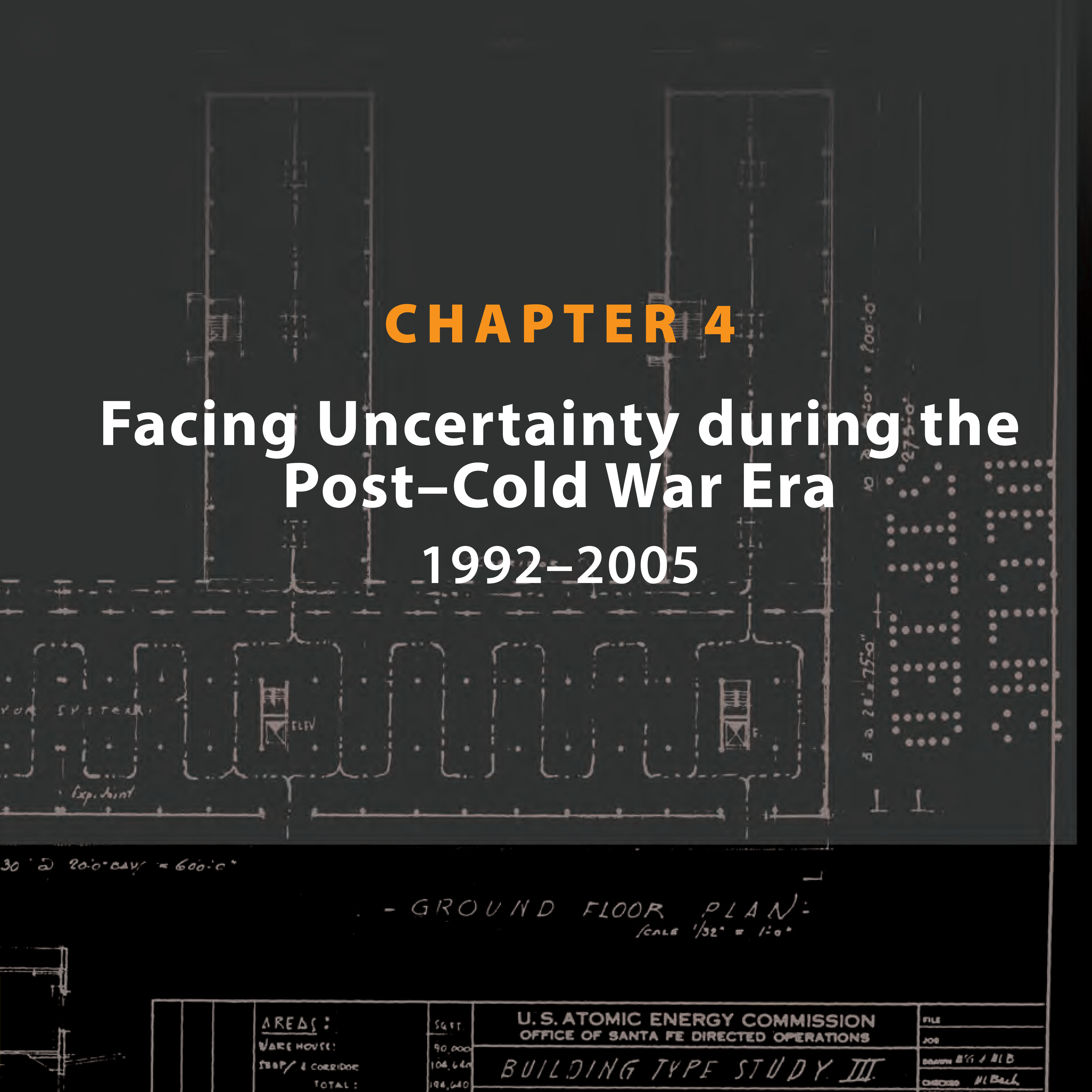
Walter Bramlett (right) enjoying his retirement party in the Records Center, 1982.

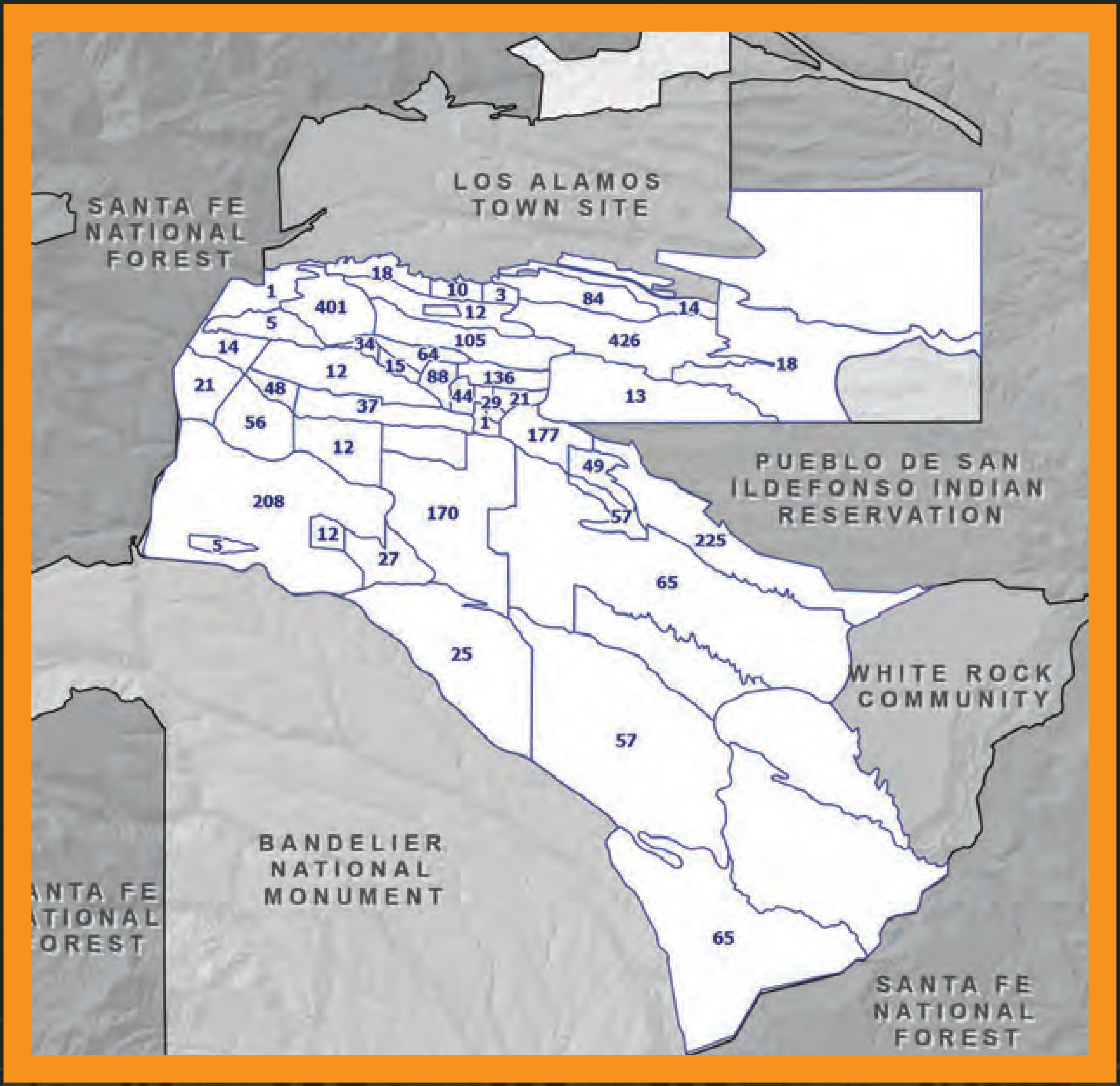
General John A. Gordon was sworn in as the first National Nuclear Security Administrator by Secretary of Energy Bill Richardson, June 2000.

CHAPTER 4

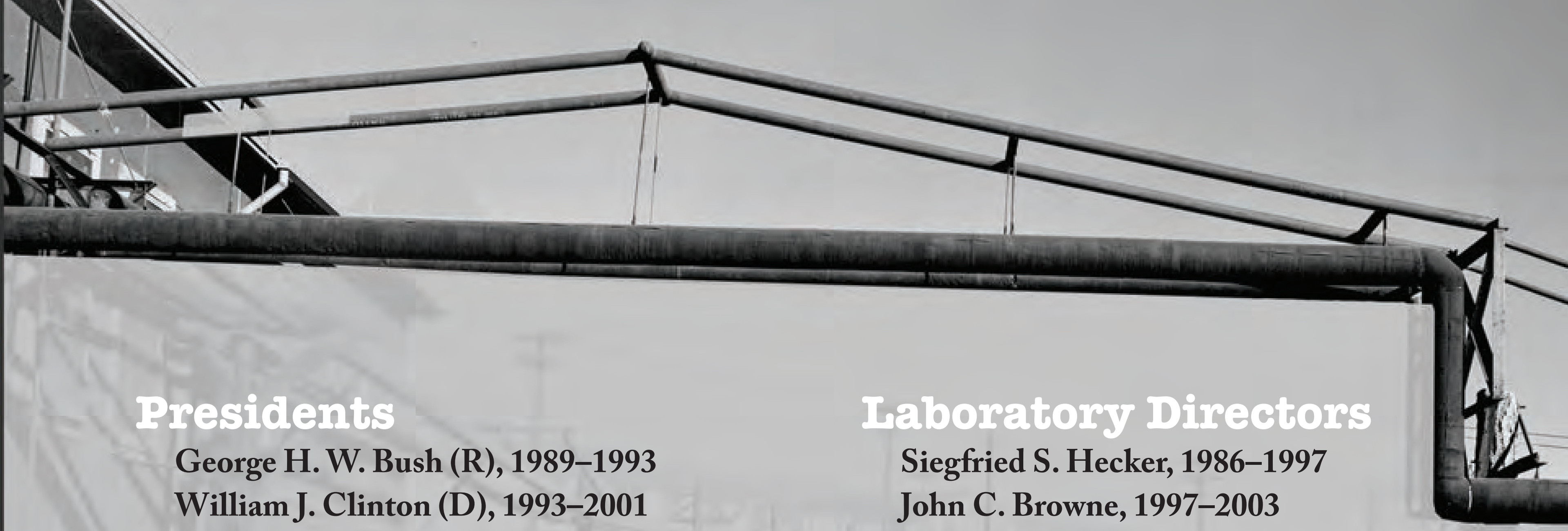
Facing Uncertainty during the Post–Cold War Era

1992–2005





Facility Counts of Los Alamos National Laboratory Technical Areas in 2004.[330]



Presidents

George H. W. Bush (R), 1989–1993
William J. Clinton (D), 1993–2001
George W. Bush (R), 2001–2009

Major Conflicts

War in Afghanistan, 2001–2021
Iraq War, 2003–2011

Treaties

Strategic Arms Reduction Treaty, 1994
Strategic Arms Reduction Treaty II[c]
Comprehensive Test Ban Treaty[d]
Strategic Offensive Reductions Treaty, 2003

Federal Oversight

U.S. Department of Energy, 1977–Present

Federal Managers[e]

Jerry L. Bellows, 1991–1994
G. Thomas Todd, 1996–1998
David Gurulé, 1998–2001
Ralph Erickson, 2002–2004
Edwin Wilmot, 2004–2007

Laboratory Directors

Siegfried S. Hecker, 1986–1997
John C. Browne, 1997–2003
G. Peter Nanos, 2003–2005
Robert Kuckuck, 2005–2006

Laboratory Budget ($K)

$1,102,360 (1992)–$2,101,211 (2005)

Laboratory Staff

7,582 (1992)–11,831 (2005)

Executives over Laboratory Operations

Allen J. Tiedman, 1986–1994
Warren F. Miller, Jr., 1996–1999
Willard R. Wadt, 1999
Joseph F. Salgado, 1999–2003
Richard A. Marquez, 2002–2006

Support Contractors

Johnson Controls World Services, 1989–1997
Johnson Controls Northern New Mexico, 1997–2003
Kellogg Brown and Root, Shaw Infrastructure, and Los Alamos Technical Associates, 2003–2008

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[c] This treaty was never entered into force.
[d] This treaty was never entered into force.
[e] Gaps in service dates reflect periods of unidentified interim or "acting" managers.

A NEW MISSION, NEW SCIENCE, AND NEW FACILITIES

With the fall of the Berlin Wall in 1989, a highly symbolic moment that would herald dissolution of the Soviet Union 2 years later, the Cold War had ended. For many across the world, it was a time to rejoice. That triumph was definitely felt in Los Alamos, but for the Laboratory, it was also a time of uncertainty, as had been the moments after the end of World War II.[331] "In the Manhattan Project, great science was married to a clear and very important national Mission," said then Laboratory Director Siegfried Hecker at a roundtable discussion in Washington, D.C. "During the Cold War, the mission was a little fuzzier, but still quite clear. In both instances, we developed technology to stay ahead of our adversaries. We did that, and we did it well."[332]

But with the close of the Cold War, what role would the Laboratory now serve? Hecker, as director from 1986 to 1997, oversaw one of the most existentially trying moments in the Laboratory's history and a time of great change. And Hecker had an answer for this question.

"What you need for nuclear weapons … is to have smart people stay associated with them."

He collectively called the new mission "reducing the nuclear danger."[333] This mission included work on environmental radiological cleanup, non-proliferation, nuclear material management, stockpile support, and stockpile stewardship. This latter mission, established officially in 1994, included maintaining the safety and reliability of the nation's current nuclear stockpile—except there would be no more underground nuclear testing. The end to testing had begun in 1992, with the unilateral moratorium announced by President George H. W. Bush, who later signed the START II ban in 1993. In 1996, President Bill Clinton signed the Comprehensive Test Ban Treaty, a seemingly permanent ban on all testing.[334] "In the end," Hecker said, "what you need for nuclear weapons more than anything else is to have smart people stay associated with them."[335]

At the Laboratory, with its new focus on reducing nuclear danger, scientists would need to find new ways to conduct their work. It was a mission "intellectually as 'seismic' as the nuclear tests had been in actual fact," Raymond J. Juzaitis, then leader of X Division at the Laboratory, would later say.[336] To accomplish this feat, Laboratory scientists would require new methods of experimentation, which would require new equipment and would call for new facilities.

While still focused on the nation's nuclear stockpile, this shift broadened the scope of scientific work done at the Laboratory. It would lead to breakthroughs in computer modeling, climate science, health care, particle physics, and many more areas that turned the Laboratory into not only a beacon for weapons development but also a global destination for scientific research. Some of the more prominent endeavors took the form of the Advanced Simulation and Computing Initiative (ASCI), the Los Alamos Neutron Science Center (LANSCE; formerly the Los Alamos Meson Physics Facility [LAMPF]), and the Dual-Axis Radiographic Hydrodynamic Test facility (DARHT).

Groundbreaking for DARHT began in 1994, with Director Hecker tossing out the first shovelful of dirt.[337] The chosen location was between Water Canyon and Cañon de Valle, about 7 miles from the Laboratory's main technical area. This new facility would simulate nuclear explosions via hydrodynamic tests, which use high explosives to detonate a mockup pit at speeds greater than 10,000 miles per hour. No plutonium is involved, but the intense pressure of the explosion turns the non-fissile

Aerial view of the Los Alamos Neutron Science Center, 2004 (opposite page).


On February 23, 1992, Hecker (right) greets physicist Yuli Khariton (front), who oversaw the creation of the Soviet Union's first atomic bomb.


DARHT in 2004.

The heart of the ASCI program at the Laboratory is the Nicholas C. Metropolis Center, which has housed many of the classified computing systems.

substitute material into liquid, similar to what would happen during a real nuclear test. These hydrotests allowed the Laboratory to "provide data critical to improve confidence in the predictive capability of codes to support a safe, secure, and reliable stockpile and maintain confidence in the nation's nuclear weapons stockpile without nuclear testing."[338] Along with being, at the time, the world's most powerful X-ray machine, DARHT also led to the development of many other technologies such as MOXIE, then the world's fastest camera.[339]

Before and during construction, the Laboratory conducted environmental surveys that focused on heavy metals in the soil and vegetation around the facility.[340] Vehicle checkpoints were established to secure access to the site. The use of high explosives, ionizing radiation, lasers, and high-voltage lines posed significant safety concerns to employees, so the facility was outfitted with a network of door interlocks that communicated with each other to prevent, for example, someone from entering the fire point during a hydrotest.[341] By 1999, construction was completed, and DARHT ran its first test.[342] The next year, Laboratory scientists had completed the first three-dimensional simulation of a nuclear weapon secondary explosion. This research led to the program extension of the W-76 warhead.[343]

But DARHT was only part of that triumph. To run such a simulation required a lot of computing power (42 days' worth!), and that task would be carried out by the ASCI program.[344]

The end of nuclear testing meant that the Laboratory needed to simulate tests, and this need would push the Laboratory into the forefront of scientific modeling. In 1995, the Department of Energy announced the ASCI supercomputing initiative, a collaboration between the Los Alamos, Lawrence Livermore, and Sandia national laboratories.[345] At Los Alamos National Laboratory, this initiative took the form of the Nicholas C. Metropolis Center (formally the Strategic Computing Complex). The facility was a three-story, 300,000-square-foot building located in TA-03 that included a massive 43,500-square-foot room that housed the mainframe computer, two visualization theaters, and a 200-seat lecture hall.[346] With stockpile stewardship central to the Laboratory mission, the Nicholas C. Metropolis Center became the primary classified computing system for the national laboratories.

At DARHT, electron accelerators pulse electrons downrange at a target, allowing scientists to view inside various materials (opposite page).

The scale of this new power transformed the scope of work possible at the Laboratory. Researchers could now model the physics of a nuclear device in three dimensions on a computer. Over the next two decades, the Laboratory became host to some of the most high-powered computers in the world: ASCI Blue Mountain, ASCI Q, Roadrunner, Cielo, and Trinity.[347]

> **Together, these facilities helped the Laboratory peer into aging materials in the nation's nuclear stockpile.**

The new computing power also allowed scientists to harness this resource for work outside the nuclear mission. The Laboratory had been interested in biological science from early on—during the Manhattan Project—to understand the effects of radiation on the human body. With supercomputers, a long-time project of mapping the human genome and the largest worldwide scientific collaboration to date, found an added boost.[348] This computing power also led to great advances in climate-change modeling, disease spread, high-energy density physics, our knowledge about the creation of stars and planets, and a host of other areas that would become important disciplines of their own at the Laboratory.

The third major renovation to the Laboratory's physical footprint, which would expand its role in scientific research, was an overhaul of LAMPF. The facility had been focused on high-energy particle physics, mainly the subatomic pi-mesons present in cosmic rays. Pi-mesons, also called pions, are important in understanding the performance of nuclear weapons and radiation effects on nuclear reactors.[349] But by the early 1990s, national scientific focus had switched from pi-mesons to neutrons.

Neutrons became essential to a range of scientific research because they can be used to probe the atomic scale of materials—everything from polymers to superconductors to biological matter.[350] This work is done by passing neutrons through the material and then studying how the characteristics of the beam have been changed by its interaction with the material, giving scientists a look into the material's internal structure and composition.

In 1995, LAMPF was renamed LANSCE to reflect this change in mission.[351] But more important than a new name, a new scientific focus again called for new equipment. The three main facilities at LANSCE that were critical to the Stockpile Stewardship program were the Proton Radiography Facility, the Luján Neutron Scattering Center, and the Weapons Neutron Research Facility.[352] Together, these facilities helped the Laboratory peer into aging materials in the nation's nuclear stockpile and identify manufacturing issues with the use of neutron scattering and high-energy neutron radiography.[353]

As a 1993 Department of Energy report pointed out, neutron-scattering experiments were also increasingly important to the broader scientific community. So the Department of Energy Office of Basic Energy Sciences began to sponsor the facility for non-weapons research so that users from across the world could experiment at LANSCE. In the coming decades, Laboratory and non-Laboratory scientists would use the facility—particularly the beam accelerator (still considered one of the most powerful in the world)—to investigate topics as varied as the prevalence of anti-matter in the universe to cancer research.[354] LANSCE's Isotope Production Facility became particularly important in this latter field of study, and it has produced important isotopes used to both diagnose and treat different forms of cancer.[355]

These advances, a few among many during the early Stockpile Stewardship era, not only improved the Laboratory's ability to achieve its nuclear mission but also helped it become an international destination for top scientists. In a time of unprecedented change, the Laboratory would need new minds to solve new problems, which included what to do with nuclear waste.

Laboratory scientists use containment vessels to confine the explosions of nonfissile material, helping the nation assure the safety of its nuclear stockpile (opposite page).


CAUTION


HOME
AUTO OFF MANUAL
MODE SELECT
CAUTION
120 VOLTS
UP OFF DOWN
CHAIN TENSION
1953
TARGET
TARGET ENABLE
POSITION
AUTHORIZED PERSONNEL ONLY
NOTICE

WHAT TO DO WITH DECADES OF NUCLEAR WASTE?

The end of Cold War not only altered the mission of the Laboratory internally; it and the rest of the Department of Energy weapons facilities were now increasingly open to public scrutiny, which led to questions about what the Laboratory had done with its nuclear waste.

During the days of the Manhattan Project, scientists had focused almost entirely on producing a useable weapon. At the time, there were no industrial precedents for how to dispose of highly radioactive materials, and there were no outside reviews by local or federal regulatory agencies.[356] So scientists set their own standards and safety procedures.

Monitors with survey meters constantly patrolled the open areas of the Laboratory. Personnel took air and water samples to test for radioactive contamination, and environmental researchers analyzed the surroundings.[357] These procedures were developed to protect the health of the employees and, for the most part, waste management was not a priority. Then, with the close of World War II came the Cold War, and weapons production once again ramped up, as did the amount of chemical and nuclear waste.

During this time, the Laboratory had processed and stored transuranic waste—byproducts of radioactive elements such as plutonium, uranium, and americium—onsite and in pits on the Pajarito Plateau.[358] The most radioactive material was processed and stored in underground shafts, some lined with concrete and some without, in a designated location called Area C. This site was used in this manner from 1948 to 1974, until another disposal site, called Area G, became the primary disposal location.[359] (Area G remains in use today, although with radically different storage procedures. Waste placed in containers is stored in above-ground domes and is monitored continually until the containers can be shipped offsite.)

But that was not the only waste produced by the Laboratory. Irradiated material, such as paper from offices, glassware, even cabinets in old offices, were often disposed of in pits "bulldozed out as deep as practical before hard rock is encountered."[360] The pits were usually about 300 feet long, 15 feet wide, and 12 feet deep.[361] The buried materials were often of lower radiological concern, but the poor record keeping of these sites caused problems. One such incident occurred in 2020, when construction near DP Road uncovered radioactive material from an old pit.[362]

But the end of the Cold War changed how the Laboratory would process this radioactive material. After President Bush ended nuclear warhead production in 1990 and following the Strategic Arms Reduction Treaty (START I) and START II, the Department of Energy announced that it would consolidate the weapons complex. By 1995, environmental cleanup made up the largest Department of Energy program, consisting of $6.5 billion of the agency's $18.5 billion budget.[363]

By 1995, environmental cleanup made up the largest Department of Energy program.

This realignment of priorities was spurred, in part, because of the declassification of Cold War–era documents, "a stack of material over three miles high," as researchers put it. "Public health-[sic] concerns began to arise as it was discovered that releases of radioactive gases into the atmosphere, and other mishandling of hazardous materials, had occurred during the Cold War period."[364]

For decades, the United States had amassed a vast quantity of nuclear and other types of hazardous material. Now the nation's laboratories

Mike Connor uses a remote-handling device at LANSCE. The yellow-tinted window is made of 4-foot-thick glass to protect researchers from radiation (opposite page).

WASTE CHARACTERIZATION AND CONTAMINATION

By the mid-1990s, the Department of Energy understood the problems of cleanup requirements, but the full characterization of contamination and waste across the complex was still in progress. Significantly, "the waste, along with the actual process of cleaning it up, creates not only health, safety, and environmental concerns but administrative and legal problems as well."[381] Washington State University's Richard Reed and others shared that cleanup activities were complicated. For example, to clean up spent nuclear fuel, the Office of Environmental Management had to conduct the work under 50 Department of Energy orders, 9 Presidential executive orders, and 22 separate acts (e.g., the Nuclear Waste Policy Act and the Archaeological Resource Protection Act).

The first shipment of transuranic waste, which originated from the Laboratory, arrives at WIPP in the early morning hours of March 26, 1999.

would take on two major tasks: ensuring the reliability of America's stockpile and helping to restore the environmental damage and any future damage caused by the years of furious nuclear production.

Luckily, a solution to the problem of nuclear waste had, in fact, been in development for decades. But it had only recently been completed. It was called the Waste Isolation Pilot Plant (WIPP).

The idea to deposit transuranic waste from the United States' national laboratories and weapons facilities at a central, secured location had been theorized as early as 1957.[365] By the early 1960s, the government was searching the nation for sites that could safely store transuranic waste, which required not only the right geological conditions but also local public support. By 1973, the United States government had settled on a stretch of desert land near Carlsbad, New Mexico, about 300 miles southeast of Los Alamos.[366]

The site is located in salt beds deposited 250 million years ago by the evaporation of the ancient Permian Sea.[367] This location was a primary recommendation decades earlier by the National Academy of Sciences when the government started its search.[368] Salt does not allow water to seep through from the earth's surface, and it deters any underground free-flowing water that might corrode containers. Salt also closes up any fissures in the ground, giving WIPP a tight seal.

By 1990, construction was complete.[369] The repository, built 2,150 feet underground, had eight massive disposal panels where the transuranic waste was stored. Surface facilities included a waste-handling building, a waste shaft, evaporation ponds, and a salt pile.

WIPP covered 16 square miles. Under federal guidelines, the facility may store 175,565 cubic meters of waste for 10,000 years.[370] The Department of Energy Carlsbad Field Office was assigned to oversee WIPP, with Nuclear Waste Partnership LLC directly operating the facility. Two contractors, Visionary Solutions and Cast Specialty Transportation, would ship transuranic waste from labs and weapons facilities across the country.[371] The trucks would drive only on designated routes, and each shipment would be tracked by satellite. By 1990—after decades of research, planning, and political wrangling—the United States had built the first underground repository for nuclear waste.

But the first shipment of transuranic waste would not be delivered that year or the next. A series of political changes, lawsuits, certifications, and regulatory changes delayed the official opening of WIPP for another 9 years, until 1999.[372]

In that year, on March 26, then Energy Secretary Bill Richardson gathered with hundreds of people and the press to mark the historic moment.[373] The shipment had originated from the Laboratory—17 containers of transuranic waste—with transporters stopping every 100 miles or 2 hours to check on their cargo. Richardson said, "This shipment to WIPP represents the beginning of fulfilling the long-overdue promise to all Americans to safely clean up the nation's Cold War legacy of nuclear waste and protect the generations to come."[374]

Although the Laboratory was the first to send transuranic waste to WIPP, it was just one of more than 20 other Department of Energy sites that would rely on the facility. Within 12 years, WIPP would celebrate its ten thousandth shipment.[375]

The rapid pace was remarkable, but it also led to complications. In February 2014, a mishap occurred that involved a waste container shipped to WIPP by the Laboratory.[376] Improperly packaged, the container ruptured, contaminated workers, and necessitated the shutdown of operations.[377] WIPP closed for almost 3 years due to the incident, which resulted in approximately $640 million in clean-up costs.[378] Investigations revealed that the root causes were associated with the Laboratory's change in packaging material and deficiencies in management systems.[379] Agreements between the Department of Energy, the National Nuclear Security Administration, and the State of New Mexico to expedite shipments may have been a contributing factor.[380] Subsequently, the Laboratory participated in numerous audits; conducted testing, modeling, and experiments; and implemented new procedures, all in an effort to avoid reoccurrence. By January 2017, WIPP had reopened and was once again receiving shipments.

Along with historic waste, WIPP played a significant role in the future of the Laboratory when, in 2021, the Laboratory was ordered by the Department of Energy to produce 30 plutonium pits each year. These pits would be furbished from those removed from old weapons, taken to TA-55 to process out impurities, and then installed into the latest technology. As the Laboratory set out on this new path, unusable radioactive material was sent to be stored safely, securely, and away from the public at WIPP.

Miners use a remote-controlled, continuous-mining machine to make space in the bedded salt for planned salt disposal investigations at the Waste Isolation Pilot Plant, 2011.

THE FIRE HEARD AROUND THE NATION

Not all major changes to the Laboratory came in the form of national policy or international politics. The decision to locate Project Y—the secret effort to build the world's first atomic bomb—on the Pajarito Plateau was made in large part because it helped conceal the work being done there. The area was heavily forested, and the winds could whip up the canyons with surprising speed. But at the time the location was decided, there was no reason to think that the Laboratory would exist beyond the end of World War II, and little thought was given to how natural disasters might factor into the Laboratory's future.

The nation was accustomed to wildfires … but not … near a facility that handled nuclear material.

In May 2000, what was then the largest wildfire in New Mexico's history burned through the nearby mountains, the town of Los Alamos, and dangerously close to the Laboratory. Although much of the Laboratory's operational buildings were spared or saved by the quick work of firefighters, the fire charred more than 8,000 of the 27,000 acres owned by the Laboratory (and 39 structures, most of which were storage buildings).[382] The Cerro Grande Fire would alter the Laboratory in significant ways.

This fire was not the first to threaten the Laboratory. The Water Canyon Fire (1954), La Mesa Fire (1977), and Dome Fire (1996) had come close. The Dome Fire led to the creation of the Interagency Fire Management Team.[383] Before this fire, county, state, federal, and Laboratory wildfire teams operated separately. Going forward, each would coordinate efforts when fighting and preventing fires, and their efforts would limit the damage wreaked by this latest blaze. Moreover, the Cerro Grande Fire transformed the Laboratory's relationship with wildfires locally and nationally.

For much of the past century, wildfires were thought of as inherently destructive. But as new forestry science emerged, the nation realized that small fires were not only natural—they helped clear forests of tinder that built up after trees fell and grass died and also controlled forest density. For example, the recommended healthy density for northern New Mexico forests is between 50 and 150 trees per acre.[384] Forests around the Laboratory often held 1,000 trees per acre. To correct this overgrowth, federal agencies often conducted controlled burns, which simulate the natural thinning of forests by fires. Before 2000, the last controlled burn in the area where the Cerro Grande fire started occurred in 1993.[385] But damp conditions at the time led to an unsatisfactory burn. The next scheduled management was set for May 4, 2000.

There would be many investigations into what went wrong that day and the planning that led to the controlled burn; the National Park Service, the Laboratory, and the Department of Energy would all conduct assessments.[386] But two factors played a major role: high winds and drought, the start of what would be the longest dry spell in the state's recent history.

The nation was accustomed to wildfires in the West but not a fire near a facility that handled nuclear material. No nuclear material would ever be at risk, but the damage to the Laboratory was extensive. Power and communication lines were severed. Five historic, Manhattan Project–era buildings that were part of V-Site—buildings that had recently been named an official project of the White House Millennium Council's Save America's Treasures Program—were leveled.[387] Hardest hit was the Physical Chemistry and Applied Spectroscopy Group, made up of mostly postdoctoral students, with half of the office losing their office trailers. About a dozen Laboratory scientists were temporarily relocated to the Santa Fe Institute, the non-profit think tank based in Santa Fe, where they were

The 2011 Las Conchas Fire behind the Laboratory (opposite page).

The La Mesa fire burned into the Laboratory's explosives fabrication facilities and testing sites at TA-16 and TA-11, 1977.

The Cerro Grande Fire in May 2000.

able to work remotely from offices they collectively deemed the "laptop lab in exile."[388] Extensive smoke and ash damage to many offices would need to be cleaned, and many reports were made about the damage to the facilities and environment. In total, more than $300 million worth of damage would be done to the Laboratory.[389]

Still, it could have been much worse. If the Interagency Fire Management Team had not, in the past 4 years since the Dome Fire, thinned the trees and tinder from nearby Laboratory facilities, the destruction would have certainly been worse. Every 2 weeks after the Dome Fire, members of the Laboratory, Los Alamos County, Bandelier National Monument, the Santa Fe National Forest, Pueblos, and state agencies met to discuss wildfire management.[390] They carefully mapped where to build firebreaks and where to thin the forest, and they also met with the community and individual homeowners. "The Interagency Team is widely recognized as being instrumental in raising community awareness, improving response, and instilling the first notion of proactively managing the forests surrounding the community," a joint Laboratory and Los Alamos County report read.[391]

The Cerro Grande wildfire would burn 48,000 acres and would not be extinguished until July 20, more than 2 months after it began. With the immediate danger of the fire behind, the Laboratory began its assessment of how such a fire could be prevented in the future and how to recover what was lost. Laboratory Director John C. Browne, who had taken over from Hecker 3 years earlier in 1997, began this effort immediately.

One of his first orders was to establish an Emergency Rehabilitation Team. This group would evaluate the impacts of the Cerro Grande Fire on Laboratory property, design erosion-mitigation solutions from land denuded of vegetation, and implement these plans to prevent further damage. Some of this work began even as the fire still burned.[392]

Under the Wildfire Hazards Reduction Project Plan, the Laboratory made forest health a major priority.[393] The Laboratory's Ecology Group sought to recreate a healthy forest, which meant clearing many dead trees and brush, as well as thinning the forest in a way that replicated the manner in which small fires naturally thin healthy forests.[394] The Laboratory's strategy also meant applying science to the wildfire problem. The Laboratory increased the robustness of its air- and water- monitoring program, which became part of normal Laboratory operations.[395]

The Cerro Grande Fire also led to general concern that another wildfire like it—but perhaps even more devastating—could further damage the Laboratory. Scientists developed models such as FARSITE, which simulates wildfire patterns in the surrounding forest.[396] Some of the models evolved do the same regionally and across the United States. Today, the effects of climate change, which include drought, a warming world, and future climate forecasting—all of which pertain to wildfires—are an important field of study at the Laboratory.

One of the more tangible results of the Cerro Grande fire was the construction of the new Interagency Emergency Operations Center at TA-69.[397] It would host the Laboratory's Emergency Management Group and serve as a command center in case of another wildfire—or any emergency. Under normal conditions, it would serve as a place for federal, state, and local emergency planners to meet and discuss preventive actions.[398]

The Laboratory's actions were praised for protecting facilities and aiding locals. But the Cerro Grande Fire also drew attention from Washington, D.C., regarding Laboratory operations. Before, divisions at the Laboratory operated more independently. The strengths of this system included nimbleness, independence to pursue projects, and speed because of a flatter organizational structure. Safety and information security might be emphasized differently among divisions. Even more mundane things, such as where to get money for building repairs, led to confusion. The response from the federal government was to reorganize this structure as a pyramid. Decisions would be passed from the division level to managers and eventually to directors and associate directors. To facilitate this new structure, Operations became centralized, charged with oversight across the Laboratory.

CERRO PELADO FIRE

In the spring of 2022, New Mexico saw four major wildfires that would devastate hundreds of thousands of acres of forest and drive many people from their homes. One of these fires—the Cerro Pelado—came within 3.5 miles of the Laboratory.[399] The cause of the fire was still under investigation during the writing of this book, but it began on April 22 during a high-wind event. The fire burned into June, enveloping 45,605 acres before its conclusion.[400]

During the fire, the Laboratory sent many employees home and encouraged those who could to work remotely. On May 9, the town of Los Alamos was also given instructions to prepare for potential evacuation as part of the "Ready, Set, Go" program, a threat system established by the National Nuclear Security Administration, Los Alamos County, the U.S. Forest Service, and the Laboratory's fire Incident Command. Under the "Set" phase, residents were asked to pack a bag of belongings and to plan an evacuation route in case the threat level was elevated to "Go;" however, by May 17, the town was returned to the "Ready" phase.

Due to past actions taken by fire officials, including the Laboratory's Wildland Fire program, it was believed that previous mitigation efforts greatly reduced the fire's potential devastation. Jim Jones, the Laboratory's Wildland Fire program manager, told local reporters, "For about the last three and a half years, we've been doing preparation for a wildland fire. We removed approximately 3,500 tons of fuel from the Lab properties—trees brush, those types of things."

Smoke from the Cerro Pelado Fire billows behind the Laboratory, April 29, 2022.

THE ERA OF CYBERSECURITY

National laboratories became targets of hackers as soon as remote access to someone else's computer was possible.[401] As repositories of massive data collections, the national laboratories possessed advanced computer technology, used remote access regularly, and operated connected and integrated networks.[402] Inconspicuously, "somebody at probably every DOE Lab helped 'invent' incident response and computer network defense."[403] According to former Laboratory high-performance computing scientist Alex Malin, several incidents transformed cybersecurity at the Department of Energy:

> the 1988 internet worm (Morris Worm) that affected multiple laboratories;
> Cliff Stoll's 1989 book, *The Cuckoo's Egg: Tracking a Spy Through the Maze of Computer Espionage*;
> the 1999 Wen Ho Lee incident at Los Alamos National Laboratory;
> the 2004 Stakkato cyberattack that affected high-performance computing and multiple laboratories;
> the accountable classified removable electronic media incident at Los Alamos National Laboratory; and
> the advanced persistent threats from 2008 to 2014 across the Department of Energy.[404]

According to Malin, cybersecurity is a living history, and "DOE Labs continue to make important contributions and innovations, adding to the legacy for leadership in network defense and intrusion response."[405]

During the Manhattan Project, General Groves had to assume that every person on the job was not above suspicion. Movements of people were watched. Every rumor was tracked down, and any indication that someone had broken the silence that surrounded the Laboratory was investigated. For these reasons, the U.S. formed a counterintelligence corps, which investigated everything from security leaks and suspected sabotage to a man at the Hanford Site in Washington State who had counterfeited and sold meal tickets. Workers at the Laboratory agreed to accept censorship of their mail before they were hired. The employees of the Manhattan Project safeguarded the secrets of their conversations and reports using improvised code words.[406] In short, the Laboratory was accustomed to the idea that, at any moment, a spy could be in its midst—and during the Manhattan Project, numerous, high-profile spies were outed by the government and later the media. In more modern times, this notion of a spy who sold secrets to foreign governments would come to be called the "insider threat," and perhaps none of the post–Cold War era was more controversial than Wen Ho Lee.

On March 6, 1999, *The New York Times* published a lengthy, troubling report of a spy in the hallways of the Laboratory.[407] Within days, the Laboratory had fired Wen Ho Lee, a research mathematician who helped develop computer programs for nuclear test simulations.[408] At the Laboratory, the Lee investigation led to a site-wide overhaul of how it safeguarded classified information from insider threats and unified site-wide regulations. The Lee incident was a catalyst for major security reform at the Laboratory. Even as this reform was underway, the Laboratory and the Department of Energy instituted a recovery plan that included, among other actions, increasing physical security at the vaults that stored classified information; ordering custodians to oversee all material checked out; requiring specialized National Security Agency encryption keys to access classified data; and completing a full audit of classified information.[409]

Protecting classified material in the digital era had always been a hard task, especially once the advent of personal computers being connected to the internet became widespread. In 1988, the Morris Worm, an early virus developed by a Cornell University graduate student, infected the Laboratory. Measures were taken to step up defenses from outside viruses and finally, in 1998, the Laboratory implemented a firewall (a digital fence to secure incoming information) for its systems. By the early 2000s, the Laboratory had to account for 150 security areas; 1,500 security containers; 6.5 million classified records; and 2,000 classified computers. The "safeguards and security program at LANL," one report noted, "is one of the most complex, geographically diverse, and operationally challenging programs in the world."[410]

The other major change that would be implemented to employees in classified areas, and later to all staff, was two-factor identification cards, called CRYPTOCards. These hand-held electronic devices would protect classified data from unauthorized access and would also help the Laboratory track those who had accessed the data.[411] This tracking required pulling employee records, including citizenship and clearance level, as well other pertinent human resources information. Interestingly, with these data compiled in a central system, the Laboratory's digitized phonebook was born.

But despite these reforms, in May 2000, the Laboratory suffered another security incident—this one involving missing disks that held classified information. Director Browne shut down parts of the Laboratory while the Federal Bureau of Investigation conducted an investigation. In June, the disks mysteriously showed up behind a copy machine.[412] The controversy spawned another series of investigations and more Congressional hearings. The compounding criticism from the missing disks, a later controversy of employee misspending, and the memory of the Wen Ho Lee incident would all lead to Director Browne's resignation in January 2003. "The controversy was so strong and so critical of management," Director Browne said, "that I personally thought the best thing for me to do was resign and to have the [University of California] come in and take it to the next level of performance."[413] With a change in leadership, the hope was to put the scandals of the past behind the Laboratory, to institute changes to solve these problems, and to get back to the science. But the coming years would not be so easy for the Laboratory.

THE 414 INCIDENT

A group of teenagers hacked a Laboratory computer, and the event became known as the 414 incident. It was facilitated through the advent of personal computing and remote-access technologies and changes in our cultural norms. Technology provided a means to access materials owned by others, and societal shifts permitted the activity. In the early 1980s, the computer club was born, and hacking became a hobby. In 1983, "the 414s became the public face of the teen 'whiz kid,'" and the film *WarGames* "glamorized hacking."[415] The September 5, 1983, edition of *Newsweek* titled its article about the 414 hackers, "Computer Capers: Trespassing in the Information Age—Pranks or Sabotage?"[416]

The teenagers, calling themselves the 414s, were part of an Explorer Scout computer club that met at their local IBM office in Milwaukee, Wisconsin. As part of their gaming activities, they began breaking into mainframes in May 1983. Within 1 month, they broke into the Laboratory's Machine G. The 414 incident was a key driver to the correction of deficiencies in cybersecurity at the Laboratory and the establishment of computer crime laws. As Malin observed, "DOE site network defenses in 1983 did not proactively account for the change in threat posed by the combination of technological culture changes."[417]

This event summary was based on a 2017 presentation by Alex Barry Malin titled, "Cyber History in the DOE—The 414s."[414]

A computer operator running programs on an IBM computer at the Laboratory, 1984.

The Blue Mountain supercomputer, installed in 1998, was the Laboratory's first large-scale cluster computer and one of many systems it used to become a world leader in computer modeling and simulation.


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ORIGIN 2000

THE SAFETY AND SECURITY STAND DOWN

When Laboratory Director Browne resigned, he was replaced by G. Peter Nanos. Beginning in 2002, Nanos served as principal deputy associate director for the Laboratory's Threat Reduction Directorate. Before that, he had retired as a vice admiral in the U.S. Navy.[421]

After the years of the Wen Ho Lee incident and widespread media descriptions, however unfair, of a culture of lax security at the Laboratory, officials and politicians hoped that Director Nanos would effect change at the Laboratory with his "tough, military style."[422] The reorganization after the Cerro Grande Fire brought a pyramidal style of leadership across the Laboratory, and Director Nanos's time centralized this structure even more. This new style would often clash with long-standing employees, and throughout his 2 years as director, employee retirements were 50 percent higher than in previous years.[423]

What brought the Laboratory to a crisis level were two more security incidents, followed by the longest Laboratory shutdown since the time of the Manhattan Project, and then another scandal in the wake of reforms.

In July 2004, while taking inventory to prepare for an experiment in the weapons physics directorate, the Laboratory discovered that four computer storage devices that contained classified research were missing. Two drives were later found—having been improperly moved to a different building—but the other two were never located. The news of missing classified information prompted another round of media headlines.[424] To remedy this system, the Laboratory worked with the Department of Energy and the National Nuclear Security Administration to digitize tens of thousands of storage devices that held classified research.

It was later learned that the other two "missing" disks had, in fact, never existed, and that there was no national security risk. The mistake was an inventory error. The National Nuclear Security Administration determined that 12 barcodes used to issue classified disk drives were issued to a group that required only 10. The extra two were nevertheless logged into the master inventory, which was why it appeared that two disks had gone missing. "The allegedly missing disks never existed and no compromise of classified material has occurred," the report stated. A simple mistake in inventory management had been misidentified as the misconduct of incompetent scientists, and a set of extreme and destructive acts of cultural re-engineering had been instituted at great cost to the Laboratory and, presumably, to national security.[425] The news of the missing disks drew remarks from outside the Laboratory, including from the University of California's Board of Regents, the Vice President of Laboratory Management, and Secretary of Energy Spencer Abraham.[426]

[N]o compromise of classified material has occurred.

On the heels of other recent security incidents, the still relatively new director tried to emphasize the seriousness of the matter to Laboratory staff. "Once again," Director Nanos wrote to employees, "the failure . . . to follow [security rules] has brought disrepute to Los Alamos."[427]

A second security failure, which occurred the same week as the missing disks, involved a student injured by a laser. The 20-year-old was helping a mentor—a Laboratory employee—set up a test that used powerful lasers. A later investigation would reveal that neither was wearing laser eye protection and that there had been missteps in safety planning for the experiment and laser operation.[428] During the test, the student bent down to look into the rear chamber of the target point while the laser was still active, resulting in a burn on her retina and damage to her eye.

Director Nanos responded very sternly to these incidents. In another email to Laboratory employees, later passed along to the media, he wrote, “This willful flouting of the rules must stop, and I don’t care how many people I have to fire to make it stop. If you think the rules are silly, if you think compliance is a joke, please resign now and save me the trouble.”[429] Soon after, Director Nanos suspended 19 Laboratory employees. He then took the almost unprecedented move of shutting down operations at the Laboratory, with non-essential research at different sites at the Laboratory ended for between 2 and 7 months. The stand down, as it was called, would cost $370 million. During this time, employees received repeated safety and security training. Director Nanos’s heavy-handed reaction to change the Laboratory’s culture was perceived as “a profound breach with the employees he was supposed to lead and represent.”[430] After being harassed by employees, Director Nanos had a safe room constructed in his home.[431]

As part of a security review, management assigned a risk level to each division’s activity. During the stand down, resumption of work was allowed only after employees and management had fulfilled a review process, managed by the Culture and Operations Model, Plan and Surety System.[432] This process sometimes included one-on-one meetings with employees to review safety procedures in their offices and, in some cases, a more rigorous assessment that required identifying and resolving a list of corrective actions before work resumed.

However, as a result, the National Nuclear Security Administration fined the University of California $3 million—money that was taken from funds that the university received to manage the Laboratory and that was typically reinvested into experiments.[433] The university was also given an “unsatisfactory” rating for its management practices.

The University of California had operated the Laboratory since the days of the Manhattan Project, but now—for the first time—the federal government opened the Laboratory’s management and operations contract up for bid.

Since this time, the Laboratory has made great efforts to digitize much of its classified material and place it on the red network. This effort would involve building dozens of new fiber networks and building security vault rooms to protect classified computing systems and material. The Laboratory would

SAFETY AND SECURITY REFORMS AT THE LABORATORY

In the wake of the Lee incident, Laboratory Director Browne hired Richard Burick as associate director for Operations to institute security reforms. Together, they stood up the Senior Information Security Policy Board to provide “institutional leadership, direction, integration, and management oversight to ensure that the Laboratory’s INFOSEC Program is meeting known threats and anticipating and responding to technological changes in a timely manner.”[418] This team would meet regularly to discuss security measures and to evaluate progress. It would stand up “red teams” to identify vulnerabilities in security and establish an External Advisory Board to review the Laboratory’s processes.[419]

Under Burick, the Laboratory developed a suite of media tracker software that automated the electronic record keeping of classified information by using barcodes. The Laboratory also bolstered its insider threat risk assessment program, which included increased personnel security and employee assistance programs for those handling classified information. Other improvements included the creation of a senior security advisor position, deployed to all directorates. This person would become the point of contact for security matters and a host of training programs and special projects, including the Enhanced Security through Human Error Reduction project, the Lessons Learned Program, and the SMART Security Suggestion Program.[420]

John Browne (left) sits with Admiral Tom Brooks during the University of California Laboratory Security Panel, 2000.

Cray 1, the Laboratory's first super-computer, at the Central Computing Facility, 1978.

The Laboratory used nine Cray Y-MP computers between 1989 and the late 1990s.

also convert personal computers in classified areas to diskless systems—first by using J-B Weld to seal the computer ports and later by phasing out many systems with newer models.

Securing classified data was a worry from the Laboratory's inception. Computers, the internet, and the proliferation of personal computers all made security more difficult. Over the years, the Laboratory has learned that security, like technology, must always evolve to meet new challenges.

But even as the Laboratory sought to make these needed reforms, it found itself connected to another incident that splashed across national headlines. In 2002, the Laboratory hired two former police chiefs, Glenn Walp and Steve Doran, to review security at the Laboratory in the wake of recent safety and security lapses. Shortly after they arrived, Walp wrote a troubling report that accused Laboratory employees of misusing funds and stealing property totaling some $3 million since 1999, he alleged. Walp's claims made headlines, and he was fired in the winter of 2002. According to Walp, he had raised concerns of corruption with Laboratory leaders, but instead of looking into his findings, Walp claimed that leaders released him from his role. Among the allegations, Walp said that Laboratory employees had tried to purchase a $30,000 Ford Mustang with taxpayer money, had used a Laboratory credit card to withdraw $2,500 in cash, and that the Laboratory could not account for many items, such as 260 missing computers.

At the time, a Laboratory spokesman responded to reports by saying there was "no culture of theft here" and that "people do not walk out of here with property" as Walp had claimed. Many of the missing items were probably misplaced among the Laboratory's more than 2,000 buildings on the 40-square-mile site, the spokesman said, adding that "there is no evidence that there is any classified information on computers reported as missing."

After Walp sued for wrongful termination, he eventually received a settlement of $930,000 from the University of California. He would also go on to write a book, titled *Implosion at Los Alamos*, about his experience.

Walp's allegations led to an investigation by the DOE and hearings in Congress. This incident, along with the previous safety and security incidents, contributed to changes in leadership. Eventually, the government would compete the Laboratory management contract, which the University of California had handled since the Manhattan Project.

CREATION OF THE NATIONAL NUCLEAR SECURITY ADMINISTRATION

Subsequent to the Wen Ho Lee incident in 1999 and the not-really-missing disks debacle in 2000, the Department of Energy established the National Nuclear Security Administration. The new federal agency would "superintend the weapons labs" Los Alamos National Laboratory and Lawrence Livermore National Laboratory.[434] The National Nuclear Security Administration immediately retrained weapons scientists and mandated new security procedures. It took the Laboratory a long time to discharge the perspective that "the scientists of Los Alamos had developed a culture of arrogance and noncompliance, and that U.S. national security was endangered by it."[435]

THE END OF THE "OPEN LAB"

Aerial view of a vehicle access portal along Pajarito Road.

On September 11, 2001, the day terrorists attacked the World Trade Center and the Pentagon, the Department of Energy ordered that the Laboratory close and placed it on SECON 2, a heightened level of security. The Laboratory was evacuated, and all non-essential operations were ceased.

The 9/11 terrorist attack reshaped the Laboratory, which had been one of the more accessible and open weapons laboratories in the Department of Energy complex. The Laboratory had prided itself on being an open campus, but with the nation on alert for more potential acts of terrorism, the National Nuclear Security Administration ordered a wide-ranging security analysis of the Laboratory.

On September 12, Laboratory employees returned to work, and already they noticed some changes. New barricades had been constructed around TA-03, and in general, so-called "soft gates" were reinforced with concrete barriers to prevent vehicle access. Any vehicle that entered the Laboratory was subject to screening, and security guards also conducted continuous, random screening of buildings. Additional guards were stationed at TA-54 and S-Site. In the months to come, the Laboratory would greatly increase the number of security guard and vehicle screening posts onsite, including guards with heavy weapons and armored car patrols.

Many of these changes, especially the increased presence of security guards, would remain permanent. The largest change was the closing of Pajarito Road, where a new policy restricted access to only badged employees (the road would be opened to the public—through traffic only—again on October 15). A truck screening station was established well away from the Laboratory, and most visibly, the Laboratory eventually constructed vehicle access points for the remaining roadways that enter the site. These actions essentially brought the long-held "open campus" model to an end.


SafeNet
PASS WORD
DIG SIG
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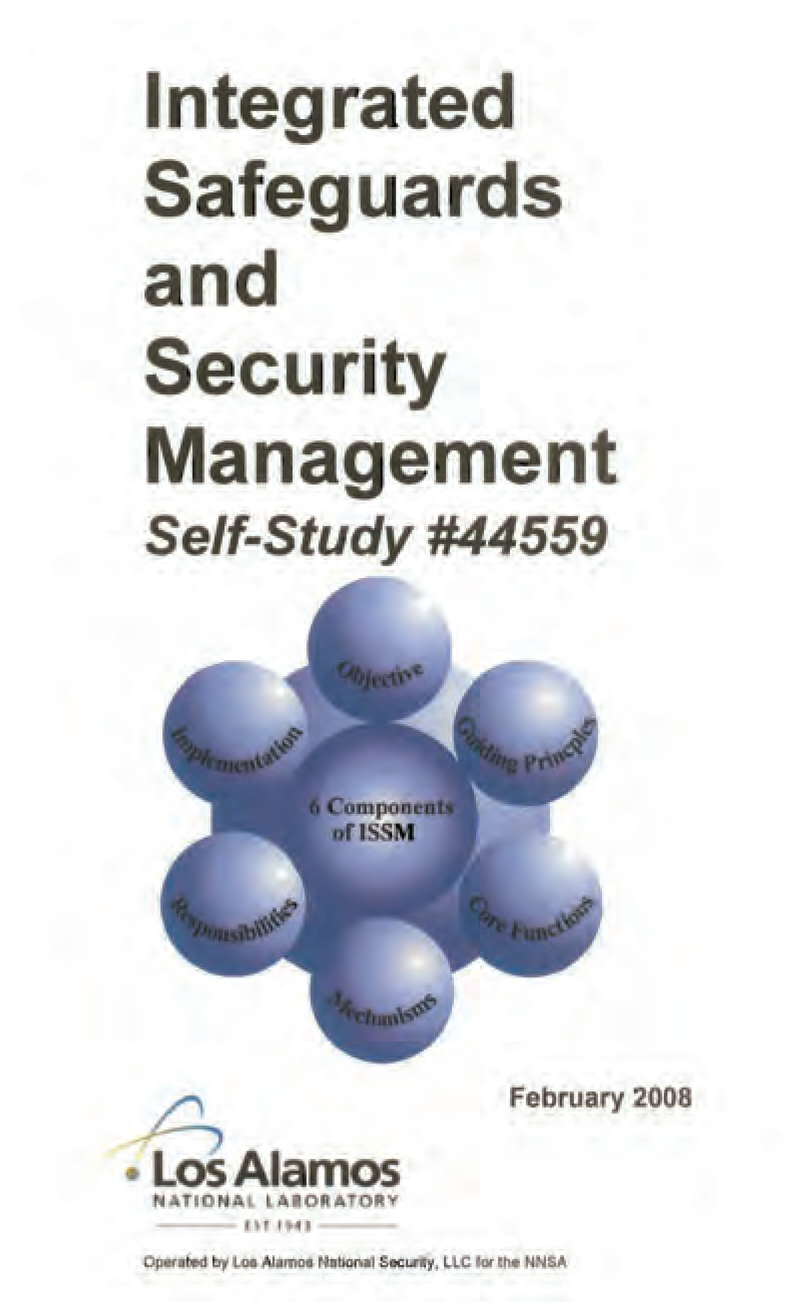
TOCard



Integrated
Safeguards
and
Security
Management
Self-Study #44559

February 2008

Los Alamos
NATIONAL LABORATORY
EST 1943

Operated by Los Alamos National Security, LLC for the NNSA

CONCEPT OF DISCIPLINED OPERATIONS

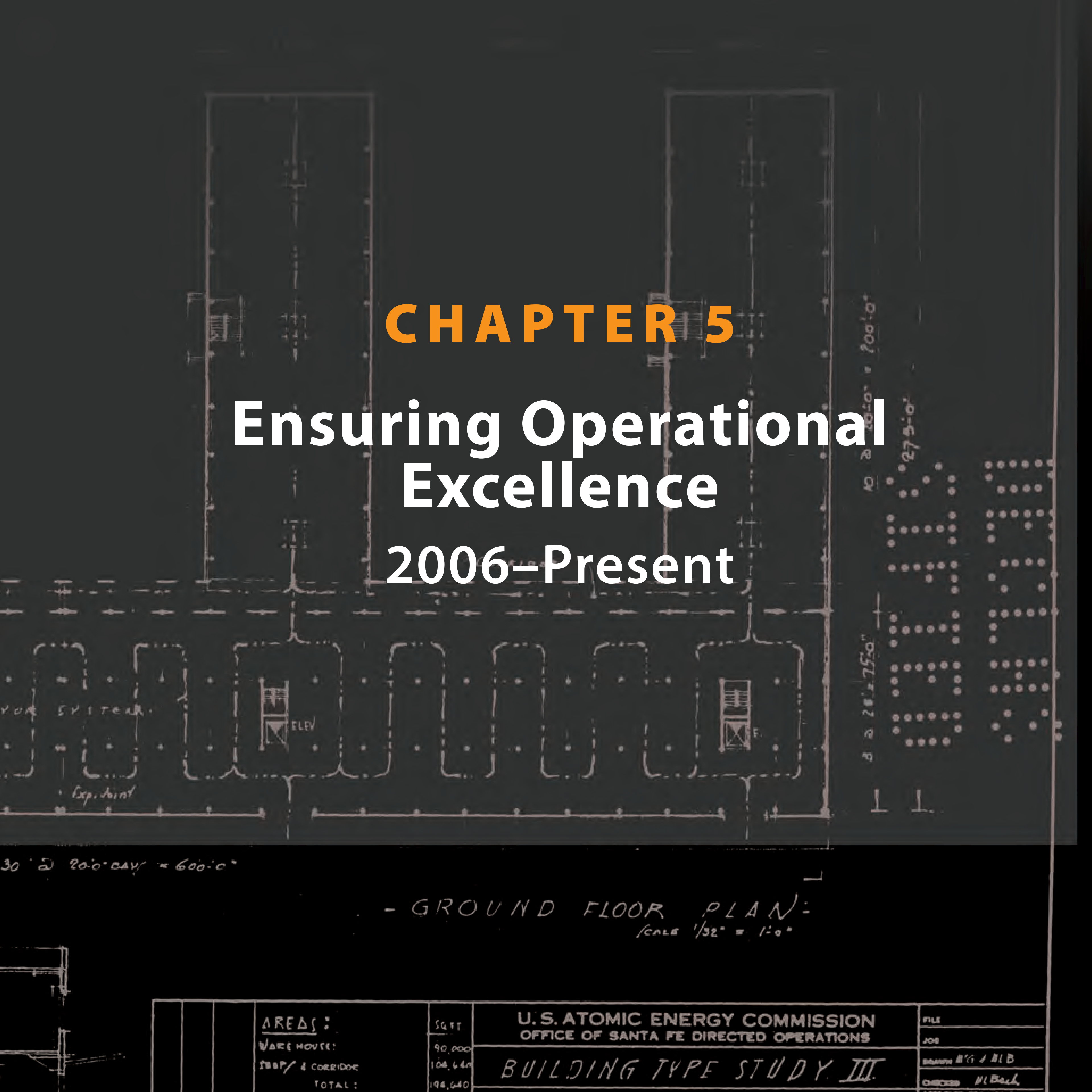
A formal program of Integrated Safety Management at the Laboratory dates back to 1996, when the Department of Energy directed the Laboratory to immediately develop a Safety Management System.[436] Developed in 1998, the program comprised

> a description of the system and its core functions,
> an assignment of roles and responsibilities,
> the required training,
> a requirements process,
> a self-assessment process,
> safety and environmentally responsible behaviors, and
> safety resource allocations.[437]

By 2000, the Laboratory had developed training materials on Integrated Safeguards and Security Management. The self-study course, required for all L- and Q-cleared employees, taught staff how to apply integrated safeguards and security management into their daily work activities.[438] The Laboratory established an interim process for Integrated Work Management in 2003 and published guidelines for all levels of management, including integrated work document templates, in 2004.

Two-factor identification cards, called CRYPTOCards, are hand-held devices that protect classified data from unauthorized access and track those who access data (opposite page).

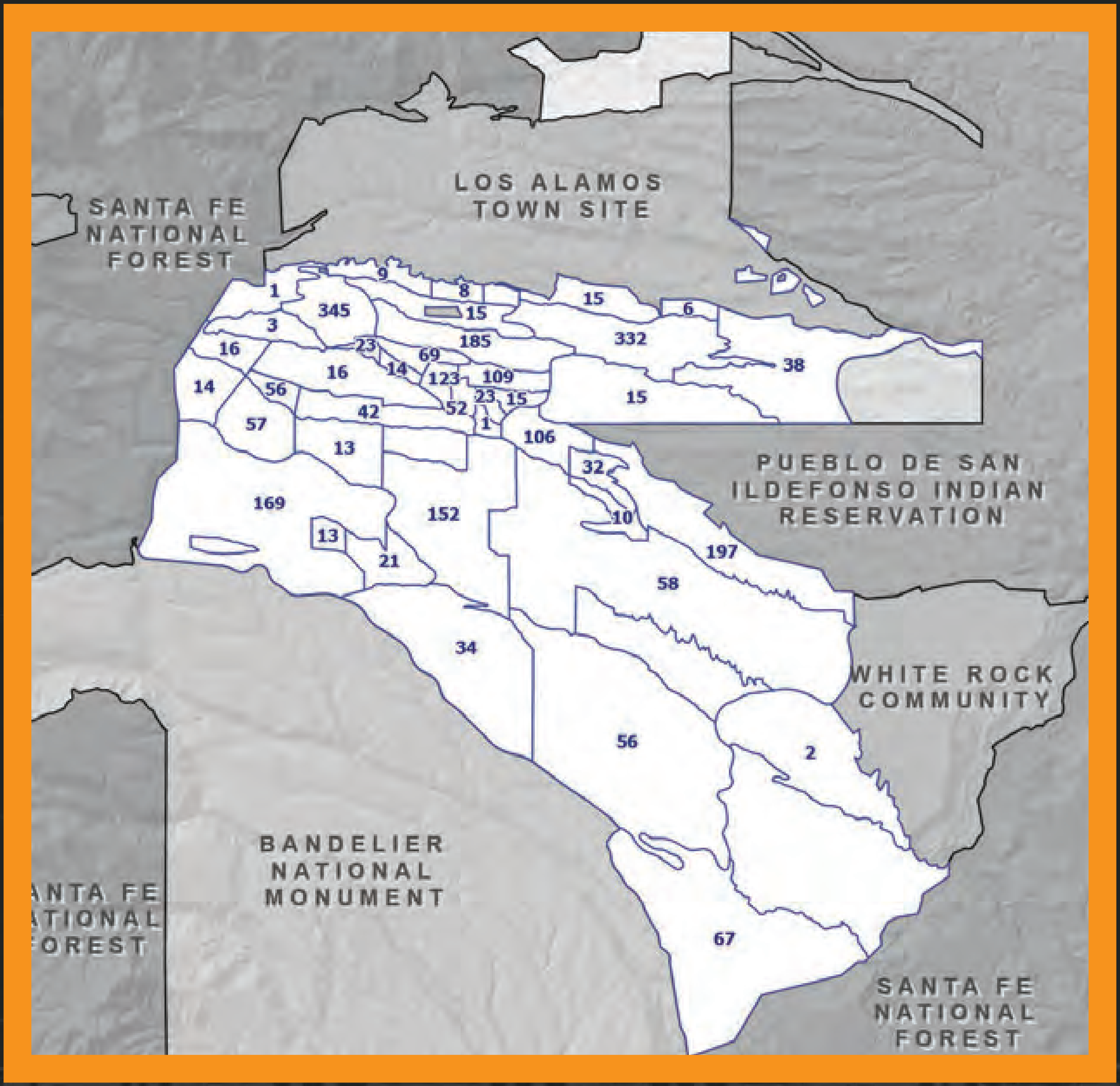
The Triad Leadership Team standing in front of the National Security Sciences Building TA-03-1400.



CHAPTER 5

Ensuring Operational Excellence

2006–Present



Facility Counts of Los Alamos National Laboratory Technical Areas in 2022.[439]

Presidents

George W. Bush (R), 2001–2009
Barack H. Obama (D), 2009–2017
Donald J. Trump (R), 2017–2021
Joseph R. Biden, Jr. (D), 2021–Present

Major Conflicts

War in Afghanistan, 2001–2021
Iraq War, 2003–2011

Treaty

New Strategic Arms Reduction Treaty, 2011

Federal Oversight

U.S. Department of Energy, 1977–Present

Federal Managers

Edwin Wilmot, 2004–2007
Donald L. Winchell, 2007–2010
Kevin W. Smith, 2010–2012
Juan Griego (acting), 2012–2013
Geoffrey L. Beausoleil (acting), 2013–2014
Kim Davis Lebak, 2014–2017
Steve Goodrum, 2017–2019
Mike Weis, 2019–2021
Ted Wyka, 2021–Present

Laboratory Directors

Robert Kuckuck, 2005–2006
Michael R. Anastasio, 2006–2011
Charles McMillan, 2011–2017
Terry C. Wallace, Jr., 2018
Thomas E. Mason, 2018–Present

Laboratory Budget ($K)

$2,145,200 (2006)–$3,264,982 (2021)

Laboratory Staff

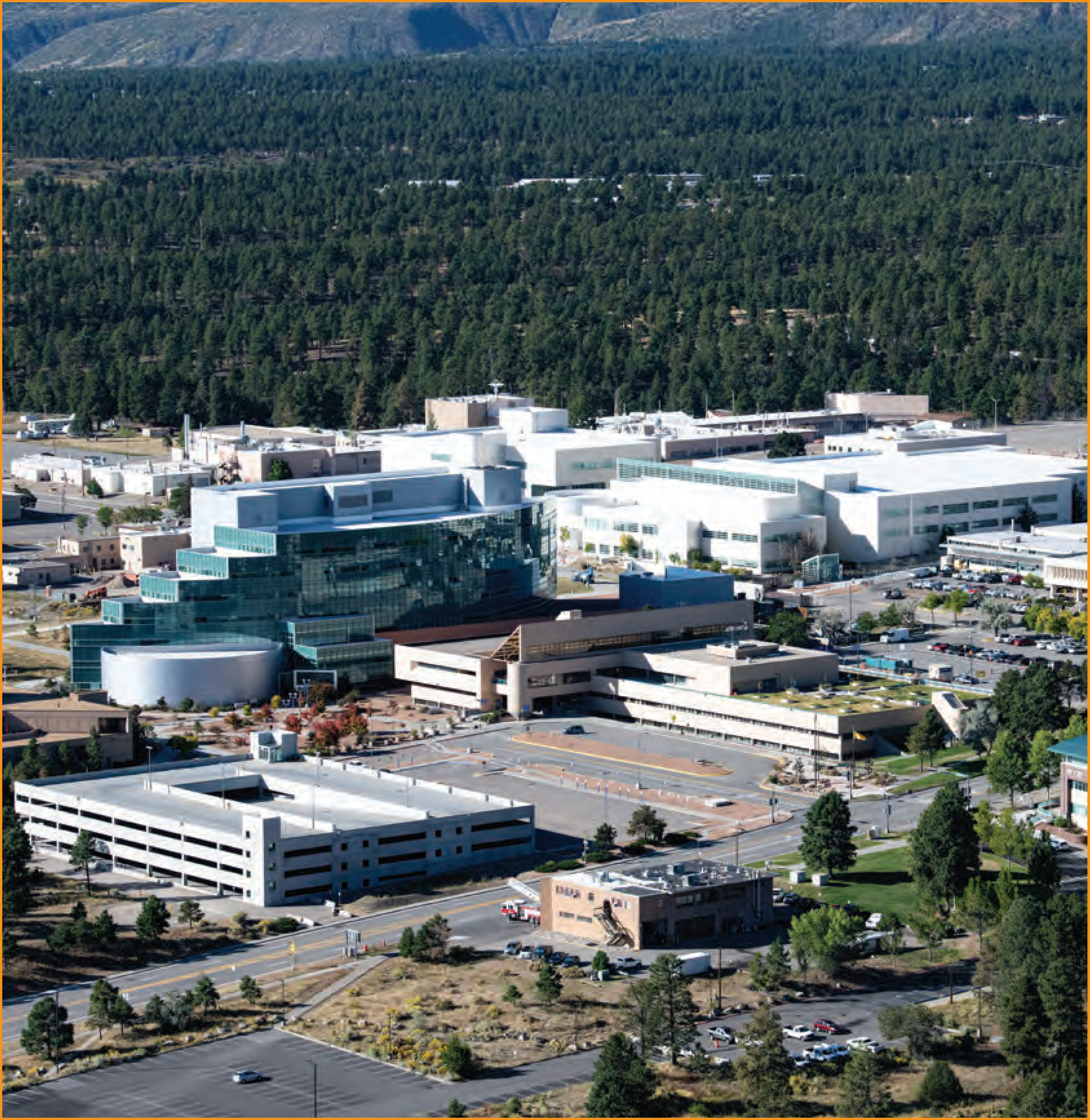
11,672 (2006)–12,144 (2021)

Executives over Laboratory Operations

Richard A. Marquez, 2002–2006
Jan A. Van Prooyen, 2006
Richard Vann Bynum, 2007
Michael B. Mallory, 2007–2011
Carl A. Beard, 2011–2014
Michael A. Lansing, 2014–2015
Craig S. Leasure, 2015–2018
Kelly J. Beierschmitt, 2018–Present

Support Contractor

Kellogg Brown and Root, Shaw Infrastructure, and Los Alamos Technical Associates, 2003–2008



Oblique aerial of TA-03 on October 19, 2019, view to the southwest (opposite page).

CHANGING ORGANIZATIONAL CULTURE

For 60 years, the University of California exclusively held the contract to manage and operate the Laboratory. Following congressional hearings in February and March 2003 that investigated management problems at the Laboratory, the Department of Energy announced its decision in April 2003 to compete the management and operating contract for the Laboratory.[440] The Laboratory was not alone in this planned transition because the Department of Energy was also competing the contracts at four other laboratories.[441]

In December 2005, the Department of Energy and National Nuclear Security Administration awarded Los Alamos National Security, LLC, the management and operating contract for the Laboratory.[442] A consortium of the University of California; Bechtel National, Inc.; Washington Group International; and BWX Technologies, Inc., Los Alamos National Security was a sole-purpose, dedicated, limited-liability corporation.[443] Team strengths included the University of California's research prowess and Bechtel National's construction expertise. Los Alamos National Security signed a cost-reimbursable-type contract, transitioning the Laboratory, for the first time, from a not-for-profit to a for-profit contract model.[444] With a base term of 7 years, the contract provided an opportunity for extensions up to 13 years and 10 months more.[445]

The mission for Los Alamos National Security was to perform excellent science research.

At that time, the U.S. Congress appropriated approximately $2–2.5 billion per year in Laboratory funding, with up to 90 percent dedicated to Department of Energy–funded programs.[446] Thirty percent of Los Alamos National Security's fee was fixed and paid monthly, and the other 70 percent remained at risk, meaning payment would be based on annual incentives performance. Vitally, the mission for Los Alamos National Security was to perform excellent science research and development activities. Beyond science and technology, the contract scope included infrastructure construction, project and program management, environmental remediation and management, business services, and oversight management.

Taking over responsibility for the Laboratory on June 1, 2006, the Los Alamos National Security leadership team was the first to occupy the National Security Sciences Building, which replaced the 1953 Administration Building. Early achievements included a reduction of the Laboratory workforce between 2006 and 2008, safety performance improvements, the institution of integrated work management policy, the establishment of an emergency operations center, and the implementation of a contractor assurance system.[447] Between 2006 and 2017, the annual budget averaged $2.26 billion, and the staff population averaged just under 10,000.

In January 2016, Laboratory Director Charles McMillan informed staff that Los Alamos National Security "narrowly failed to qualify for a one-year extension of its contract."[448] Scoring only satisfactory in operations and infrastructure, Director McMillan explained that Los Alamos National Security fell short in safety, management systems, and cybersecurity. Reasons for the poor score included a 2012 contamination and a 2015 arc-flash accident at the Los Alamos Neutron Science Center, the 2014 Waste Isolation Pilot Plant (WIPP) incident, a 2-year pause in Plutonium Facility operations, and shipping and construction project issues.[449] Former Laboratory Director Robert Kuckuck observed, ". . . the interests of the private sector and the university were not aligned . . ."[450] and noted a detrimental "culture difference."[451]

Laboratory Director Michael Anastasio (left), Robert Kuckuck (center), and Linton Brooks (right) after the contract is awarded to Los Alamos National Security, January 19, 2006.

LA-UR-22-20658

Lab Agenda

January 2022 Update

Simultaneous Excellence

Mission Operations

Nuclear Security

Mission-Focused Science, Technology, and Engineering

Community Relations

Los Alamos National Laboratory

The current Lab Agenda.

The Department of Energy competed the Laboratory's management and operations contract for the second time in history. Triad National Security, LLC (Triad)—a consortium of the Regents of the University of California, Battelle Memorial Institute, and Texas A&M University—won the contract on June 8, 2018. The Department of Energy National Nuclear Security Administration tasked Triad "with changing lab culture around safety, security, conduct of operations, contract assurance."[452] Taking over responsibility for the Laboratory on November 1, 2018, Triad brought in a new leadership team from outside the Laboratory and introduced significant changes. These senior leaders had experience at other laboratories and in industry and were tasked with ensuring simultaneous excellence in mission and operations.[453]

Triad … continues to enable the Laboratory's mission by implementing an annual strategic planning process … a Laboratory Agenda …

Triad accomplished its initial commitments and continues to enable the Laboratory's mission[454] by implementing an annual strategic planning process. The result is a Laboratory Agenda that establishes the priorities for the next 5, 10, and 25 years.[455] Identifying critical outcomes and strategic initiatives, the Laboratory Agenda is a touchstone for all employees to develop their own performance goals. This approach is Triad's way to "harness the full strength of the Laboratory in delivering our mission."[456]

Primary to the new contract was the development of an integrated strategy for national pit production. Triad is developing the Savannah River Site pit production capability, supporting the transfer of knowledge to future Savannah River Site workers, and improving infrastructure and staff skills to support pit production here at the Laboratory.[457] Part of this focus was on the Laboratory's critical processes that support pit production. These processes included criticality safety, renewal of waste management processes, and the improvement of project performance. Triad cleared the criticality-safety backlog to improve productivity at the

The Department of Energy and National Nuclear Security Administration recapitalization portfolio invested more than $99 million in the TA-55 Plutonium Facility upgrade and replacement projects (opposite page).

Laboratory's Plutonium Facility and expanded the educational program with the University of California, Berkeley.[458] A first since 2016, the Laboratory resumed shipments to the WIPP and continues to ship at a regular cadence. Markedly, the Laboratory reduced the amount of generated waste and reduced the cycle time for transuranic waste. Triad has improved the performance—schedule, budget, quality, and safety—of projects.[459] Triad established and integrated management systems, allowing the Laboratory to execute a significant increase in mission scope with fewer operations upsets; advance safety, security, and emergency management systems; improve procurement processes and cybersecurity; and develop a fully integrated strategy for building the Laboratory of the future.[460]

Another contract priority was improving the conduct of operations and establishing a continuous learning culture.[461] Triad placed a renewed focus on improving disciplined operations through monthly lessons learned and best practices. To train all first-line managers in Safe Conduct of Research principles, Triad implemented a Laboratory Operations Safety Academy.[462] Before the COVID-19 pandemic, 80 percent of the appropriate staff had completed the program. Triad inextricably linked employee performance, behaviors, compensation, and recognition, and the Laboratory established an Operational Excellence award in 2021 that recognizes contributions in mission operations.[463] Triad fundamentally changed the culture of the workforce and the workplace with the goal to use "the strength of the entire institution to address and respond to major issues and events holistically to achieve mission success."[464]

Although challenges remain, Triad is making steady progress in improving the state of the Laboratory. With the Laboratory's entire staff engaged in this transformation process, Triad has made significant advancements in transforming the operational environment, physical site, and Laboratory culture.

TRANSFORMING HUMAN RESOURCES

In January 2020, the Human Resources Division embarked on a 5-year initiative to improve operational excellence, transform service delivery, and strengthen the Laboratory's workforce.[474] Within the first year, the division created three new internal teams to steer the transformation approach. The Core Transformation Team comprises subject matter experts who will oversee the change-management progression. Involving leaders from across the Laboratory, the Cross-Organizational Steering Committee will provide a broader perspective to the effort. The Employee Council, consisting of human resources staff at various stages in their career, will assist with integration of the changes. The Human Resources Division continues its transformation process by assessing current business processes and systems and implementing greater efficiencies.

This profile appeared in an April 2021 *LANLInside* news story.

Laboratory Human Resources staff participate in a career fair for students visiting from Texas A&M University, April 19, 2022.

A new employee training building was leased and remodeled into a modern 40,000-square-foot facility to train the workforce needed to execute the pit production mission (opposite page).

PLANNING THE CAMPUS

In 2010, the Laboratory comprised 26,322 leased and owned acres and 1,169 facilities.[465] President Barack Obama issued Executive Order 13589, "Promoting Efficient Spending," in November 2011.[466] Subsequently, the Office of Management and Budget established a policy in 2012 to "Freeze the Footprint."[467] In response, the Laboratory developed a business strategy to "eliminate non-enduring real property assets."[468] From fiscal year 2005 through fiscal year 2013, the Laboratory reduced its owned buildings by 3 percent, approximately 250,000 square feet. By 2015, the Laboratory had reduced its office and warehouse spaces by 2 percent.[469] This reduction boded well; the Office of Management and Budget established another policy that same year to "Reduce the Footprint."[470] In 2018, Triad assumed the management and operations contract for the Laboratory and set out to develop a fully integrated strategy for building the Laboratory of the future.[471] Triad completed the Laboratory's first comprehensive plan in 20 years.[472]

As explained by current Laboratory Director Thom Mason, "This Campus Master Plan (CMP) is a robust institutional effort that provides the framework for facility and infrastructure development to make sure we can meet future national security challenges, enable sustainable growth, better connect our workforce and capabilities, and continue our environmental stewardship."[473] At the end of fiscal year 2021, the Laboratory comprised 25,506 acres and 897 facilities (more than 8.4 million gross square feet). As the Laboratory increases the hiring rate and improves the retention rate, it must also innovate and find different ways to get work done within the footprint. With anticipated growth on the horizon, there is a renewed emphasis on improving the safety and performance of capital-project construction and on increasing the utilization of existing infrastructure.

CLEANING UP THE PAST

Many Laboratory activities produce waste and have throughout the Laboratory's history. At the start, the Manhattan Engineering District provided little direction to Manhattan Project sites on the management of waste, so each site developed its own program. Nevertheless, developing waste management solutions at the Laboratory was a low priority compared with making an atomic bomb and winning World War II.[475] An Atomic Energy Commission safety and industrial health review in 1947 established that the Laboratory exhibited "sloppy conditions" and "sloppy habits."[476] The Laboratory "simply dumped radioactive and toxic materials into adjacent canyons." [477]

In response to this scathing review, the Laboratory established a Waste Management group in 1948, primarily to minimize the negative impacts of liquid radioactive wastes to the environment.[478] In 1950, the Atomic Energy Commission took over control of Los Alamos townsite's sanitation program and all of the Laboratory's industrial waste activities, although they handed back the latter responsibility in 1955. Assigned to the Laboratory's Health Division, tasks included operating and maintaining treatment plants and laundry, and developing methods to treat generated wastes.[479] Subsequent decades saw the Laboratory focus on managing and treating wastes generated by new missions and activities.

The Laboratory transitioned to a self-performance model of waste management.

In 1987, the Department of Energy began an Environmental Restoration Program (presently overseen by the Office of Environmental Management) to address environmental cleanup across the complex. In 1989, it acquired a Resource Conservation and Recovery Act Permit from the State of New Mexico.[480] The Laboratory began a comprehensive process of documenting former and current waste-generating activities on the site. In 1990, funding for environmental cleanup neared 20 percent of the Laboratory's budget.[481]

In the absence of an off-the-shelf program, in 2006, the Laboratory commenced to develop a system to manage and track waste.[482] The goal was an all-in-one, comprehensive solution that addressed the challenges of aging technologies and the lack of communication between systems. In 2010, the Laboratory began managing nuclear, radioactive, chemical, and hazardous wastes using its Waste Compliance and Tracking System.

Two events in 2014 changed the way the Laboratory managed waste: the February 2014 mishap at the WIPP in Carlsbad, New Mexico, and the Department of Energy's establishment of an Office of Environmental Management at the Laboratory.[483] The former resulted in the Laboratory's participating in numerous audits; conducting testing, modeling, and experiments; and implementing new procedures, all in an effort to avoid a reoccurrence. The latter provided the opportunity for the Laboratory to focus on the waste that it was creating because the new office assumed oversight of all legacy contamination at the Laboratory.[484]

Triad assumed responsibility for the Laboratory in 2018 and immediately implemented a comprehensive housekeeping and clean-up program focused on waste identification and efforts to reduce waste during generation. The Laboratory transitioned to a self-performance model of waste management with the establishment of a single waste operations division in 2019.[485] With a philosophy of implementing change where needed and ensuring continuity where critical, this division addresses enduring waste management and improves waste management throughput.[486] The Laboratory has reduced the Triad-stored waste inventory by 366 containers since the beginning of fiscal year 2021.[487] Today, the Laboratory's Waste Management Division provides "a central, compliant, efficient, and operationally excellent waste and material management program."[488] The Laboratory is committed to cleaning up the past, controlling the present, and creating a sustainable future.[489]

Solid waste disposal at the Laboratory, April 1968 (opposite page).

Workers excavated a vehicle in 2011 as part of a cleanup of Material Disposal Area B.

HISTORICAL EXCAVATIONS

Workers excavated a 13-foot mixing tank in 2011 as part of a cleanup of Material Disposal Area B, the Laboratory's first hazardous and radioactive waste landfill, used from 1944 to 1948. The cleanup began in 2010 using American Recovery and Reinvestment Act funding (above).

Workers also excavated a radiation-protection suit in 2011 as part of the same cleanup and same waste landfill (left).

SUPPORTING OUR NATION'S NUCLEAR POLICY

Developed in 1940, plutonium, a human-made element, and plutonium-bearing pits are major components of a nuclear weapon.[495] One of the "most interesting materials known to mankind," plutonium is strange, very reactive, and ultimately unstable.[496] Most importantly, Laboratory scientists, in collaboration with other scientists, discovered that the material properties of pits change over time.[497] Therefore, as long as plutonium is in the stockpile or is used for nuclear reactors, the United States must retain the capability to handle, store, process, and produce it.[498] The Laboratory serves as the nation's Plutonium Center of Excellence,[499] and pit production serves to

> modernize existing weapons for safety, security, and reliability;
>
> prevent nuclear proliferation and terrorism;
>
> maintain strategic deterrence; and
>
> sustain a safe, secure, and effective nuclear arsenal.[500]

After testing its first pit in the July 1945 Trinity test, the Laboratory produced all of the nation's pits until 1952.[501] At this time, the Atomic Energy Commission transferred pit production to the Rocky Flats Plant in Colorado.[502] Notably, this move pleased Laboratory scientists because they did not want research and development collocated with production at the Laboratory.[503] The Rocky Flats Plant produced pits until 1989, after which the United States briefly lost its capability.[504] Asking the Laboratory to assume the task of pit surveillance in 1991, the Department of Energy requested the Laboratory to resume pit production in 1993.[505] The Laboratory's Plutonium Facility was, and still is, the only physical plant in the nation equipped to do pit production.[506]

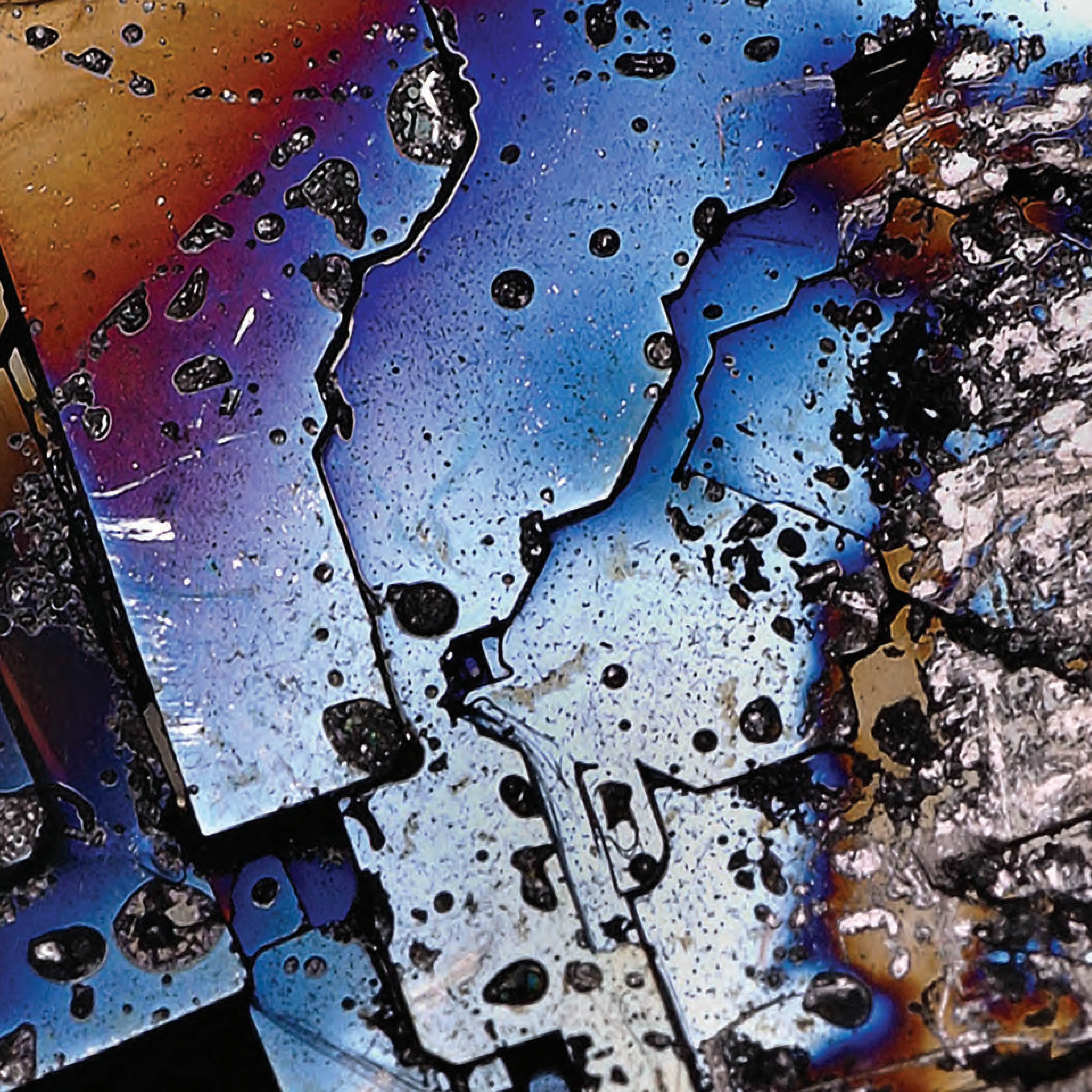
Forty-one years later, the resumption of pit manufacturing at the Laboratory has been a tremendous feat. An effort far beyond simply restarting former processes, it required facility upgrades, replacement and retooling of equipment, addition of new technologies, wide-ranging process improvements, comprehensive testing and inspection programs, and extensive staff training.[507] All of these steps significantly increased product precision and accuracy.[508] The intense, 10-year effort culminated in the Laboratory's producing its first certifiable nuclear weapons pit in 2003.[509] Subsequently, the Laboratory delivered its first war-reserve pit to the Department of Energy in 2007, and they accepted it for use in the nation's stockpile.[510]

The Department of Energy National Nuclear Security Administration's 2014 strategic plan called for the Laboratory to produce at least 30 pits per year by 2026 and in perpetuity.[511] Recommending a two-site approach, the *2018 Nuclear Posture Review* established an initiative to produce no fewer than 80 pits per year during 2030.[512] This recommendation provides for continued investment in the Laboratory to produce their 30 pits per year and prepares to repurpose the Savannah River Site to produce the other 50 pits. In response, the Laboratory established a new Associate Laboratory Directorate for Plutonium Infrastructure in April 2021 that will support the Plutonium Center of Excellence, the Los Alamos Plutonium Pit Production Project, the Chemistry and Metallurgy Research Replacement Project, and the TA-55 Reinvestment Project.[513] The Laboratory is also training the staff who will work at the Savannah River Plutonium Processing Facility.

One of the "most interesting materials known to mankind," plutonium is strange …

In 2022, the Department of Energy and the National Nuclear Security Administration praised a team of more than 45 Laboratory employees of

Plutonium crystal (opposite page).



Department of Energy National Nuclear Security Administration Administrator Jill Hruby observes activities at the Laboratory's Plutonium Facility, August 26, 2021.

Radiological control technicians simulate Plutonium Facility work-related processes at the TA-55 cold lab.

EARLY RADIOACTIVE WASTE

This is an aerial photograph of Los Alamos Ranch School taken in 1942, looking to the east. In 2020, excavations for a Los Alamos County sewer line exposed unexpected radiologically contaminated materials of Laboratory origin within the former DP Site. A Laboratory researcher asks, "If you were a young army person in 1943, and you were asked to bury some radioactive waste, where would you bury it?"[490]

Oblique aerial photo of Los Alamos Ranch School, 1942.

the Capital Projects and the Plutonium Infrastructure Associate Laboratory Directorates.[514] Comprising staff from several divisions and groups, this team completed a complex submittal for the pit production project in half the time it usually takes and in a high-quality manner. Never having done this task before, this team exceeded their customer's immense expectations.

Similar to the enormous efforts of the mid-1990s, the Laboratory is making significant investments in facilities, equipment, and staff to attain the capability to produce 30 pits per year for the nuclear weapons stockpile. Part of this modernization process is reshaping the Laboratory campus and the workforce for 24/7 operations and making improvements that will mitigate all types of potential unexpected events.[515] Noticeably, the support from maintenance and operations is growing exponentially to maintain the Laboratory's high standards in safety, health, safeguards and security, quality waste management, construction, procurement, and staffing. This support includes meeting rigorous environmental and waste disposal standards and making infrastructure investments in offices, laboratories, shops and warehouses, utilities, transportation, and parking.[516] Triad believes that the Laboratory "is the right place for pit manufacturing for three reasons: we have the technical knowledge, the physical infrastructure, and the capable workforce."[517]

Waste shipment being prepared to leave Los Alamos National Laboratory for the Waste Isolation Pilot Plant, Carlsbad, New Mexico, on April 11, 2019.

SHIPMENT TO WIPP

On April 11, 2019, the Laboratory made its first shipment since 2014 of transuranic (TRU) waste to the Waste Isolation Pilot Plant (WIPP) near Carlsbad, New Mexico.[491] Shipped from the newly opened Radioactive Assay Nondestructive Testing facility (RANT), the resumption of shipments "puts Los Alamos in a stronger position to fulfill its national security mission."[492] The Laboratory is the largest producer of transuranic waste in the nuclear security enterprise and requires a regular cadence of waste shipments. The new facility replaces a previously used outdoor area and increases the Laboratory's shipping capacity of transuranic waste. As stated by Deputy Director for Operations Kelly Beierschmitt, "Getting the RANT facility back in service and successfully moving TRU waste to WIPP will add to our operational and safety margins and provide a better level of efficiency as we continue to improve our waste operations."[493] Subsequently, the Laboratory shipped more than 2,300 drums.[494]

Laboratory workers prepare a shipment for the Waste Isolation Pilot Plant in Carlsbad, New Mexico.

CONFRONTING THE PANDEMIC

Coronavirus disease (or COVID-19) is an infectious disease caused by the SARS-CoV-2 virus.[520] On March 11, 2020, the State of New Mexico reported its first four cases.[521] This same day, the World Health Organization declared COVID-19 a pandemic, and the governor of New Mexico declared a state of public health emergency.[522] In response, on March 16, 2020, Laboratory Director Thom Mason directed staff to telecommute as much as possible and to limit domestic travel to mission-essential business only.[523] Almost overnight, the Laboratory transitioned from more than 12,000 staff working on campus to more than 10,000 teleworking.[524]

The Laboratory quickly transitioned the information technology staff primarily to support teleworkers.[525] Astoundingly, information technology staff rapidly prepared more than 9,000 laptops for staff to use at home. Quadrupling virtual private network capacity and tripling phone connectivity, the Laboratory created a virtual onboarding process, shifted to online training formats, and implemented a remote student program.

Recognizing a new approach that enabled effective and productive execution of the Laboratory's mission with very low numbers of the onsite workforce present,[526] the Laboratory created a Telework Pilot. This program shifted a portion of the already pandemic-related teleworking staff (approximately 1,400 or 11 percent) to largely telework mode.[527] Subsequently, the Laboratory placed workforce functions that proved highly productive while teleworking into that status for the duration of the pilot. The offices of pilot participants were repurposed to disperse staff conducting onsite mission activities. The Telework Pilot evaluated the potential simultaneous benefits of significant future mission enablement and infrastructure cost savings and provided the framework necessary to assess the optimal use of telework and telework benefits and to address drawbacks.[528] The Laboratory was the first site in the Department of Energy National Nuclear Security Administration complex to implement a telework pilot.[529]

The Telework Pilot required the rapid development and implementation of new processes and systems, including the revision of charging, funding, and pay guidance and the development of a process to monitor and analyze costs.[530] Serving as an unforeseen opportunity, the Telework Pilot regularized and documented numerous ad hoc practices because the Laboratory had to decide which ones applied and whether they applied to offsite workers. Between October 2020 and September 2021, the Laboratory developed a formal approach to implement, assess, measure, and refine the pilot. During this time, the Laboratory overhauled much of its aging infrastructure and developed drop-in or turnaround spaces for teleworkers. Increased workforce productivity and cost and space savings were among the greatest benefits, along with pilot participant satisfaction. Teleworking is now a strength of the Laboratory. A marked success, the Telework Pilot transformed into a viable option in the Laboratory's January 2021 work location policy and set the standard for other sites in the complex.[531]

In support of the national response, the Laboratory, along with other research institutions, shared its equipment and expertise to study the virus's history, nature, genomics, and molecular structure.

Based on active lessons learned and continuously refined, Laboratory COVID-19 safety processes and procedures (some of which are still in use today) were established at the onset of the pandemic.[532] As remarked by the Deputy Director for Operations Beierschmitt, "LANL COVID policy became enterprise approach."[533] Early in the pandemic, the Laboratory ensured workforce safety through multiple measures beyond teleworking, including the development of a Pandemic Advisory Team on January 30, 2020; activation of an Emergency Operations Center on March 9, 2020; and establishment of a COVID-19 hotline on March 12, 2020.[534] Testing and modeling became fundamental components for how the Laboratory managed work activities and locations. Most importantly, the employee-employer partnership was at the heart of the Laboratory's success. Staff recognized the importance of protective behaviors, and the Laboratory purposefully concentrated on developing the necessary systems (risk management) and culture (staff leadership).[535]

While the Laboratory maintained full operability during the pandemic, it likewise increased productivity, accomplished the mission, reduced costs, and increased job satisfaction. Conspicuously, the Laboratory led the Department of Energy National Nuclear Security Administration complex in addressing the challenges of the pandemic. The Laboratory was the first site to test staff, the first site to vaccinate staff, and the first site to mandate COVID-19 vaccinations.[536] Receiving high praise from the Department of Energy National Nuclear Security Administration Los Alamos Field Office, the Laboratory demonstrated its ability to manage the impacts of a constantly changing pandemic.[537] As noted by Beierschmitt, the circumstances "harnessed the strength of the Lab to proactively manage COVID and enable mission."[538]

In support of the national response, the Laboratory, along with other research institutions, shared its equipment and expertise to study the virus's history, nature, genomics, and molecular structure.[539] Using its high-performance computing and complex system-modeling capabilities, the Laboratory provided methods to predict the pandemic's progression and to screen potential drug candidates.[540] Laboratory staff founded their own research initiatives and studied vaccine development, testing and mitigation strategies, and medical equipment supply.[541] In support of public health efforts, the Laboratory established a special office for COVID-19 that provided technical capabilities to the community.[542] The Laboratory worked especially close with New Mexico state officials on major policy issues during two to three conference calls per week. As stated by *1663* magazine editor Craig Tyler, "COVID-19 is a killer, and Los Alamos is doing everything it

PRAISING SAFE WORK

The Laboratory's Worker Environmental, Safety and Security Team in the Associate Laboratory Directorate for Capital Projects developed initiatives for supervisors and peers to praise "craft workers for putting safety first in the field."[518] Recognized under the Job Well Done or Caught Being Safe initiatives, leadership acknowledges workers during monthly all-hands meetings and provides a certificate of recognition and a backpack with tools of their trade. Practicing disciplined operations, engaging in worker safety, exhibiting a questioning attitude, or providing exceptional customer service, these recognized Laboratory employees identify safer and smarter ways to work.[519]

This profile appeared in a February 2022 *LANLInside* news story.

Electricians at the Los Alamos Neutron Science Center (left to right) Martin Gutierrez, Joshua F. Salazar, and Leonard Maestas are recognized in January 2022 for exceptional customer service.

LANL COVID-19 website.

Deputy Director for Operations Kelly Beierschmitt receives the vaccine at the Laboratory's Emergency Operations Center, January 20, 2021.

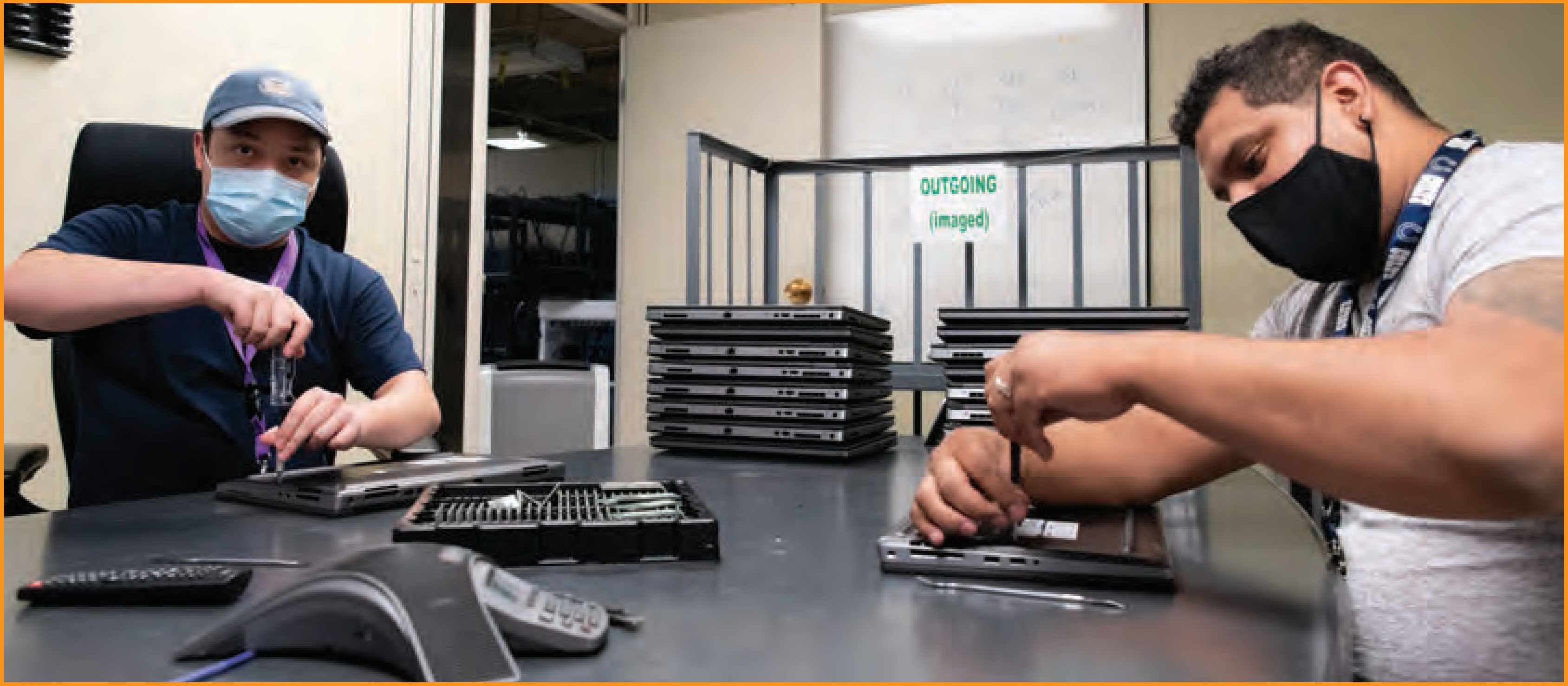
Vaccines ready to administer to Laboratory staff at the Emergency Operations Center, January 20, 2021.

can to provide life-saving scientific guidance for policymakers."[543] In 2022, the New Mexico state legislature recognized the contributions of more than 100 Laboratory researchers in the battle against COVID-19.[544]

The COVID-19 pandemic was the beginning of a challenge that lasted more than 2 years and enacted institutionally adopted safety protocols, rapidly implemented staff guidance, and judicious policy changes alongside teleworking and COVID-19 testing, surges, vaccinations, and variants.[545] The Laboratory integrated COVID-19 controls (signage, hand sanitizer, etc.) in all work planning; transitioned infrastructure and assets rapidly; and used and strengthened the Worker Environment, Safety, and Security Team for communication and implementation of COVID-19 controls. Advocating for cross-organization interaction, collaboration, and feedback, the Laboratory used a systems and data-driven approach to decision-making and operational changes. Wholly meeting the challenge, the Laboratory also enhanced operations with a broad array of internal and external initiatives that employed all of the strengths of the organization. The Laboratory's shared principles, values, and behaviors were demonstrated and put into action during the difficult times. "How we do our work has become as important as what we do"[546] at the Laboratory, and the institution has changed forever and for the better. The success and learning during the COVID-19 pandemic will be translated to improve all areas of the Laboratory, including delivering the pit production mission.

The Laboratory offers COVID-19 vaccinations to staff at the Emergency Operations Center, April 7, 2021.

Masked statues of J. Robert Oppenheimer and General Leslie R. Groves outside of Fuller Lodge in downtown Los Alamos, 2020.



While masked, the Laboratory's DeployIT staff prepares laptops and peripherals for remote work, July 14, 2020.

EXECUTIVES OVER LABORATORY OPERATIONS, 1945–2022

David Hawkins
Liaison with Post Administration, 1943–1944

Arthur L. Hughes
Personnel Department,
1943–1944

B. E. Brazier
Construction and Maintenance,
1943–1944

David Dow
Asst. to the Dir. in Charge of
Non-Technical Admin. Matters,
1944–1945/1946

Charles I. Browne
Asst. Dir. for Admin., 1974–1976; Assoc. Dir. for Admin., 1976–1979; Assoc. Dir. for Tech. Support, 1979–1983

Christopher S. Adams, Jr.
Associate Director, 1983–1986

Robert W. Selden
Associate Director, 1984–1986

James F. Jackson
Deputy Director, 1985–1998

Jan A. Van Prooyen
Principal Associate Director,
2006

Richard Vann Bynum
Principal Associate Director,
2007

Michael B. Mallory
Principal Associate Director,
2007–2011

Carl A. Beard
Principal Associate Director,
2011–2014

Col. L. E. Seeman
Associate Director for Administration, 1945–1946

Col. Austin W. Betts
Assoc. Dir. for Admin. and Services, 1945–1946; Assoc. Dir. for Admin., 1946–1948

Robert M. Kimball
Administrative Associate Director, 1948–1950

Henry R. Hoyt
Assistant Director for Administration, 1950–1970

Raemer Schreiber
Technical Associate Director, 1962–1972; Deputy Director, 1972–1974

Allen J. Tiedman
Associate Director, 1986–1994

Warren F. Miller, Jr.
Deputy Director, 1996–1999

Willard R. Wadt
Deputy Director, 1999

Joseph F. Salgado
Deputy Laboratory Director, 1999–2001; Principal Deputy Director, 2001–2003

Richard A. Marquez
Associate Director, 2002–2006

Michael A. Lansing
Principal Associate Director, 2014–2015

Craig S. Leasure
Principal Associate Director, 2015–2018

Kelly J. Beierschmitt
Deputy Laboratory Director, 2018–Present

Los Alamos National Laboratory is known for its world-renowned research and Nobel Prize–winning scientists. Few know about the support required to keep the Laboratory running. Since 1943, 25 individuals have served the Laboratory as the executive over operations. Often sharing the role during the early years and enduring numerous title changes over time, the executive over operations serves a critical role in the Laboratory's success.

ABOUT THE AUTHORS

Rekha S. Pillai was hired by Los Alamos National Laboratory in October 2018 as a member of the Deputy Laboratory Directorate for Operations, reporting directly to the deputy director of Operations. Dr. Pillai has a PhD in management science (1992), an MS in Operations Research (1987), and a BS in statistics, mathematics, and physics (1981). From 1981 through 1984, she worked at Blue Chip Computer Consultants as a programmer, building many back-office business process automation tools for invoicing, accounting, procurement, and employee-time-and-effort capture for manufacturing and service companies. Dr. Pillai worked at Oak Ridge National Laboratory (ORNL) from 1992 to 1996 and again from 1999 to 2013. Starting as a postdoc fellow, she held a variety of research and management positions with increasing responsibility, including senior research scientist, group leader of Decision Engineering (a group she founded), Laboratory Directed Research and Development program manager, and director of International Science and Technology Programs. Dr. Pillai developed and led ORNL R&D programs in operations research and decision analysis. From 1996 to 1999, she worked at Resource Optimization, Inc., as director for Operations Research, leading the development of large-scale optimization tools for manufacturing companies in areas such as supply chain management, production planning, and product-mix planning. From 2001 through 2009, Dr. Pillai taught information technology strategy as a joint faculty member for the executive MBA program at the University of Tennessee Business School. From 2013 to 2015, Dr. Pillai was director of programs at Qatar National Research Funds (Qatar Foundation), where she led the effort to design their R&D investment portfolio (>$400M) to help build Qatar's science and innovation ecosystem and help its transition to a knowledge-based economy. From 2015 through 2018, she was director of strategic planning and investments at Idaho National Laboratory, where she established its science and technology core capabilities and designed and implemented seminal integrated laboratory agenda, annual laboratory planning process and plan, and R&D budgeting and investment processes. Dr. Pillai has more than 80 publications and presentations to her credit.

Carrie J. Gregory was hired by Los Alamos National Laboratory in 2020 as a Historic Buildings Specialist. With a BS in anthropology from San Diego State University and an MS in historic preservation from Goucher College, she worked in the private sector as a cultural resources specialist in southern California and in the Southwest for most of her 25-year career. Her specialties included prehistoric and historical trail studies, cultural landscape surveys, and Cold War military facility significance evaluations. Currently, she serves as an architectural and landscape historian for the Laboratory's Environmental Protection and Compliance Division and the Manhattan Project National Historical Park.

Weston Phippen was hired as a contractor for Los Alamos National Laboratory in 2019. He graduated from Arizona State University's Walter Cronkite School of Journalism and Mass Communications in 2012 and has worked at national newspapers and magazines. He lives in Santa Fe, New Mexico, and currently serves as a communications specialist for the Technical Editing and Communications group at the Laboratory.

J. T. Stark was hired by Los Alamos National Laboratory in 2020 as a historic buildings specialist, concentrating on the built environment of the Manhattan Project National Historical Park. Before working at the Laboratory, J. T. spent 15 years with the National Park Service as an archaeologist and historic preservationist at several parks throughout Arizona and New Mexico. Coupled with his experience in cultural resource management and his nearly life-long captivation with World War II history, J. T. is overjoyed to serve the Laboratory with helping to preserve some of the last-remaining buildings and structures of the Manhattan Project.

ENDNOTES

1 J. T. Stark after Edith C. Truslow, *Manhattan District History: Nonscientific Aspects of the Los Alamos Project Y 1942–1946* (Los Alamos, NM: Los Alamos Historical Society, 1997), 18, and LASL Engineering Department n.d.: Main Technical Area, Drawing No. ENG-R-100; Bethann McVicker, LANL GIS Program update, 2022.

2 Stanley Goldberg, "Groves Takes the Reins," *The Bulletin of the Atomic Scientists*, 1992.

3 Stanley Goldberg, "Groves and the Scientists: Compartmentalization and the Building of the Bombs," *Physics Today*, August 1995.

4 Leslie R. Groves, *Now It Can Be Told* (New York: Harper and Brothers, 1962), 64.

5 Leslie R. Groves, *Now It Can Be Told* (New York: Harper and Brothers, 1962), 65–66.

6 Leslie R. Groves, *Now It Can Be Told* (New York: Harper and Brothers, 1962), 66–67.

7 Leslie R. Groves, *Now It Can Be Told* (New York: Harper and Brothers, 1962), 65.

8 Leslie R. Groves, *Now It Can Be Told* (New York: Harper and Brothers, 1962), 66.

9 Leslie R. Groves, *Now It Can Be Told* (New York: Harper and Brothers, 1962), 64–65.

10 James W. Kunetka, *Oppenheimer: The Years of Risk* (New Jersey: Prentice-Hall, Inc., 1982), 42.

11 James W. Kunetka, *Oppenheimer: The Years of Risk* (New Jersey: Prentice-Hall, Inc., 1982), 43.

12 Leslie R. Groves, *Now It Can Be Told* (New York: Harper and Brothers, 1962), 66.

13 Leslie R. Groves, *Now It Can Be Told* (New York: Harper and Brothers, 1962), 66.

14 A. W. Betts, *A Technical Maintenance Group Report on General Background Data Concerning The Los Alamos Scientific Laboratory Required for Planning Purposes* (Los Alamos, NM: Los Alamos Scientific Laboratory, 1947), 3.

15 Leslie R. Groves, *Now It Can Be Told* (New York: Harper and Brothers, 1962), 149.

16 Leslie R. Groves, *Now It Can Be Told* (New York: Harper and Brothers, 1962), 149.

17 James W. Kunetka, *Oppenheimer: The Years of Risk* (New Jersey: Prentice-Hall, Inc., 1982), 13.

18 Alan Brady Carr, *The University of California Contract to Operate the Los Alamos Laboratory, 1942-1947, A Documentary History* (Los Alamos National Laboratory report LA-UR-04-07896, 2004).

19 Alan Brady Carr, *The University of California Contract to Operate the Los Alamos Laboratory, 1942-1947, A Documentary History* (Los Alamos National Laboratory report LA-UR-04-07896, 2004).

20 Stanley Goldberg, “Groves and the Scientists: Compartmentalization and the Building of the Bombs,” *Physics Today*, August 1995.

21 Los Alamos Scientific Laboratory, *Los Alamos Beginning of an Era 1943-1945* (Los Alamos, NM: Los Alamos Scientific Laboratory, Public Relations Office, 1967).

22 Roger A. Meade, *Total Quality Management and Nuclear Weapons, A Historian’s Perspective* (Los Alamos National Laboratory report LA 12643-H, 1993).

23 Roger A. Meade, *Total Quality Management and Nuclear Weapons, A Historian’s Perspective* (Los Alamos National Laboratory report LA 12643-H, 1993).

24 Ellen D. McGehee, *The Women of Project Y Working At the Birthplace of the Bomb 1942–1946 Workforce Consideration, Part I* (Los Alamos National Laboratory report LA-UR-03-02821, 2003).

25 Edith C. Truslow, *Manhattan District History: Nonscientific Aspects of the Los Alamos Project Y 1942-1946* (Los Alamos, NM: Los Alamos Historical Society, 1997), 11.

26 David Hawkins, *Project Y: The Los Alamos Story* (Los Angeles, CA: Tomash Publishers, 1983), 59.

27 Jon Hunner, *Inventing Los Alamos: The Growth of an Atomic Community* (Norman, OK: University of Oklahoma Press, 2004), 32–33.

28 Jon Hunner, *Inventing Los Alamos: The Growth of an Atomic Community* (Norman, OK: University of Oklahoma Press, 2004), 33.

29 Provisional Military Police Battalion, *Armed Forces Special Weapons Project Provisional Military Police Battalion History of Military Units at Los Alamos* (Los Alamos, NM: Los Alamos Times, 1947).

30 U.S. Army Corps of Engineers, *Security Handbook* (Washington, D.C.: U.S. Army Corps of Engineers, ca. 1944).

31 U.S. Army Corps of Engineers, *Security Handbook* (Washington, D.C.: U.S. Army Corps of Engineers, ca. 1944).

32 Robert de Vore, "The Man Who Made Manhattan," *Colliers*, October 1945.

33 Alex Barry Malin, "Cyber History in the DOE—The 414s" (presentation, Cyber Fire, San Diego, CA, November 16, 2017, Los Alamos National Laboratory report LA-UR-30371).

34 Robert de Vore, "The Man Who Made Manhattan," *Colliers*, October 1945.

35 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: Department of Energy, History Division, 1994).

36 Barton C. Hacker, *The Dragon's Tail: Radiation Safety in the Manhattan Project, 1942-1946* (Los Angeles, CA: University of California Press, 1987), 60–61.

37 Barton C. Hacker, *The Dragon's Tail: Radiation Safety in the Manhattan Project, 1942-1946* (Los Angeles, CA: University of California Press, 1987), 60–61.

38 David Hawkins, *Project Y: The Los Alamos Story* (Los Angeles, CA: Tomash Publishers, 1983), 53.

39 Barton C. Hacker, *The Dragon's Tail: Radiation Safety in the Manhattan Project, 1942-1946* (Los Angeles, CA: University of California Press, 1987), 61.

40 Barton C. Hacker, *The Dragon's Tail: Radiation Safety in the Manhattan Project, 1942-1946* (Los Angeles, CA: University of California Press, 1987), 62.

41 David Hawkins, *Project Y: The Los Alamos Story* (Los Angeles, CA: Tomash Publishers, 1983), 53.

42 David Hawkins, *Project Y: The Los Alamos Story* (Los Angeles, CA: Tomash Publishers, 1983), 54.

43 Thomas L. Shipman, *Health, Safety and Biomedical Research at Los Alamos* (Los Alamos, NM: Los Alamos Scientific Laboratory, 1948), 1, also available electronically, https://www.osti.gov/opennet/servlets/purl/16111545.pdf.

44 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management,*

1942–1994 (Washington, D.C.: Department of Energy, History Division, 1994).

45 Bethann McVicker update of map originally developed by Mona Valencia and subsequently updated by Brad McCown, "Los Alamos National Laboratory Acquired and Dispositioned Real Estate" (map, Los Alamos National Laboratory report LA-UR-16-23631, 2022); this map (22-038-02) was created by the LANL GIS Program using the best data available and might not represent all land transactions.

46 Bethann McVicker update of map originally developed by Mona Valencia and subsequently updated by Brad McCown, "Los Alamos National Laboratory Acquired and Dispositioned Real Estate" (map, Los Alamos National Laboratory report LA-UR-16-23631, 2022); this map (22-038-04) was created by the LANL GIS Program using the best data available and might not represent all land transactions.

47 Bethann McVicker update of map originally developed by Mona Valencia and subsequently updated by Brad McCown, "Los Alamos National Laboratory Acquired and Dispositioned Real Estate" (map, Los Alamos National Laboratory report LA-UR-16-23631, 2022); this map (22-038-05) was created by the LANL GIS Program using the best data available and might not represent all land transactions.

48 Bethann McVicker of the LANL GIS Program created this map (22-038-01_1965) using the best data available.

49 Roger Allen Meade, ed., *The Postwar Laboratory* (Los Alamos National Laboratory report LA-UR-16-28879, 2016), 1.

50 Alan Brady Carr, "Mister Los Alamos" (presentation, Los Alamos National Laboratory report LA-UR-20-29957, 2020), 15; Zia Company, *Presenting… The Zia Company: Maintenance and Operations Contractor, Los Alamos, New Mexico* (Los Alamos, NM: Zia Company, 1964), 2.

51 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 2.

52 Roger Allen Meade, ed., *The Postwar Laboratory* (Los Alamos National Laboratory report LA-UR-16-28879, 2016), 1.

53 Vic Hogsett, "Director's Interviews," *The Atom* 17, no. 3 (1980): 26.

54 Alan Brady Carr, "The Life, the Times, and the Laboratory of Norris E. Bradbury," (presentation, Los Alamos National Laboratory report LA-UR-13-25312, 2013).

55 Alan Brady Carr, *Of Clouds and Craters: The History of U.S. Nuclear Weapons Testing* (Los Alamos National Laboratory report LA-UR-20-22980, 2020), 6.

56 Roger Meade, "Post-war Weapons Testing Started 75 Years Ago," *LANLInside*, July 1, 2021, https://int.lanl.gov/news/news_stories/2021/july/0701-crossroads.shtm.

57 Harold M. Agnew and Raemer E. Schreiber, *Norris E. Bradbury 1909–1996* (Washington, D.C.: National Academies Press, 1998), 6.

58 Vic Hogsett, "Director's Interviews," *The Atom* 17, no. 3 (1980), 26.

59 Jeff Pederson, ed., "Crossroads to the Sun: A Time Table," *The Atom* 17, no. 3 (1980), 16.

60 Vic Hogsett, "Director's Interviews," *The Atom* 17, no. 3 (1980): 26; Norris E. Bradbury and edited by Roger Allen Meade, *Peace and the Atomic Bomb* (Los Alamos National Laboratory report LA-UR-16-25417, 2016), 7.

61 Norris E. Bradbury and edited by Roger Allen Meade, *Peace and the Atomic Bomb* (Los Alamos National Laboratory report LA-UR-16-25417, 2016), 4.

62 Norris E. Bradbury and edited by Roger Allen Meade, *Peace and the Atomic Bomb* (Los Alamos National Laboratory report LA-UR-16-25417, 2016), 7.

63 Alan Brady Carr, "Mister Los Alamos" (presentation, Los Alamos National Laboratory report LA-UR-20-29957, 2020), 18; F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: Department of Energy, History Division, 1994), 5.

64 Norris E. Bradbury and edited by Roger Allen Meade, *Peace and the Atomic Bomb* (Los Alamos National Laboratory report LA-UR-16-25417, 2016), 7; Roger Allen Meade, "From A Bombs to H Bombs to the Moratorium: Los Alamos during the Tenure of Norris E. Bradbury" (presentation, Los Alamos National Laboratory report LA-UR-99-05433, 1999), 4.

65 A. W. Betts, *A Technical Maintenance Group Report on General Background Data Concerning The Los Alamos Scientific Laboratory Required for Planning Purposes* (Los Alamos, NM: Los Alamos Scientific Laboratory, 1947).

66 Willard C. Kruger, *Interim Report on Reconstruction of TA-1. Submitted to the Office of Santa Fe Directed Operations, U. S. Atomic Energy Commission* (Los Alamos, NM: Associated Architects-Engineers, 1947), also available electronically, https://www.osti.gov/opennet/servlets/purl/901022.pdf.

67 Willard C. Kruger, I*nterim Report on Reconstruction of TA-1. Submitted to the Office of Santa Fe Directed Operations, U. S. Atomic Energy Commission* (Los Alamos, NM: Associated Architects-Engineers, 1947), 17, also available electronically, https://www.osti.gov/opennet/servlets/purl/901022.pdf.

68 Willard C. Kruger, *Interim Report on Reconstruction of TA-1. Submitted to the Office of Santa Fe Directed Operations, U. S. Atomic Energy Commission* (Los Alamos, NM: Associated Architects-Engineers, 1947), 17–18, available electronically, https://www.osti.gov/opennet/servlets/purl/901022.pdf.

69 U.S. Atomic Energy Commission, "Press Release, Subject: Award of Contract to Vinson Construction Company for Construction of Bridge across Los Alamos Canyon," U. S. Department of Energy OpenNet, https://www.osti.gov/opennet/detail?osti-id=16197359; Jeff Pederson, ed., "Crossroads to the Sun: A Time Table," *The Atom* 17, no. 3 (1980), 17.

70 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 3.

71 Harold M. Agnew and Raemer E. Schreiber, *Norris E. Bradbury 1909–1996* (Washington, D.C.: National Academies Press, 1998), 6–7.

72 Alan Brady Carr, "Mister Los Alamos" (presentation, Los Alamos National Laboratory report LA-UR-20-29957, 2020), 17–18.

73 Harold M. Agnew and Raemer E. Schreiber, *Norris E. Bradbury 1909–1996* (Washington, D.C.: National Academies Press, 1998), 6.

74 Harold M. Agnew and Raemer E. Schreiber, *Norris E. Bradbury 1909–1996* (Washington, D.C.: National Academies Press, 1998), 6, 8; Alan Brady Carr, "Mister Los Alamos" (presentation, Los Alamos National Laboratory report LA-UR-20-29957, 2020), 16.

75 Alan Brady Carr, "Mister Los Alamos" (presentation, Los Alamos National Laboratory report LA-UR-20-29957, 2020), 5.

76 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 3.

77 Norris E. Bradbury and edited by Roger Allen Meade, *The Los Alamos Scientific Laboratory—An Isolated Nuclear Research Establishment* (Los Alamos National Laboratory report LA-UR-16-27298, 2016), 3–4.

78 Vic Hogsett, "Director's Interviews," *The Atom* 17, no. 3 (1980), 26.

79 Alan Brady Carr, *Of Clouds and Craters: The History of U.S. Nuclear Weapons Testing* (Los Alamos National Laboratory report LA-UR-20-22980, 2020), 21; *U.S. Department of Energy, United States Nuclear Tests: July 1945 through September 1992*, Report DOE/NV209 (Las Vegas, NV: U.S. Department of Energy, Nevada Operations Office, 1994), rev. ed. 14, 1–30.

80 Alan Brady Carr, "Mister Los Alamos" (presentation, Los Alamos National Laboratory report LA-UR-20-29957, 2020), 31.

81 Harold M. Agnew and Raemer E. Schreiber, *Norris E. Bradbury 1909–1996* (Washington, D.C.: National Academies Press, 1998), 10.

82 Alan Brady Carr, "Mister Los Alamos" (presentation, Los Alamos National Laboratory report LA-UR-20-29957, 2020), 31.

83 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021), 21.

84 Kelly J. Beierschmitt, Thomas Edward Mason, Frances Chadwick, Robert Blair Webster, and John Louis Sarrao, *Lab Agenda January 2022 Update* (Los Alamos National Laboratory report LA-UR-22-20658, 2022).

85 Willard C. Kruger, *Interim Report on Reconstruction of TA-1. Submitted to the Office of Santa Fe Directed Operations, U. S. Atomic Energy Commission* (Los Alamos, NM: Associated Architects-Engineers, 1947), 17–18, also available electronically, https://www.osti.gov/opennet/servlets/purl/901022.pdf.

86 Alan Brady Carr, *LANL Organization Chart 1943–1984* (Los Alamos National Laboratory report LA-UR-20-28134, 2020); Whitney Spivey, "Jane Hall: Queen of the Hill," *National Security Science*, October 1, 2018, https://www.lanl.gov/discover/publications/national-security-science/2018-October/Jane%20Hall.php; Los Alamos National Laboratory, personnel file on Jane Hall, National Security Research Center, Los Alamos, New Mexico.

87 Raeanna Sharp-Geiger, email message to authors, May 26, 2022.

88 Los Alamos National Laboratory, "Jane Hall Award Nominations Open," *LANLInside*, March 26, 2019, https://int.lanl.gov/news/news_stories/2019/march/0327-jane-hall-award.shtml.

89 Alan Brady Carr, *LANL Organization Chart 1943–1984* (Los Alamos National Laboratory report LA-UR-20-28134, 2020); Los Alamos National Laboratory, personnel file on Henry Hoyt, National Security Research Center, Los Alamos, New Mexico; The Atom, "Short Subjects: Henry Hoyt," *The Atom*, no. 7 (1970), 17.

90 Norris E. Bradbury and edited by Roger Allen Meade, *Peace and the Atomic Bomb* (Los Alamos National Laboratory report LA-UR-16-25417, 2016), 7; Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 2.

91 Roger Allen Meade, ed., *Presidential Executive Order 9816 Providing for the Transfer of Properties and Personnel to the Atomic Energy Commission* (Los Alamos National Laboratory report LA-UR-16-28963, 2016), 1.

92 Herbert I. Miller and Ralph Carlisle Smith, *Memorandum on Los Alamos Operation: A Generalized Study of the Problem* (Los Alamos Scientific Laboratory report LA-UR-00540-MS, 1947).

93 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: Department of Energy, History Division, 1994), 5.

94 Carroll L. Tyler, *Report of the Manager, Santa Fe Operations, U. S. Atomic Energy Commission, July 1950 to*

January 1954 (Albuquerque, NM: U.S. Atomic Energy Commission, 1954), 2.

95 Carroll L. Tyler, *Report of the Manager, Santa Fe Operations, U. S. Atomic Energy Commission, July 1950 to January 1954* (Albuquerque, NM: U.S. Atomic Energy Commission, 1954), 6.

96 Herbert I. Miller and Ralph Carlisle Smith, *Memorandum on Los Alamos Operation: A Generalized Study of the Problem* (Los Alamos Scientific Laboratory report LA-UR-00540-MS, 1947).

97 Michael E. Welsh, *A Mission in the Desert: Albuquerque District, 1935–1985* (Albuquerque, NM: U.S. Army Corps of Engineers, Albuquerque District, 1985), 82–88.

98 Robert E. McKee, *The Zia Company in Los Alamos: A History* (El Paso, Texas: Carl Hertzog, 1950), 2.

99 Robert E. McKee, *The Zia Company in Los Alamos: A History* (El Paso, Texas: Carl Hertzog, 1950), 5; Michael E. Welsh, *A Mission in the Desert: Albuquerque District, 1935–1985* (Albuquerque, NM: U.S. Army Corps of Engineers, Albuquerque District, 1985), 225.

100 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 13.

101 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 3.

102 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 3–4.

103 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 2; Carroll L. Tyler, *Report of the Manager, Santa Fe Operations, U. S. Atomic Energy Commission, July 1950 to January 1954* (Albuquerque, NM: U.S. Atomic Energy Commission, 1954), 2.

104 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 2.

105 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 14–17.

106 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 2.

107 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 16–17.

108 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 5.

109 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 13–17.

110 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 10, 12.

111 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 2.

112 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 17.

113 U.S. Department of Labor, Office of Workers' Compensation Programs, Division of Energy Employees Occupational Illness Compensation, *U.S. Department of Energy, National Nuclear Security Administration, Los Alamos Field Office, Los Alamos National Laboratory* (presentation, ca. 2010). Available electronically, https://www.dol.gov/sites/dolgov/files/owcp/energy/regs/compliance/public_reading_room/deeoic_training/DOE_Info_Sessions/PDFs/LANL.pdf.

114 U.S. Department of Labor, Office of Workers' Compensation Programs, Division of Energy Employees Occupational Illness Compensation, "U.S. Department of Energy, National Nuclear Security Administration, Los Alamos Field Office, Los Alamos National Laboratory" (presentation, ca. 2010), also available electronically, https://www.dol.gov/sites/dolgov/files/owcp/energy/regs/compliance/public_reading_room/deeoic_training/DOE_Info_Sessions/PDFs/LANL.pdf.

115 Andrew W. Erickson (operations manager, Utilities and Institutional Facilities, Los Alamos National Laboratory), in discussion with the author, April 18, 2022.

116 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 2.

117 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 4, 9–10.

118 Oakes, Maureen, *Laboratory in a Changing World: A Los Alamos Chronology* (Los Alamos National Laboratory report LALP-01-065, 2001); U.S. Atomic Energy Commission, Santa Fe Operations Office, "Last Outside Toilet Soon to Disappear at Los Alamos" (press release, Los Alamos National Laboratory report LA-UR-12-01611, 2012).

119 U.S. Department of Labor, Office of Workers' Compensation Programs, Division of Energy Employees Occupational Illness Compensation, "U.S. Department of Energy, National Nuclear Security Administration, Los Alamos Field Office, Los Alamos National Laboratory" (presentation, ca. 2010), also available electronically, https://www.dol.gov/sites/dolgov/files/owcp/energy/regs/compliance/public_reading_room/deeoic_training/DOE_Info_Sessions/PDFs/LANL.pdf.

120 Kari L. M. Garcia, David M. Holtkamp, Ellen D. McGehee, Sheila A. McCarthy, Ken Towery, and John Ronquillo, *Standing Guard: An Evaluation of Early Cold War Guard Stations at LANL, 1948–1959* (Los Alamos National Laboratory report LA-UR-15-22369, 2015), 12.

121 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 6–7.

122 Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 7, 10.

123 U.S. Department of Labor, Office of Workers' Compensation Programs, Division of Energy Employees Occupational Illness Compensation, "U.S. Department of

Energy, National Nuclear Security Administration, Los Alamos Field Office, Los Alamos National Laboratory" (presentation, ca. 2010), also available electronically, https://www.dol.gov/sites/dolgov/files/owcp/energy/regs/compliance/public_reading_room/deeoic_training/DOE_Info_Sessions/PDFs/LANL.pdf.

124 Kari L. M. Garcia, David M. Holtkamp, Ellen D. McGehee, Sheila A. McCarthy, Ken Towery, and John Ronquillo, *Standing Guard: An Evaluation of Early Cold War Guard Stations at LANL, 1948–1959* (Los Alamos National Laboratory Report, LA-UR-15-22369, 2015), 7, 14, 21.

125 Richard D. Baker, quoted in "Bradbury's Colleagues Remember His Era," *Los Alamos Science* (Winter/Spring 1983): 33.

126 Roger Allen Meade, "From A Bombs to H Bombs to the Moratorium: Los Alamos during the Tenure of Norris E. Bradbury" (presentation, Los Alamos National Laboratory report LA-UR-99-05433, 1999), 2; Alan Brady Carr, "Mister Los Alamos" (presentation, Los Alamos National Laboratory report LA-UR-20-29957, 2020), 31.

127 Roger Allen Meade, "From A Bombs to H Bombs to the Moratorium: Los Alamos during the Tenure of Norris E. Bradbury" (presentation, Los Alamos National Laboratory report LA-UR-99-05433, 1999), 2.

128 Roger Allen Meade, "From A Bombs to H Bombs to the Moratorium: Los Alamos during the Tenure of Norris E. Bradbury" (presentation, Los Alamos National Laboratory report LA-UR-99-05433, 1999), 2; Alan Brady Carr, "Mister Los Alamos" (presentation, Los Alamos National Laboratory report LA-UR-20-29957, 2020), 25.

129 Donald P. MacMillan, "Los Alamos Nuclear Rocket Project Rover" (presented paper, American Nuclear Society Materials Symposium, San Diego, CA, 1962), 1, also available electronically, https://www.osti.gov/servlets/purl/4673160.

130 Alan Brady Carr, "Beyond the Moon," (presentation, Los Alamos National Laboratory report LA-UR-20-30089, 2020), 10.

131 Donald P. MacMillan, "Los Alamos Nuclear Rocket Project Rover" (presented paper, American Nuclear Society Materials Symposium, San Diego, CA, 1962), 1–2, also available electronically, https://www.osti.gov/servlets/purl/4673160.

132 Judy Machen, Kari L. M. Garcia, and Ellen D. McGehee, *SM-43, Nerve Center of a National Laboratory: A History of the Los Alamos Administration Building (1956–2006), Vol. 1* (Los Alamos National Laboratory report LA-UR-11-00922, 2010), 17.

133 Daniel R. Koenig, *Experience Gained from the Space Nuclear Rocket Program* (Rover) (Los Alamos National Laboratory report LA-10062-H, 1986), 1, 7.

134 Diane Benegas, ed., "Los Alamos Timeline: Significant Events and 50 Years of Research Highlights," in *Dateline Los Alamos, Special Issue* (1995), 29.

135 Billy Joe Archer, "A History of Los Alamos Scientific Computing" (lecture, XCP Seminar, Los Alamos, NM, June 25, 2020, Los Alamos National Laboratory report LA-UR-20-24471).

136 Judy Machen, Kari L. M. Garcia, and Ellen D. McGehee, SM-43, *Nerve Center of a National Laboratory: A History of the Los Alamos Administration Building (1956–2006), Vol. 1* (Los Alamos National Laboratory report LA-UR-11-00922, 2010), 110; Edward A. Voorhees, "Software and Operations," in *Computing at LASL in the 1940s and 1950s,* by Roger B. Lazarus, Edward A. Voorhees, Mark B. Wells, and W. Jack Worlton, (Los Alamos Scientific Laboratory report LA-6943-H, 1978), 7.

137 Billy Joe Archer, "A History of Los Alamos Scientific Computing" (lecture, XCP Seminar, Los Alamos, NM, June 25, 2020, Los Alamos National Laboratory report LA-UR-20-24471).

138 Nicholas Dale Lewis, "On 'The Lunatic Fringe': Los Alamos High-Performance Computing History" (presentation, HPC Summer Presentation Series, Los Alamos, NM, August 8, 2016, Los Alamos National Laboratory report LA-UR-16-25748).

139 Judy Machen, Kari L. M. Garcia, and Ellen D. McGehee, *SM-43, Nerve Center of a National Laboratory: A History of the Los Alamos Administration Building (1956–2006), Vol. 1* (Los Alamos National Laboratory report LA-UR-11-00922, 2010), 110.

140 Judy Machen, Kari L. M. Garcia, and Ellen D. McGehee, *SM-43, Nerve Center of a National Laboratory: A History of the Los Alamos Administration Building (1956–2006), Vol. 1* (Los Alamos National Laboratory report LA-UR-11-00922, 2010), 107–109; Alan Brady Carr, "Computing at Los Alamos" (presentation, Los Alamos National Laboratory report LA-UR-10-00132, 2010).

141 Mario R. Perez and Richard D. Belian, "Vela Satellite Program" (presentation, Los Alamos National Laboratory report LA-UR-08-05501, 2008); Morris B. Pongratz, "Los Alamos in Space: The 50 Years since Vela" (presentation, IGPPS Science of Signatures for Climate, Geophysics, Space and Astrophysics, Los Alamos, NM, October 9, 2013, Los Alamos National Laboratory report LA-UR-13-27772).

142 Richard Marc Kippen and John R. Gustafson, "Ensuring America's Security, 50 Years of Treaty Verification from Space" (poster, Los Alamos National Laboratory report LA-UR-13-26737, 2013).

143 Edward F. Hammel, *Los Alamos Scientific Laboratory Energy-Related History, Research, Managerial Reorganization Proposals, Actions Taken, and Results 1945–1979* (Los Alamos National Laboratory report LA-UR-13072-H, 1997), 3; Mario R. Perez and Richard D. Belian, "Vela Satellite Program" (presentation, Los Alamos National Laboratory report LA-UR-08-05501, 2008).

144 Judy Machen, Kari L. M. Garcia, and Ellen D. McGehee, SM-43, *Nerve Center of a National Laboratory: A History of the Los Alamos Administration Building (1956–2006), Vol. 1* (Los Alamos National Laboratory report LA-UR-11-00922, 2010), 98.

145 Mario R. Perez and Richard D. Belian, "Vela Satellite Program" (presentation, Los Alamos National Laboratory report LA-UR-08-05501, 2008).

146 Judy Machen, Kari L. M. Garcia, and Ellen D. McGehee, SM-43, *Nerve Center of a National Laboratory: A History of the Los Alamos Administration Building (1956–2006), Vol. 1* (Los Alamos National Laboratory report LA-UR-11-00922, 2010), 130.

147 Alice L. Buck, *A History of the Atomic Energy Commission* (Washington, D.C.: U.S. Department of Energy, History Division, 1983), 3.

148 Alice L. Buck, *A History of the Atomic Energy Commission* (Washington, D.C.: U.S. Department of Energy, History Division, 1983), 6.

149 U.S. Atomic Energy Commission, *The Future Role of the Atomic Energy Commission Laboratories: A Report to the Joint Committee on Atomic Energy, Vol. 1* (Washington, D.C.: U.S. Atomic Energy Commission, 1960), 66.

150 Alice L. Buck, *A History of the Atomic Energy Commission* (Washington, D.C.: U.S. Department of Energy, History Division, 1983), 6; Judy Machen, Kari L. M. Garcia, and Ellen D. McGehee, *SM-43, Nerve Center of a National Laboratory: A History of the Los Alamos Administration Building (1956–2006), Vol. 1* (Los Alamos National Laboratory report LA-UR-11-00922, 2010), 34.

151 Judy Machen, Kari L. M. Garcia, and Ellen D. McGehee, *SM-43, Nerve Center of a National Laboratory: A History of the Los Alamos Administration Building (1956–2006), Vol. 1* (Los Alamos National Laboratory report LA-UR-11-00922, 2010), 90.

152 Harold M. Agnew and Raemer E. Schreiber, *Norris E. Bradbury 1909–1996* (Washington, D.C.: National Academies Press, 1998), 6.

153 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021), 11.

154 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021), 11, 27, 36.

155 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021), 11–12.

156 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021), 11.

157 Thomas L. Shipman, introduction to *Health Division Annual Report, 1949* (Los Alamos Scientific Laboratory report LA-UR-01072, 1950), 3.

158 Richard D. Baker, quoted in “Bradbury’s Colleagues Remember His Era,” *Los Alamos Science* (Winter/Spring 1983): 45.

159 Thomas L. Shipman, “H Division Activities” (paper presentation, Los Alamos Scientific Laboratory, May 6, 1969), 30, also available electronically, https://www.osti.gov/opennet/servlets/purl/16288769.pdf.

160 Alan Brady Carr, *LANL Organization Chart 1943–1984* (Los Alamos National Laboratory report LA-UR-20-28134, 2020).

161 Thomas L. Shipman, *Health, Safety and Biomedical Research at Los Alamos* (Los Alamos, NM: Los Alamos Scientific Laboratory, 1948), 1, also available electronically, https://www.osti.gov/opennet/servlets/purl/16111545.pdf.

162 Thomas L. Shipman, *Health, Safety and Biomedical Research at Los Alamos* (Los Alamos, NM: Los Alamos Scientific Laboratory, 1948), also available electronically, https://www.osti.gov/opennet/servlets/purl/16111545.pdf; Alan Brady Carr, *LANL Organization Chart 1943–1984* (Los Alamos National Laboratory report LA-UR-20-28134, 2020).

163 Thomas L. Shipman, “Introduction,” in *Health Division Annual Report 1949* (Los Alamos Scientific Laboratory report LA-UR-01072), 3–8.

164 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: Department of Energy, History Division, 1994), 6.

165 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: Department of Energy, History Division, 1994), 7.

166 Thomas L. Shipman, introduction to *Health Division Annual Report, 1949* (Los Alamos Scientific Laboratory report LA-UR-01072, 1950), 3.

167 Wright H. Langham (Los Alamos Scientific Laboratory Health Division) to Theodore B. Jenson (Atomic Energy Commission Operations Office), memo, 27 August 1948, also available electronically, https://www.osti.gov/opennet/servlets/purl/903549.pdf; Roger Allen Meade, ed., *Notes on Los Alamos* (Los Alamos National Laboratory report LA-UR-17-22764, 2017), 12; Thomas L. Shipman, *Health Division Annual Report, 1953* (Los Alamos Scientific Laboratory report LA-UR-01689, 1954), 6.

168 Thomas L. Shipman, introduction to *Health Division Annual Report, 1949* (Los Alamos Scientific Laboratory report LA-UR-01072, 1950), 5.

169 Roger Allen Meade, “From A Bombs to H Bombs to the Moratorium: Los Alamos during the Tenure of Norris E. Bradbury” (presentation, Los Alamos National Laboratory report LA-UR-99-05433, 1999), 4.

170 Hugh C. Paxton, *A History of Critical Experiments at Pajarito Site* (Los Alamos National Laboratory report LA-09685-H, 1983), 2–3.

171 Evelyn Mullen, Los Alamos National Laboratory, Chief of Operations, Global Security Directorate, email message to authors, March 15, 2022.

172 Alan Brady Carr, “The Ultimate Safety Share” (presentation, Los Alamos National Laboratory report LA-UR-20-26608, 2020), 5.

173 John B. Ramsay, *Incidents and Accidents Involving Explosives at the Los Alamos National Laboratory, 1951–1999* (Los Alamos National Laboratory report LA-UR-13697, 2001), 5.

174 John B. Ramsay, *Incidents and Accidents Involving Explosives at the Los Alamos National Laboratory, 1951–1999* (Los Alamos National Laboratory report LA-UR-13697, 2001), 6.

175 John B. Ramsay, *Incidents and Accidents Involving Explosives at the Los Alamos National Laboratory, 1951–1999* (Los Alamos National Laboratory report LA-UR-13697, 2001), 2.

176 Cary B. Skidmore, “The Seven LANL Explosives Fatalities—Technical and Human Perspectives” (presentation, Los Alamos Historical Society 2012–2013 Lecture Series: History and Science, February 12, 2013, Los Alamos National Laboratory report LA-UR-13-20561), 27.

177 Necia Grant Cooper, ed., “The Cecil Kelley Criticality Accident” *Los Alamos Science* 23 (1995): 250.

178 Thomas P. Mc Laughlin, Shean P. Monahan, Norman L. Pruvost, Vladimir V. Frolov, Boris G. Ryazanov, and Victor I. Sviridov. *Review of Criticality Accidents: 2000 Revision* (Los Alamos National Laboratory report LA-UR-13638, 2000), 17.

179 Richard E. Anderson, “History of Criticality Accidents” (working paper for an agreement between the United States and France on Nuclear Criticality Safety, December 18–19, 2008, Los Alamos National Laboratory report LA-UR-08-07765), 2.

180 Alan Brady Carr, “The Ultimate Safety Share” (presentation, Los Alamos National Laboratory report LA-UR-20-26608, 2020), 5.

181 Carrie J. Gregory, Elliot M. Schultz, Cameron D. Townsend, Kari L. M. Garcia, and Jeremy C. Brunette, *From Protection and Prevention to Research and Discovery: Eligibility Assessment of the Health Research Laboratory (TA-43) and Historic Documentation for TA-43-0001, Vol. 1* (Los Alamos National Laboratory report LA-UR-22-29600, 2022), 3.11, 3.65–3.67.

182 David Sundberg, “LASL’s Mr. Safety,” *The Atom* 2, no. 3 (1965), 20–23.

183 Alan Brady Carr, *LANL Organization Chart 1943–1984* (Los Alamos National Laboratory report LA-UR-20-28134, 2020).

184 David Sundberg, “LASL’s Mr. Safety,” *The Atom* 2, no. 3 (1965), 20.

185 David Sundberg, “LASL’s Mr. Safety,” *The Atom* 2, no. 3 (1965), 23.

186 David Sundberg, “LASL’s Mr. Safety,” *The Atom* 2, no. 3 (1965), 23.

187 Philip N. Dean and John H. Larkins, “Thermoluminescent Dosimetry with Activated Lithium Fluoride,” in *Biological and Medical Research Group (H-4) of the Health Division Annual Report, July 1962 through June 1963*, by Wright H. Langham and Thomas L. Shipman (Los Alamos Scientific Laboratory report LA-UR-03034-MS, 1964), 205, 221.

188 Philip N. Dean and John H. Larkins, “Thermoluminescent Dosimetry with Activated Lithium Fluoride,” in *Biological and Medical Research Group (H-4) of the Health Division Annual Report, July 1962 through June 1963*, by Wright H. Langham and Thomas L. Shipman (Los Alamos Scientific Laboratory report LA-UR-03034-MS, 1964), 221, 223.

189 Oliver W. Larson, A. John Ahlquist, and Richard W. Henderson, *Radiation Measurements of the Effluent from the NRX A-4 Reactor* (Los Alamos Scientific Laboratory report LA-UR-03583-MS, 1966), 10.

190 Donald F. Petersen and Elizabeth M. Sullivan, *Biomedical and Environmental Research Program of the LASL Health Division, January–December 1975* (Los Alamos Scientific Laboratory report LA-UR-06313-PR, 1976), 29.

191 Raeanna Sharp-Geiger, email message to authors, May 26, 2022.

192 Thomas L. Shipman, “H Division Activities” (paper presentation, Laboratory Information Meeting, Los Alamos, NM, May 6, 1969), https://www.osti.gov/opennet/servlets/purl/16288769.pdf.

193 Harry F. Schulte, “Group H-5, Industrial Hygiene,” in *Health Division Annual Report, 1953*, by Thomas L. Shipman (Los Alamos Scientific Laboratory report LA-UR-01689, 1954), 38–41.

194 The Atom, “They Clean the Air,” *The Atom* 2, no. 13 (1965), 3–6.

195 Alan Brady Carr, *LANL Organization Chart 1943–1984* (Los Alamos National Laboratory report LA-UR-20-28134, 2020).

196 Harry J. Ettinger, *Survey of Techniques Employed to Define Aerosol "Respirable Dust" Concentration and Particle-Size Characteristics, vol. 2* (Los Alamos Scientific Laboratory report LA-UR-04249, 1971), 5.

197 Raeanna Sharp-Geiger, email message to authors, May 26, 2022.

198 Necia Grant Cooper, ed., “The Cecil Kelley Criticality Accident,” *Los Alamos Science* 23 (1995): 250–251.

199 Necia Grant Cooper, ed., “The Cecil Kelley Criticality Accident,” *Los Alamos Science* 23 (1995): 250.

200 Necia Grant Cooper, ed., “The Cecil Kelley Criticality Accident,” *Los Alamos Science* 23 (1995): 250.

201 Necia Grant Cooper, ed., "The Cecil Kelley Criticality Accident," *Los Alamos Science* 23 (1995): 251.

202 James F. McInroy, "A True Measure of Exposure: The Human Tissue Analysis Program at Los Alamos," *Los Alamos Science* 23 (1995): 235–237.

203 Bethann McVicker of the LANL GIS Program created this map (22-038-01_1991) using the best data available.

204 John Walsh, "Los Alamos: Coming to Terms with the 1980's," *Science* 209, no. 4462 (1980): 1211.

205 John Walsh, "Los Alamos: Coming to Terms with the 1980's," *Science* 209, no. 4462 (1980): 1211.

206 Louis Rosen, "LAMPF: A Dream and a Gamble," *Los Alamos Science* 7 (1983).

207 Louis Rosen, "LAMPF: A Dream and a Gamble," *Los Alamos Science* 7 (1983).

208 John Walsh, "Los Alamos: Coming to Terms with the 1980's," *Science* 209, no. 4462 (1980): 1211.

209 John Walsh, "Los Alamos: Coming to Terms with the 1980's," *Science* 209, no. 4462 (1980): 1211.

210 Louis Rosen, "LAMPF: A Dream and a Gamble," *Los Alamos Science* 7 (1983).

211 Louis Rosen, "LAMPF: A Dream and a Gamble," *Los Alamos Science* 7 (1983).

212 Louis Rosen, "LAMPF: A Dream and a Gamble," *Los Alamos Science* 7 (1983).

213 Louis Rosen, "LAMPF: A Dream and a Gamble," *Los Alamos Science* 7 (1983).

214 Richard A. Reichelt, "Probing the Structure of Matter," *Los Alamos Science* 21 (1993): 99.

215 John Walsh, "Los Alamos: Coming to Terms with the 1980's," *Science* 209, no. 4462 (1980): 1211.

216 Edward F. Hammel, *Los Alamos Scientific Laboratory Energy-Related History, Research, Managerial Reorganization Proposals, Actions Taken, and Results 1945–1979* (Los Alamos National Laboratory report LA-UR-13072-H, 1997), 13.

217 Edward F. Hammel, *Los Alamos Scientific Laboratory Energy-Related History, Research, Managerial Reorganization Proposals, Actions Taken, and Results 1945–1979* (Los Alamos National Laboratory report LA-UR-13072-H, 1997), 11.

218 Edward F. Hammel, *Los Alamos Scientific Laboratory Energy-Related History, Research, Managerial Reorganization Proposals, Actions Taken, and Results 1945–1979* (Los Alamos National Laboratory report LA-UR-13072-H, 1997), 13.

219 Edward F. Hammel, *Los Alamos Scientific Laboratory Energy-Related History, Research, Managerial Reorganization Proposals, Actions Taken, and Results*

1945–1979 (Los Alamos National Laboratory report LA-UR-13072-H, 1997), 13.

220 Edward F. Hammel, *Los Alamos Scientific Laboratory Energy-Related History, Research, Managerial Reorganization Proposals, Actions Taken, and Results 1945–1979* (Los Alamos National Laboratory report LA-UR-13072-H, 1997), 13.

221 Edward F. Hammel, *Los Alamos Scientific Laboratory Energy-Related History, Research, Managerial Reorganization Proposals, Actions Taken, and Results 1945–1979* (Los Alamos National Laboratory report LA-UR-13072-H, 1997), 3–4; John Walsh, "Los Alamos: Coming to Terms with the 1980's," *Science* 209, no. 4462 (1980): 1211.

222 Judy Machen, Kari L. M. Garcia, and Ellen D. McGehee, *SM-43, Nerve Center of a National Laboratory: A History of the Los Alamos Administration Building (1956–2006), Vol. 1* (Los Alamos National Laboratory report LA-UR-11-00922, 2010).

223 Raymond Garde, E.J. Cox, Allen M. Valentine, *Los Alamos DP West Plutonium Facility Decontamination Project, 1978-1981* (Los Alamos National Laboratory report LA-UR-9513-MS, 1982).

224 Dane Robert Spearing, *TA-55 and Sigma Overview* (Los Alamos National Laboratory report LA-UR-16-29084, 2016).

225 Dane Robert Spearing, *TA-55 and Sigma Overview* (Los Alamos National Laboratory report LA-UR-16-29084, 2016).

226 John Walsh, "Los Alamos: Coming to Terms with the 1980's," *Science* 209, no. 4462 (1980): 1211.

227 John Walsh, "Los Alamos: Coming to Terms with the 1980's," *Science* 209, no. 4462 (1980): 1211.

228 William J. Broad, "Los Alamos: The Winds of Mutiny," *Science* 218, no. 4568 (1982): 135.

229 William J. Broad, "Los Alamos: The Winds of Mutiny," *Science* 218, no. 4568 (1982): 134; John Walsh, "Los Alamos: Coming to Terms with the 1980's," *Science* 209, no. 4462 (1980): 1211.

230 John Walsh, "Los Alamos: Coming to Terms with the 1980's," *Science* 209, no. 4462 (1980): 1211–1212.

231 John Walsh, "Los Alamos: Coming to Terms with the 1980's," *Science* 209, no. 4462 (1980): 1212.

232 Donald M. Kerr in "Los Alamos: Coming to Terms with the 1980's," by John Walsh, *Science* 209, no. 4462 (1980): 1212.

233 William J. Broad, "Los Alamos: The Winds of Mutiny," *Science* 218, no. 4568 (1982): 135.

234 John Walsh, "Los Alamos: Coming to Terms with the 1980's," *Science* 209, no. 4462 (1980).

235 Donald M. Kerr in "Los Alamos: The Winds of Mutiny," by William J. Broad, *Science* 218, no. 4568 (1982): 136.

236 Siegfried S. Hecker, "Is There Life for Los Alamos 50 Years after Trinity?" *The Washington Roundtable on Science and Public Policy* (Washington, D.C.: George C. Marshall Institute, 1995), 8.

237 Siegfried S. Hecker, "Is There Life for Los Alamos 50 Years after Trinity?" *The Washington Roundtable on Science and Public Policy* (Washington, D.C.: George C. Marshall Institute, 1995), 8.

238 Siegfried S. Hecker, "Is There Life for Los Alamos 50 Years after Trinity?" *The Washington Roundtable on Science and Public Policy* (Washington, D.C.: George C. Marshall Institute, 1995), 8.

239 Siegfried S. Hecker, "Is There Life for Los Alamos 50 Years after Trinity?" *The Washington Roundtable on Science and Public Policy* (Washington, D.C.: George C. Marshall Institute, 1995), i.

240 Siegfried S. Hecker, "Is There Life for Los Alamos 50 Years after Trinity?" *The Washington Roundtable on Science and Public Policy* (Washington, D.C.: George C. Marshall Institute, 1995), 3.

241 Siegfried S. Hecker, "Is There Life for Los Alamos 50 Years after Trinity?" *The Washington Roundtable on Science and Public Policy* (Washington, D.C.: George C. Marshall Institute, 1995), 4.

242 Siegfried S. Hecker, "Is There Life for Los Alamos 50 Years after Trinity?" *The Washington Roundtable on Science and Public Policy* (Washington, D.C.: George C. Marshall Institute, 1995), 5.

243 Siegfried S. Hecker, "Is There Life for Los Alamos 50 Years after Trinity?" *The Washington Roundtable on Science and Public Policy* (Washington, D.C.: George C. Marshall Institute, 1995), 6.

244 Siegfried S. Hecker, "Is There Life for Los Alamos 50 Years after Trinity?" *The Washington Roundtable on Science and Public Policy* (Washington, D.C.: George C. Marshall Institute, 1995), 6.

245 Siegfried S. Hecker, "Is There Life for Los Alamos 50 Years after Trinity?" *The Washington Roundtable on Science and Public Policy* (Washington, D.C.: George C. Marshall Institute, 1995), 6.

246 Edward F. Hammel, *Los Alamos Scientific Laboratory Energy-Related History, Research, Managerial Reorganization Proposals, Actions Taken, and Results 1945–1979* (Los Alamos National Laboratory report LA-UR-13072-H, 1997).

247 J. J. Wechsler in "Los Alamos: Coming to Terms with the 1980's," by John Walsh, *Science* 209, no. 4462 (1980): 1213.

248 John Walsh, "Los Alamos: Coming to Terms with the 1980's," *Science* 209, no. 4462 (1980): 1212.

249 Edward F. Hammel, *Los Alamos Scientific Laboratory Energy-Related History, Research, Managerial Reorganization Proposals, Actions Taken, and Results 1945–1979* (Los Alamos National Laboratory report LA-UR-13072-H, 1997), 48.

250 John Walsh, "Los Alamos: Coming to Terms with the 1980's," *Science* 209, no. 4462 (1980): 1213.

251 Edward F. Hammel, *Los Alamos Scientific Laboratory Energy-Related History, Research, Managerial Reorganization Proposals, Actions Taken, and Results 1945–1979* (Los Alamos National Laboratory report LA-UR-13072-H, 1997), 49.

252 Siegfried S. Hecker, "Is There Life for Los Alamos 50 Years after Trinity?" *The Washington Roundtable on Science and Public Policy* (Washington, D.C.: George C. Marshall Institute, 1995), 10.

253 Siegfried S. Hecker, "Is There Life for Los Alamos 50 Years after Trinity?" *The Washington Roundtable on Science and Public Policy* (Washington, D.C.: George C. Marshall Institute, 1995), 10.

254 Siegfried S. Hecker, "Is There Life for Los Alamos 50 Years after Trinity?" *The Washington Roundtable on Science and Public Policy* (Washington, D.C.: George C. Marshall Institute, 1995), 10.

255 Secretary of the Energy Advisory Board Task Force on Alternative Futures for the Department of Energy National Laboratories, *Alternative Futures for the Department of Energy National Laboratories* (Washington, D.C.: U.S. Department of Energy, 1995), 4.

256 Secretary of the Energy Advisory Board Task Force on Alternative Futures for the Department of Energy National Laboratories, *Alternative Futures for the Department of Energy National Laboratories* (Washington, D.C.: U.S. Department of Energy, 1995), 7.

257 Secretary of the Energy Advisory Board Task Force on Alternative Futures for the Department of Energy National Laboratories, *Alternative Futures for the Department of Energy National Laboratories* (Washington, D.C.: U.S. Department of Energy, 1995), 8.

258 Steve Stokes, email message to author, January 18, 2022.

259 Los Alamos National Laboratory, personnel file on James F. Jackson, National Security Research Center, Los Alamos, New Mexico.

260 Alan Brady Carr, *LANL Organization Chart 1943–1984* (Los Alamos National Laboratory report LA-UR-20-28134, 2020).

261 Los Alamos National Laboratory, personnel file on James F. Jackson, National Security Research Center, Los Alamos, New Mexico.

262 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: U.S. Department of Energy, History Division, 1994).

263 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: U.S. Department of Energy, History Division, 1994).

264 Margaret Anne Rogers, *History and Environmental Setting of LASL Near-Surface Land Disposal for Radioactive Wastes* (Los Alamos Scientific Laboratory report LA-UR-6848, 1997).

265 N3B Los Alamos, "Chromium Plume Fact Sheet," U.S. Department of Energy, Environmental Management Field Office, https://www.energy.gov/sites/default/files/2018/11/f57/Chromium%20Plume%20Fact%20Sheet%20Fall%202018.pdf.

266 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: U.S. Department of Energy, History Division, 1994).

267 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: U.S. Department of Energy, History Division, 1994).

268 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: U.S. Department of Energy, History Division, 1994).

269 U.S. Congress, Office of Technology Assessment, *Complex Cleanup: The Environmental Legacy of Nuclear Weapons Production*, Report no. OTA-O-484 (Washington D.C.: U.S. Government Printing Office, 1991), also available electronically, https://sgp.fas.org/othergov/doe/lanl/lib-www/ota/00418554.pdf.

270 U.S. Department of Energy, Office of Legacy Management, "Brief History of the Department of Energy," https://www.energy.gov/lm/doe-history/brief-history-department-energy.

271 U.S. Department of Energy, Office of Legacy Management, "Brief History of the Department of Energy," https://www.energy.gov/lm/doe-history/brief-history-department-energy.

272 *Environmental Studies Group, Environmental Surveillance at Los Alamos During 1976* (Los Alamos Scientific Laboratory report LA-UR-06801-MS, 1977).

273 *Environmental Studies Group, Environmental Surveillance at Los Alamos During 1976* (Los Alamos Scientific Laboratory report LA-UR-06801-MS, 1977).

274 Environmental Studies Group, *Omnibus Environmental Assessment* (Los Alamos Scientific Laboratory report LA-UR-75-05012, 1975).

275 Environmental Studies Group, *Omnibus Environmental Assessment* (Los Alamos Scientific Laboratory report LA-UR-75-05012, 1975).

276 National Research Council, *Improving the Environment: An Evaluation of the DOE's Environmental Management Program* (Washington, D.C.: National Academy Press, 1995).

277 National Research Council, *Improving the Environment: An Evaluation of the DOE's Environmental Management Program* (Washington, D.C.: National Academy Press, 1995).

278 U.S. Department of Energy, Office of Environmental Management, "Los Alamos Interim Measure to Control Contaminant Plume Reaches Full Operation," https://www.energy.gov/em/articles/los-alamos-interim-measure-control-contaminant-plume-reaches-full-operation.

279 Carol A. Clark, "N3B: Los Alamos Interim Measure to Control Contaminant Plume beneath LANL Reaches Full Operation," *Los Alamo Daily Post*, May 8, 2021, https://ladailypost.com/n3b-los-alamos-interim-measure-to-control-contaminant-plume-reaches-full-operation/.

280 Alice Buck, *A History of the Energy Research and Development Administration* (Washington D.C.: U.S. Department of Energy, Office of History and Heritage Resources, 1982), 4–5.

281 Alice Buck, *A History of the Energy Research and Development Administration* (Washington D.C.: U.S. Department of Energy, Office of History and Heritage Resources, 1982), 5.

282 John Walsh, "Los Alamos: Coming to Terms with the 1980's," *Science* 209, no. 4462 (1980): 1213.

283 J. J. Wechsler in "Los Alamos: Coming to Terms with the 1980's," by John Walsh, *Science* 209, no. 4462 (1980): 1213.

284 U.S. Department of Labor, Occupational Safety and Health Administration, "OSHA at 50," https://www.osha.gov/osha50#.

285 U.S. Department of Labor, Occupational Safety and Health Administration, "About OSHA," https://www.osha.gov/aboutosha.

286 The Atom, "New Address for H-5 and H-8," *The Atom* 3, no. 4 (1966): 7.

287 The Atom, "Complying with OSHA," *The Atom* 10, no. 3 (1973): 6.

288 The Atom, "Complying with OSHA," *The Atom* 10, no. 3 (1973): 7.

289 Barbara Storms, "A Sideline Mushroomed," *The Atom* 9, no. 8 (1972): 4.

290 The Atom, "Interpreting the Requirements for Respirator Programs," *The Atom* 10, no. 7 (1973): 1.

291 Jack Nelson, ed., "Respirator Road Show," *The Atom*, January-February (1976): 20.

292 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: U.S. Department of Energy, History Division, 1994), 18; Alan Brady Carr, *On the Front Lines of the Cold War, Los Alamos 1970–1992* (Los Alamos National Laboratory report LA-UR-13-24021, 2013), 5.

293 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: U.S. Department of Energy, History Division, 1994), 23.

294 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: U.S. Department of Energy, History Division, 1994), 44.

295 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: U.S. Department of Energy, History Division, 1994), 43–45.

296 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: U.S. Department of Energy, History Division, 1994), 64.

297 U.S. Department of Energy, *Tiger Team Assessment of the Los Alamos National Laboratory*, DOE/EH 0204, vol. 2 (Washington, D.C.: U.S. Department of Energy, Office of Environment, Safety, and Health, 1991), 4.1.

298 U.S. Department of Energy, *Tiger Team Assessment of the Los Alamos National Laboratory*, DOE/EH 0204, vol. 2 (Washington, D.C.: U.S. Department of Energy, Office of Environment, Safety, and Health, 1991).

299 U.S. Department of Energy, *Tiger Team Assessment of the Los Alamos National Laboratory*, DOE/EH 0204, vol. 2 (Washington, D.C.: U.S. Department of Energy, Office of Environment, Safety, and Health, 1991), 4.3–4.4.

300 U.S. Department of Energy, *Tiger Team Assessment of the Los Alamos National Laboratory*, DOE/EH 0204, vol. 2 (Washington, D.C.: U.S. Department of Energy, Office of Environment, Safety, and Health, 1991), 4.4.

301 U.S. Department of Energy, *Tiger Team Assessment of the Los Alamos National Laboratory*, DOE/EH 0204, vol. 2 (Washington, D.C.: U.S. Department of Energy, Office of Environment, Safety, and Health, 1991), 4.3.

302 U.S. Department of Energy, *Tiger Team Assessment of the Los Alamos National Laboratory*, DOE/EH 0204, vol. 2 (Washington, D.C.: U.S. Department of Energy, Office of Environment, Safety, and Health, 1991), 4.4.

303 Andrew W. Erickson (operations manager, Utilities and Institutional Facilities, Los Alamos National Laboratory), in discussion with the author, April 18, 2022.

304 Andrew W. Erickson (operations manager, Utilities and Institutional Facilities, Los Alamos National Laboratory), in discussion with the author, April 18, 2022.

305 Alan Brady Carr, "The Ultimate Safety Share" (presentation, Los Alamos National Laboratory report LA-UR-20-26608, 2020), 6.

306 Alan Brady Carr, "The Ultimate Safety Share" (presentation, Los Alamos National Laboratory report LA-UR-20-26608, 2020), 6; The Atom, Eight Scientists Die in Plane Crash, *The Atom* 9, no. 5 (1972), 20.

307 The Atom, Eight Scientists Die in Plane Crash, *The Atom* 9, no. 5 (1972), 20.

308 National Transportation Safety Board, *Aircraft Accident Report: Ross Aviation, Inc., Beechcraft 65-B8O, Queen Air, N841NS, Albuquerque, New Mexico, May 19, 1972* (Washington D.C.: National Transportation Safety Board, Bureau of Aviation Safety, 1972), ii.

309 National Transportation Safety Board, *Aircraft Accident Report: Ross Aviation, Inc., Beechcraft 65-B8O, Queen Air, N841NS, Albuquerque, New Mexico, May 19, 1972* (Washington D.C.: National Transportation Safety Board, Bureau of Aviation Safety, 1972), ii.

310 John Armistead, ed., "LASL's Trucking Company," *The Atom*, February (1977): 1.

311 John Armistead, ed., "LASL's Trucking Company," *The Atom*, February (1977): 1–6.

312 U.S. Department of Energy, Office of Scientific and Technical Information, *Infotech 1992: DOE Technical Information Meeting, Oak Ridge, Tennessee, Oct. 21–23, 1992* (Washington, D.C: U.S Department of Energy, Office of Scientific and Technical Information, 1992).

313 U.S. Department of Energy, Office of Scientific and Technical Information, *Infotech 1992: DOE Technical Information Meeting, Oak Ridge, Tennessee, Oct. 21–23, 1992* (Washington, D.C: U.S Department of Energy, Office of Scientific and Technical Information, 1992).

314 Marjorie Mascheroni, ed., *Innovation: Technology Transfer 2005–2006 Progress Report* (Los Alamos National Laboratory report LALP-07-038, 2007).

315 Marjorie Mascheroni, ed., *Innovation: Technology Transfer 2005–2006 Progress Report* (Los Alamos National Laboratory report LALP-07-038, 2007).

316 Siegfried Hecker, "Los Alamos: Beginning the Second Fifty Years," *Los Alamos Science* 21 (1993).

317 Siegfried Hecker, "Los Alamos: Beginning the Second Fifty Years," *Los Alamos Science* 21 (1993).

318 Siegfried Hecker, "Los Alamos: Beginning the Second Fifty Years," *Los Alamos Science* 21 (1993).

319 Marjorie Mascheroni, ed., *Innovation: Technology Transfer 2005–2006 Progress Report* (Los Alamos National Laboratory report LALP-07-038, 2007).

320 Marjorie Mascheroni, ed., *Innovation: Technology Transfer 2005–2006 Progress Report* (Los Alamos National Laboratory report LALP-07-038, 2007).

321 Steve Girrens, Duncan McBranch, Mig Owens, Tatjana Rosev, Jeff Berger, John Russell, Steve Stringer, Belinda Padilla, John Mott, David Holmes, Shandra Clow, and Marjorie Mascheron, *Technology Transfer Progress Report 2007–2008* (Los Alamos National Laboratory report LALP-09-020, February 2009.

322 Steve Girrens, Duncan McBranch, Mig Owens, Tatjana Rosev, Jeff Berger, John Russell, Steve Stringer, Belinda Padilla, John Mott, David Holmes, Shandra Clow, and Marjorie Mascheron, *Technology Transfer Progress Report*

2007–2008 (Los Alamos National Laboratory report LALP-09-020, February 2009.

323 David Moore, ed., “Novel Approach Leads to Potential HIV-1 Vaccine,” Los Alamos National Laboratory, March 1, 2018, https://www.lanl.gov/discover/publications/connections/2018/2018-03/science.php.

324 Alice Buck, *A History of the Energy Research and Development Administration* (Washington D.C.: U.S. Department of Energy, Office of History and Heritage Resources, 1982), 9.

325 Ellen D. McGehee, , Kari L. M. Garcia, Judy Machen, Sheila McCarthy, Erik Loomis, Naomi Naranjo, Kristen Honig, Ken Towery, and John Ronquillo, *Pillars of the Cold War: Historic Administration and Support Buildings, Los Alamos, New Mexico; Historic Building Documentation for the Department of Energy Land Conveyance and Transfer Project* (Los Alamos National Laboratory report LA-UR-10-03659, 2010), 17.

326 Ellen D. McGehee, Kari L. M. Garcia, Judy Machen, Sheila McCarthy, Erik Loomis, Naomi Naranjo, Kristen Honig, Ken Towery, and John Ronquillo, *Pillars of the Cold War: Historic Administration and Support Buildings, Los Alamos, New Mexico; Historic Building Documentation for the Department of Energy Land Conveyance and Transfer Project* (Los Alamos National Laboratory report LA-UR-10-03659, 2010), 17.

327 Ellen D. McGehee, , Kari L. M. Garcia, Judy Machen, Sheila McCarthy, Erik Loomis, Naomi Naranjo, Kristen Honig, Ken Towery, and John Ronquillo, *Pillars of the Cold War: Historic Administration and Support Buildings, Los Alamos, New Mexico; Historic Building Documentation for the Department of Energy Land Conveyance and Transfer Project* (Los Alamos National Laboratory report LA-UR-10-03659, 2010), 22.

328 Ellen D. McGehee, , Kari L. M. Garcia, Judy Machen, Sheila McCarthy, Erik Loomis, Naomi Naranjo, Kristen Honig, Ken Towery, and John Ronquillo, *Pillars of the Cold War: Historic Administration and Support Buildings, Los Alamos, New Mexico; Historic Building Documentation for the Department of Energy Land Conveyance and Transfer Project* (Los Alamos National Laboratory report LA-UR-10-03659, 2010), 22.

329 Michael Pierre Bernardin and Alan Brady Carr, *History of the Los Alamos National Security Research Center Collections* (Los Alamos National Laboratory report LA-UR-20-30312, 2020).

330 Bethann McVicker of the LANL GIS Program created this map (22-038-01_2004) using the best data available.

331 Hans A. Bethe, “What is the Future of Los Alamos?” *Los Alamos Science* 21 (1993).

332 Siegfried S. Hecker, “Is There Life for Los Alamos 50 Years after Trinity?” *The Washington Roundtable on Science and Public Policy* (Washington, D.C.: George C. Marshall Institute, 1995).

333 Siegfried S. Hecker, "Is There Life for Los Alamos 50 Years after Trinity?" *The Washington Roundtable on Science and Public Policy* (Washington, D.C.: George C. Marshall Institute, 1995).

334 Judy Machen, Kari L. M. Garcia, and Ellen D. McGehee, *SM-43, Nerve Center of a National Laboratory: A History of the Los Alamos Administration Building (1956–2006), Vol. 1* (Los Alamos National Laboratory report LA-UR-11-00922, 2010).

335 Siegfried S. Hecker, "Is There Life for Los Alamos 50 Years after Trinity?" *The Washington Roundtable on Science and Public Policy* (Washington, D.C.: George C. Marshall Institute, 1995).

336 Raymond J. Juzaitis, "Science-Based Stockpile Stewardship An overview," *Los Alamos Science* 23 (2003).

337 Judy Machen, Kari L. M. Garcia, and Ellen D. McGehee, *SM-43, Nerve Center of a National Laboratory: A History of the Los Alamos Administration Building (1956–2006), Vol. 1* (Los Alamos National Laboratory report LA-UR-11-00922, 2010).

338 Mark L. Allen, *LANS Benefits LANL, NNSA, and National Security: Six-Year History of Accomplishment from June 2006 to June 2012* (Los Alamos National Laboratory report LA-UR-12-01692, 2012).

339 Whitney Spivey, "A Day at DARHT," *National Security Science*, October 1, 2018, https://www.lanl.gov/discover/publications/national-security-science/2018-October/DARHT.php.

340 Philip R. Fresquez, Harvey T. Haagenstad, and Louis Naranjo, *Baseline Concentrations of Radionuclides and Heavy Metals in Soils and Vegetations around the DARHT Facility: Construction Phase (1996)* (Los Alamos National Laboratory report LA-UR-13273, 1997).

341 Edward B. Jacquez, *The Dual Axis Radiographic Hydrodynamic (DARHT) Facility Personnel Control System* (Los Alamos National Laboratory report LA-UR-08-6022, 2008).

342 Judy Machen, Kari L. M. Garcia, and Ellen D. McGehee, *SM-43, Nerve Center of a National Laboratory: A History of the Los Alamos Administration Building (1956–2006), Vol. 1* (Los Alamos National Laboratory report LA-UR-11-00922, 2010).

343 Phillip D. Goldstone, "LANSCE and the Nuclear Weapons Program," *Los Alamos Science* 30 (2006).

344 Judy Machen, Kari L. M. Garcia, and Ellen D. McGehee, *SM-43, Nerve Center of a National Laboratory: A History of the Los Alamos Administration Building (1956–2006), Vol. 1* (Los Alamos National Laboratory report LA-UR-11-00922, 2010).

345 Los Alamos National Laboratory, "SCC The Strategic Computing Complex, 2012," https://www.lanl.gov/about/_ assets/docs/scc.pdf.

346 Los Alamos National Laboratory, "SCC The Strategic Computing Complex, 2012," https://www.lanl.gov/about/_ assets/docs/scc.pdf.

347 U.S. Department of Energy, National Nuclear Security Administration, "NNSA's High-Performance Computing Achievements," https://www.energy.gov/nnsa/nnsas-high-performance-computing-achievements.

348 Larry L. Deaven and Robert K. Moyzis, "The Los Alamos Center for Human Genome Studies," *Los Alamos Science* 20 (1992).

349 Louis Rosen, "LAMPF: A Dream and a Gamble," *Los Alamos Science* 7 (1983).

350 Kurt F. Schoenberg and Paul W. Lisowski, "LANSCE, a Key Facility for National Science and Defense," *Los Alamos Science* 30 (2006).

351 Amy M. Longshore, *History of the Los Alamos Neutron Science Center* (Los Alamos National Laboratory report LALP-95-0218, 1995).

352 Michael R. Furlanetto, "The Los Alamos Neutron Science Center (LANSCE): Status and Plans" (presentation, LANSCE User Group Meeting, Los Alamos, NM, November 10, 2021, LA-UR-21-31238).

353 Amy M. Longshore, *History of the Los Alamos Neutron Science Center* (Los Alamos National Laboratory report LALP-95-0218, 1995).

354 Martin D. Cooper and W. Scott Wilburn, "Overview of Fundamental Physics at LANSCE," *Los Alamos Science* 30 (2006).

355 Judy Machen, Kari L. M. Garcia, and Ellen D. McGehee, *SM-43, Nerve Center of a National Laboratory: A History of the Los Alamos Administration Building (1956–2006), Vol. 1* (Los Alamos National Laboratory report LA-UR-11-00922, 2010).

356 Ludgard A. Emelity, *Waste Management at Los Alamos: Protecting Our Environment* (Los Alamos National Laboratory report LALP-90-30, 1990).

357 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: U.S. Department of Energy, History Division, 1994).

358 Margaret Anne Rogers, *History and Environmental Setting of LASL Near-Surface Land Disposal for Radioactive Wastes* (Los Alamos Scientific Laboratory report LA-UR-06848, 1997).

359 Los Alamos Scientific Laboratory, "Area C," https://hwbdocuments.env.nm.gov/Los%20Alamos%20National%20Labs/TA%2050/8241.pdf.

360 Margaret Anne Rogers, *History and Environmental Setting of LASL Near-Surface Land Disposal for Radioactive Wastes* (Los Alamos Scientific Laboratory report LA-UR-06848, 1997).

361 N3B, *Solid Waste Management Unit Assessment Work Plan for Middle DP Road Site, Revision 1, Report no. EM2021-0095* (Los Alamos, NM: N3B, 2021), also available electronically, https://n3b-la.b-cdn.net/wp-content/uploads/2021/04/MDPR_WP_R1_032521.pdf.

362 N3B, *Solid Waste Management Unit Assessment Work Plan for Middle DP Road Site, Revision 1, Report no. EM2021-0095* (Los Alamos, NM: N3B, 2021), also available electronically, https://n3b-la.b-cdn.net/wp-content/uploads/2021/04/MDPR_WP_R1_032521.pdf.

363 Richard Reed, David J. Lemak, and W. Andrew Hesser, "Cleaning up after the Cold War: Management and Social Issues, *The Academy of Management Review* 22, no. 3 (1997).

364 Richard Reed, David J. Lemak, and W. Andrew Hesser, "Cleaning up after the Cold War: Management and Social Issues," *The Academy of Management Review* 22, no. 3 (1997).

365 Douglas James Weaver, "Waste Isolation Pilot Plant Overview" (presentation on WIPP overview for Yasuhiro Nakai technical visit, March 30, 2017, LA-UR-17-22495).

366 Douglas James Weaver, "Waste Isolation Pilot Plant Overview" (presentation on WIPP overview for Yasuhiro Nakai technical visit, March 30, 2017, LA-UR-17-22495).

367 Tammy Ann Lopez, *Waste Isolation Pilot Plant (WIPP): The Nation's Solution to Nuclear Storage and Disposal Issues* (Los Alamos National Laboratory report LA-UR-14-25415, 2017).

368 Douglas James Weaver, "Waste Isolation Pilot Plant Overview" (presentation on WIPP overview for Yasuhiro Nakai technical visit, March 30, 2017, LA-UR-17-22495).

369 Douglas James Weaver, "Waste Isolation Pilot Plant Overview" (presentation on WIPP overview for Yasuhiro Nakai technical visit, March 30, 2017, LA-UR-17-22495).

370 Rebecca Moss, "With Limited Room at WIPP, Feds Urged to Study Expansion," *New Mexican*, September 6, 2017, https://apnews.com/article/863cb3d2463c43cbb867120dc2468e13.

371 Douglas James Weaver, "Waste Isolation Pilot Plant Overview" (presentation on WIPP overview for Yasuhiro Nakai technical visit, March 30, 2017, LA-UR-17-22495).

372 U.S. Department of Energy, Waste Isolation Pilot Plant, "History/Timeline," Nuclear Waste Partnership, LLC, https://wipp.energy.gov/historytimeline.asp#1504107780103-88fe7afa-0531.

373 U.S. Department of Energy, Waste Isolation Pilot Plant, "First Shipment of Transuranic Radioactive Waste Arrives at WIPP," https://www.wipp.energy.gov/pr/1999nr.htm#Worlds_First_Begins_Operations.

374 U.S. Department of Energy, Waste Isolation Pilot Plant, "First Shipment of Transuranic Radioactive Waste Arrives at WIPP," https://www.wipp.energy.gov/pr/1999nr.htm#Worlds_First_Begins_Operations.

375 U.S. Department of Energy, Office of Environmental Management, “Waste Isolation Pilot Plant Receives Milestone 13,000th Shipment,” https://www.energy.gov/em/articles/waste-isolation-pilot-plant-receives-milestone-13000th-shipment.

376 David Kramer, “What Went Wrong with the Los Alamos Contract?” *Physics Today* 69, no. 3 (2016): 22.

377 David Kramer, “What Went Wrong with the Los Alamos Contract?” *Physics Today* 69, no. 3 (2016): 22.

378 U.S. Department of Energy, Waste Isolation Pilot Plant, “Recovery/Restart,” Nuclear Waste Partnership, LLC, https://wipp.energy.gov/recoveryrestart.asp; Ralph Vartabedian, “Nuclear Accident in New Mexico Ranks among the Costliest in U.S. History,” *Los Angeles Times*, August 22, 2016, https://www.latimes.com/nation/la-na-new-mexico-nuclear-dump-20160819-snap-story.html.

379 U.S. Department of Energy Office of Environmental Management, *Accident Investigation Report Phase 2: Radiological Release Event at the Waste Isolation Pilot Plant, February 14, 2014* (Washington, D.C.: U.S. Department of Energy Office of Environmental Management, 2015), ES.6–ES.7.

380 Sharon Ann Walker, “The Los Alamos National Laboratory Nitrate (LANL) Salt Event: Causes and Cures” (presentation, TA-V Brown Bag Session, Albuquerque, NM, September 19, 2017, Los Alamos National Laboratory report LA-UR-17-28468), 21.

381 Richard Reed, David J. Lemak, and W. Andrew Hesser, “Cleaning up after the Cold War: Management and Social Issues, *The Academy of Management Review* 22, no. 3 (1997): 619.

382 Meredith Coonley, ed., “A Great Laboratory Comes Back,” *Dateline Los Alamos*, Summer Issue (2000).

383 Patricia Jones, “MDAs and the Threat of Wildfire” (fact sheet, LA-UR-13-25837, 2013).

384 Sonja Louise Salzman, “A Curtain of Air Assists with Cerro Grande Rehabilitation Project,” (article, Los Alamos National Laboratory report LA-UR-03-00062, 2003).

385 National Interagency Fire Center, *Cerro Grande Prescribed Fire Investigation Report: May 4–8, 2000* (Boise, ID: National Interagency Fire Center, 2000).

386 U.S. Department of Energy, Office of NEPA Policy and Compliance, “Summary: Proposed Future Disposition of Certain Cerro Grande Fire Flood and Sediment Retention Structures at Los Alamos National Laboratory, Los Alamos, New Mexico,” https://www.energy.gov/nepa/doeea-1408-proposed-future-disposition-certain-cerro-grande-fire-flood-and-sediment-retention.

387 Meredith Coonley, ed., “A Great Laboratory Comes Back,” *Dateline Los Alamos*, Summer Issue (2000).

388 Meredith Coonley, ed., “A Great Laboratory Comes Back,” *Dateline Los Alamos*, Summer Issue (2000).

389 Meredith Coonley, ed., "A Great Laboratory Comes Back," *Dateline Los Alamos*, Summer Issue (2000).

390 M. Diana Webb and Kelly Carpenter, *The Cerro Grande Fire, Los Alamos, New Mexico* (Los Alamos National Laboratory report LA-UR-01-1630, 2001).

391 M. Diana Webb and Kelly Carpenter, *The Cerro Grande Fire, Los Alamos, New Mexico* (Los Alamos National Laboratory report LA-UR-01-1630, 2001).

392 Kevin J. Buckley, Jeffrey C. Walterscheid, Samuel R. Loftin, and Gregory A. Kuyumjian, *Final Progress Report on Los Alamos National Laboratory Cerro Grande Fire Rehabilitation Activities* (Los Alamos National Laboratory report LA-UR-03-07139, 2003).

393 Ecology Group, *Wildfire Hazard Reduction Project Plan* (Los Alamos National Laboratory report LA-UR-01-02017, 2001).

394 Ecology Group, *Wildfire Hazard Reduction Project Plan* (Los Alamos National Laboratory report LA-UR-01-02017, 2001).

395 Craig Eberhart, *Measurements of Air Contaminants during the Cerro Grande Fire at Los Alamos National Laboratory* (Los Alamos National Laboratory report LA-UR-14250, 2010).

396 Teresa Hiteman, *A Wildfire Behavior Modeling System at Los Alamos National Laboratory for Operational Applications* (Los Alamos National Laboratory report LA-UR-14017, 2004).

397 U.S. Department of Energy, National Nuclear Security Administration, *Environmental Assessment for the Proposed Construction and Operation of a New Interagency Emergency Operations Center at Los Alamos National Laboratory, Los Alamos, New Mexico, Report DOE/EA-1376* (Los Alamos, NM: U.S. Department of Energy, National Nuclear Security Administration, Los Alamos Area Office, 2001).

398 U.S. Department of Energy, National Nuclear Security Administration, *Environmental Assessment for the Proposed Construction and Operation of a New Interagency Emergency Operations Center at Los Alamos National Laboratory, Los Alamos, New Mexico, Report DOE/EA-1376* (Los Alamos, NM: U.S. Department of Energy, National Nuclear Security Administration, Los Alamos Area Office, 2001).

399 Los Alamos National Laboratory, "Cerro Pelado Fire (May 8) Update," Los Alamos National Laboratory, May 8, 2022, https://discover.lanl.gov/news/0508-cerro-pelado-2.

400 National Wildfire Coordinating Group, "InciWeb Incident information System: Cerro Pelado," https://inciweb.nwcg.gov/incident/8075/.

401 Alex Barry Malin, "Cyber History in the DOE—The 414s" (presentation, Cyber Fire, San Diego, CA, November 16, 2017, Los Alamos National Laboratory report LA-UR-30371), 3.

402 Alex Barry Malin, "Cyber History in the DOE—The 414s" (presentation, Cyber Fire, San Diego, CA, November 16, 2017, Los Alamos National Laboratory report LA-UR-30371), 3.

403 Alex Barry Malin, "Cyber History in the DOE—The 414s" (presentation, Cyber Fire, San Diego, CA, November 16, 2017, Los Alamos National Laboratory report LA-UR-30371), 3.

404 Alex Barry Malin, "Cyber History in the DOE—The 414s" (presentation, Cyber Fire, San Diego, CA, November 16, 2017, Los Alamos National Laboratory report LA-UR-30371), 5.

405 Alex Barry Malin, "Cyber History in the DOE—The 414s" (presentation, Cyber Fire, San Diego, CA, November 16, 2017, Los Alamos National Laboratory report LA-UR-30371), 45.

406 Robert de Vore, "The Man Who Made Manhattan," *Colliers*, October 1945.

407 James Risen and Jeff Gerth, "BREACH AT LOS ALAMOS: A Special Report; China Stole Nuclear Secrets for Bombs, U.S. Aides Say," *New York Times*, March 6, 1999, https://www.nytimes.com/1999/03/06/world/breach-los-alamos-special-report-china-stole-nuclear-secrets-for-bombs-us-aides.html.

408 Los Alamos National Laboratory, "Spies, Lies, & Portable Tapes: The Wen Ho Lee Case," https://int.lanl.gov/org/dir/ office-counterintelligence/counterintelligence-program/spy-of-the-month/_assets/docs/WenHoLee.pdf.

409 Los Alamos National Laboratory, *LANL Nine-Point Plan*, April 1999.

410 Meredith Brown, *Security Improvement Initiatives Safeguards and Security Best Practices* (Los Alamos National Laboratory report LALP-02-221, 2002).

411 Meredith Brown, *Security Improvement Initiatives Safeguards and Security Best Practices* (Los Alamos National Laboratory report LALP-02-221, 2002).

412 James Risen, "Missing Nuclear Data Found behind a Los Alamos Copier," *New York Times*, June 17, 2000, https://www.nytimes.com/2000/06/17/us/missing-nuclear-data-found-behind-a-los-alamos-copier.html.

413 Leslie Hoffman, "N.M. Lab Director Resigns amid Gov't Probe," *National Intelligencer*, January 2003, https://www.theintelligencer.com/news/article/N-M-Lab-Director-Resigns-Amid-Gov-t-Probe-10558512.php.

414 Alex Barry Malin, "Cyber History in the DOE—The 414s" (presentation, Cyber Fire, San Diego, CA, November 16, 2017, Los Alamos National Laboratory report LA-UR-17-30371, 2017).

415 Alex Barry Malin, "Cyber History in the DOE—The 414s" (presentation, Cyber Fire, San Diego, CA, November 16, 2017, Los Alamos National Laboratory report LA-UR-17-30371, 2017), 20.

416 Alex Barry Malin, "Cyber History in the DOE—The 414s" (presentation, Cyber Fire, San Diego, CA, November 16, 2017, Los Alamos National Laboratory report LA-UR-17-30371, 2017), 2.

417 Alex Barry Malin, "Cyber History in the DOE—The 414s" (presentation, Cyber Fire, San Diego, CA, November 16, 2017, Los Alamos National Laboratory report LA-UR-17-30371, 2017), 17.

418 John C. Browne, Tri-Lab Information Security Plan, Los Alamos National Laboratory Office of the Director memorandum, May 1999.

419 John C. Browne, Tri-Lab Information Security Plan, Los Alamos National Laboratory Office of the Director memorandum, May 1999.

420 Meredith Brown, *Security Improvement Initiatives Safeguards and Security Best Practices* (Los Alamos National Laboratory report LALP-02-221, 2002).

421 Judy Machen, Kari L. M. Garcia, and Ellen D. McGehee, *SM-43, Nerve Center of a National Laboratory: A History of the Los Alamos Administration Building (1956–2006), Vol. 1* (Los Alamos National Laboratory report LA-UR-11-00922, 2010).

422 Judy Machen, Kari L. M. Garcia, and Ellen D. McGehee, *SM-43, Nerve Center of a National Laboratory: A History of the Los Alamos Administration Building (1956–2006), Vol. 1* (Los Alamos National Laboratory report LA-UR-11-00922, 2010).

423 Hugh Gusterson, "The Assault on Los Alamos National Laboratory: A Drama in Three Acts," *Bulletin of the Atomic Scientists* 67, no. 6 (2011).

424 Washington Post, "Energy Dept. Shelves Removable Disks," https://webcache.googleusercontent.com/search?q=cache:lYlzb4NJG30J:https://www.washingtonpost.com/archive/politics/2004/07/24/energy-dept-shelves-removable-disks/3e04b066-593e-411c-b802-976f61cd7380/+&cd=19&hl=en&ct=clnk&gl=us&client=firefox-b-1-e.

425 Hugh Gusterson, "The Assault on Los Alamos National Laboratory: A Drama in Three Acts," *Bulletin of the Atomic Scientists* 67, no. 6 (2011).

426 Hugh Gusterson, "The Assault on Los Alamos National Laboratory: A Drama in Three Acts," *Bulletin of the Atomic Scientists* 67, no. 6 (2011): 13.

427 David Malakoff, "Security, Safety Probes Shut down Los Alamos National Lab," *Science*, July 2004, https://www.science.org/doi/10.1126/science.305.5683.462a.

428 Frederick A. Tarantino, Dennis Derkacs, R. Ronald Geoffrion, Rita Henins, Matt Hardy, Thomas P. Turner, John Milewski, Gary Lewis, Connon Odom, *LANL Investigation of a Laser Eye Injury* (Los Alamos National Laboratory report, LA-UR-04-06229, 2004).

429 David Malakoff, "Security, Safety Probes Shut down Los Alamos National Lab," *Science*, July 2004, https://www.science.org/doi/10.1126/science.305.5683.462a.

430 Hugh Gusterson, "The Assault on Los Alamos National Laboratory: A Drama in Three Acts," *Bulletin of the Atomic Scientists* 67, no. 6 (2011): 13.

431 Hugh Gusterson, "The Assault on Los Alamos National Laboratory: A Drama in Three Acts," *Bulletin of the Atomic Scientists* 67, no. 6 (2011): 13.

432 U.S. Government Accountability Office, *Stand-down of Los Alamos National Laboratory* (Washington, D.C.: U.S. Government Accountability Office, 2005).

433 Albuquerque Journal, "Updated: Univ. of Calif. Fined $3 million Over LANL Problems," https://www.abqjournal.com/2000/updated-univ-of-calif-fined-3-million-over-lanl-problems.html.

434 Hugh Gusterson, "The Assault on Los Alamos National Laboratory: A Drama in Three Acts," *Bulletin of the Atomic Scientists* 67, no. 6 (2011): 11.

435 Hugh Gusterson, "The Assault on Los Alamos National Laboratory: A Drama in Three Acts," *Bulletin of the Atomic Scientists* 67, no. 6 (2011): 12.

436 Bruce G. Twining (Department of Energy, Albuquerque Operations Office) to Siegfried Hecker (Los Alamos National Laboratory), memo, 2 December 1996 (Los Alamos National Laboratory report LA-UR-98-2837).

437 Philip Thullen, J. Lee McAtee, Steven J. Greene, Carl A. Ostenak, Hillard H. Howard, Joel Williams, C. Michael Montoya, and Lisa M. Woodrow, I*ntegrated Safety Management* (Los Alamos National Laboratory report LA-UR-98-2837, 1998).

438 David Copeland, *Integrated Safeguards and Security Management* (Los Alamos National Laboratory report LA-UR-08-00526, 2008).

439 Bethann McVicker of the LANL GIS Program created this map (22-038-01_2022) using the best data available.

440 House Subcommittee on Oversight and Investigations of the Committee on Energy and Commerce, *Investigation of Management Problems at Los Alamos National Laboratory:* 108th Cong., 1st sess., 2003; Secretary of Energy, Notice, "Decision To Compete Management and Operating Contracts for Los Alamos National Laboratory, Ames National Laboratory, Lawrence Berkeley National Laboratory, Argonne National Laboratory, and Lawrence Livermore National Laboratory," *Federal Register* 04-1655 (January 27, 2004): 3904, also available electronically, https://www.federalregister.gov/documents/2004/01/27/04-1655/decision-to-compete-management-and-operating-contracts-for-los-alamos-national-laboratory-ames.

441 Secretary of Energy, Notice, "Decision To Compete Management and Operating Contracts for Los Alamos National Laboratory, Ames National Laboratory, Lawrence Berkeley National Laboratory, Argonne National Laboratory, and Lawrence Livermore National Laboratory," *Federal Register* 04-1655 (January 27, 2004): 3904, also available electronically, https://www.federalregister.gov/documents/2004/01/27/04-1655/decision-to-compete-management-and-operating-contracts-for-los-alamos-national-laboratory-ames.

442 Ike Richardson, "Los Alamos National Laboratory Prime Contract Brief" (briefing to United Kingdom Visitors, Los Alamos, NM, June 7, 2011, Los Alamos National Laboratory report LA-UR-11-03169), 2.

443 Alan Chodos, ed., "DOE Picks University of California to Head Los Alamos Management Team," *American Physical Society* 15, no. 2 (February 2006), https://www.aps.org/publications/apsnews/200602/lanl.cfm; Mark L. Allen, *LANS Benefits LANL, NNSA, and National Security: Six-Year History of Accomplishment from June 2006 to June 2012* (Los Alamos National Laboratory report LA-UR-12-01692, 2012), 1.

444 Ike Richardson, "Los Alamos National Laboratory Prime Contract Brief" (briefing to United Kingdom Visitors, Los Alamos, NM, June 7, 2011, Los Alamos National Laboratory report LA-UR-11-03169), 2.

445 Ike Richardson, "Los Alamos National Laboratory Prime Contract Brief" (briefing to United Kingdom Visitors, Los Alamos, NM, June 7, 2011, Los Alamos National Laboratory report LA-UR-11-03169), 4.

446 Ike Richardson, "Los Alamos National Laboratory Prime Contract Brief" (briefing to United Kingdom Visitors, Los Alamos, NM, June 7, 2011, Los Alamos National Laboratory report LA-UR-11-03169), 2–5.

447 Mark L. Allen, *LANS Benefits LANL, NNSA, and National Security: Six-Year History of Accomplishment from June 2006 to June 2012* (Los Alamos National Laboratory report LA-UR-12-01692, 2012).

448 David Kramer, "What Went Wrong with the Los Alamos Contract?" *Physics Today* 69, no. 3 (2016): 22.

449 Frances Chadwick, "Contract Transition at LANL" (presentation, JOWOG-30 Oversight Board Meeting, Reading, United Kingdom, May 7–9, 2019, Los Alamos National Laboratory report LA-UR-19-23830), 3.

450 David Kramer, "What Went Wrong with the Los Alamos Contract?" *Physics Today* 69, no. 3 (2016): 23.

451 Robert Kuckuck, quoted in David Kramer, "What Went Wrong with the Los Alamos Contract?" *Physics Today* 69, no. 3 (2016): 23.

452 Frances Chadwick, "Contract Transition at LANL" (presentation, JOWOG-30 Oversight Board Meeting, Reading, United Kingdom, May 7–9, 2019, Los Alamos National Laboratory report LA-UR-19-23830), 8.

453 Frances Chadwick, "Contract Transition at LANL" (presentation, JOWOG-30 Oversight Board Meeting, Reading, United Kingdom, May 7–9, 2019, Los Alamos National Laboratory report LA-UR-19-23830).

454 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021).

455 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021), 5; Kelly J. Beierschmitt, Thomas Edward Mason, Frances Chadwick, Robert Blair

Webster, and John Louis Sarrao, *Lab Agenda January 2022 Update* (Los Alamos National Laboratory report LA-UR-22-20658, 2022).

456 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021), 5.

457 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021) 6, 33.

458 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021) 6.

459 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021) 7–8, 27–28.

460 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021) 8, 17, 24, 29.

461 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021), 8, 14–15.

462 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021), 6, 10.

463 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021), 13; Los Alamos National Laboratory, "Nominations Open for New Operations Excellence Medal," *LANLInside*, June 10, 2021, https://int.lanl.gov/news/news_stories/2021/june/0609-operations-excellence-medal.shtml.

464 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021), 15.

465 William H. Jones, *Ten-year Site Plan FY2012–2021* (Los Alamos National Laboratory report LA-UR-11-03036, 2011), 3.

466 Kristen A. Honig, *Ten Year Site Plan Limited Update: FY 2015* (Los Alamos National Laboratory report LA-UR-14-22957, 2014), 3.

467 Office of Management and Budget, *Management Procedures Memorandum No. 2013-02*, implementation of OMB Memorandum M-12-12 Section 3: Freeze the Footprint, March 14, 2013, 1.

468 Kristen A. Honig, *Ten Year Site Plan Limited Update: FY 2015* (Los Alamos National Laboratory report LA-UR-14-22957, 2014), 2.

469 Kristen A. Honig, *Ten Year Site Plan Limited Update: FY 2015* (Los Alamos National Laboratory report LA-UR-14-22957, 2014), 3.

470 Office of Management and Budget, *Management Procedures Memorandum No. 2013-02*, implementation

of OMB Memorandum M-12-12 Section 3: Reduce the Footprint, March 25, 2015, 1.

471 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021), 24.

472 Thomas Edward Mason, "Director's Foreword," quoted in Rae A. Tate, Harvey Todd Haagenstad, and Michael Arens Bodelson, *2021 Campus Master Plan* (Los Alamos National Laboratory report LA-UR-CP-21-20800, 2021), 1.1.

473 Thomas Edward Mason, "Director's Foreword," quoted in Rae A. Tate, Harvey Todd Haagenstad, and Michael Arens Bodelson, *2021 Campus Master Plan* (Los Alamos National Laboratory report LA-UR-CP-21-20800, 2021), 1.1.

474 Los Alamos National Laboratory, "Changing How We Do Business: Year One Review of the HR Transformation," *LANLInside*, April 26, 2021, https://int.lanl.gov/news/news_stories/2021/april/0426-hr-transformation-update.shtml.

475 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: Department of Energy, History Division, 1994), 3–4.

476 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: Department of Energy, History Division, 1994), 7.

477 F. G. Gosling and Terrence R. Fehner, *Closing the Circle: The Department of Energy and Environmental Management, 1942–1994* (Washington, D.C.: Department of Energy, History Division, 1994), 7.

478 Ludgard A. Emelity, *Waste Management at Los Alamos: Protecting Our Environment* (Los Alamos National Laboratory report LALP-90-30, 1990), 3.

479 Ludgard A. Emelity, *A History of Radioactive Liquid Waste Management at Los Alamos* (Los Alamos National Laboratory report LA-UR-96-01283, 1996), 19, 22–23.

480 Sandra E. Wagner, *RFI Work Plan for Operable Unit 1079* (Los Alamos National Laboratory report LA-UR-92-00850, 1992), 1.1; Alison M. Dorries, Ronald C. Conrad, and Linda Nonno, *RCRA Facility Investigation for the Townsite of Los Alamos, New Mexico* (Los Alamos National Laboratory report LA-UR-91-4069, 1991).

481 Oakes, Maureen, *Laboratory in a Changing World: A Los Alamos Chronology* (Los Alamos National Laboratory report LALP-01-065, 2001).

482 Martin Alexander Baker, "Waste Compliance and Tracking System: A Comprehensive Solution for Managing Waste" (presentation, Los Alamos National Laboratory report LA-UR-19-24573, 2019).

483 David Kramer, "What Went Wrong with the Los Alamos Contract?" *Physics Today* 69, no. 3 (2016): 22; Leo P. Duffy (Director, Office of Environmental Restoration

and Waste Management, Department of Energy) to Manager, Albuquerque Operations Office, Department of Energy), memorandum, 16 November 1989, also available electronically, https://www.energy.gov/sites/default/files/2019/09/f66/Establishment-of-the-Office-of-Environmental-Restoration-and-Waste-Management-Nov-16-1989.pdf.

484 Victoria A. George, "Environmental Management Legacy Cleanup Contract Transition" (presentation, EM Transition: EM-LA Kick-Off Meeting, Los Alamos, NM, January 25, 2018, Los Alamos National Laboratory report LA-UR-18-20527).

485 John C. Kelly, "LANL's Transition to a Single Waste Operations Program to Support the Waste Needs of the Laboratory" (Waste Management Symposia, Los Alamos, NM, February 23, 2021, Los Alamos National Laboratory report LA-UR-21-21194).

486 John C. Kelly, "LANL's Transition to a Single Waste Operations Program to Support the Waste Needs of the Laboratory" (Waste Management Symposia, Los Alamos, NM, February 23, 2021, Los Alamos National Laboratory report LA-UR-21-21194), 4.

487 Peter H. Carson, "LANL's Integrated Waste Management Strategy in Support of Pit Production" (Waste Management Symposia 2022, Phoenix, AZ, March 7, 2022, Los Alamos National Laboratory report LA-UR-22-21156), 9.

488 John C. Kelly, "LANL's Transition to a Single Waste Operations Program to Support the Waste Needs of the Laboratory" (Waste Management Symposia, Los Alamos, NM, February 23, 2021, Los Alamos National Laboratory report LA-UR-21-21194), 7.

489 Debora Lynn Hall and Rebecca Lyn Schwarzkopf, "32461_EMS_R2.1" (training course, Los Alamos National Laboratory report LA-UR-22-22164, 2022).

490 Michael McNaughton (environmental health physicist, Los Alamos National Laboratory), in discussion with the author, December 3, 2020.

491 Los Alamos National Laboratory, "Los Alamos Waste Shipment Successfully Completed at WIPP," *LANLInside*, April 15, 2019, https://int.lanl.gov/news/news_stories/2019/april/0415-wipp.shtml.

492 Thomas Edward Mason, quoted in "Los Alamos Waste Shipment Successfully Completed at WIPP," *LANLInside*, April 15, 2019, https://int.lanl.gov/news/news_stories/2019/april/0415-wipp.shtml.

493 Kelly Beierschmitt, quoted in "Los Alamos Waste Shipment Successfully Completed at WIPP," *LANLInside*, April 15, 2019, https://int.lanl.gov/news/news_stories/2019/april/0415-wipp.shtml.

494 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021) 37.

495 Los Alamos National Laboratory, "An Abbreviated Guide to Pit Production," *LANLInside*, March 8, 2022, https://int.lanl.gov/news/news_stories/2022/march/0308-mission-focus-pits.shtml; Douglas D. Kautz, David B. Mann, Richard G. Castro, Lawrence E. Lucero, and Steven M. Dinehart, "The Pit Production Story," *Los Alamos Science* 28 (2003): 58.

496 David E. Eyler, Frank E. Gibbs, and David Edward Dooley, "Weapons Production (ALDWP) Overview Nuclear Fundamentals Orientation" (presentation, Fuller Lodge Hiring Event, Los Alamos, NM, March 5, 2020, Los Alamos National Laboratory report LA-UR-20-22121), 15; Douglas D. Kautz, David B. Mann, Richard G. Castro, Lawrence E. Lucero, and Steven M. Dinehart, "The Pit Production Story," *Los Alamos Science* 28 (2003): 58; Los Alamos National Laboratory, "An Abbreviated Guide to Pit Production," *LANLInside*, March 8, 2022, https://int.lanl.gov/news/news_stories/2022/march/0308-mission-focus-pits.shtml.

497 Los Alamos National Laboratory, "An Abbreviated Guide to Pit Production," *LANLInside*, March 8, 2022, https://int.lanl.gov/news/news_stories/2022/march/0308-mission-focus-pits.shtml.

498 David E. Eyler, Frank E. Gibbs, and David Edward Dooley, "Weapons Production (ALDWP) Overview Nuclear Fundamentals Orientation" (presentation, Fuller Lodge Hiring Event, Los Alamos, NM, March 5, 2020, Los Alamos National Laboratory report LA-UR-20-22121), 13.

499 David E. Eyler, Frank E. Gibbs, and David Edward Dooley, "Weapons Production (ALDWP) Overview Nuclear Fundamentals Orientation" (presentation, Fuller Lodge Hiring Event, Los Alamos, NM, March 5, 2020, Los Alamos National Laboratory report LA-UR-20-22121), 10.

500 David E. Eyler, Frank E. Gibbs, and David Edward Dooley, "Weapons Production (ALDWP) Overview Nuclear Fundamentals Orientation" (presentation, Fuller Lodge Hiring Event, Los Alamos, NM, March 5, 2020, Los Alamos National Laboratory report LA-UR-20-22121), 7; Maureen Elizabeth Lunn and Kevin Neil Roark, "National Geographic Interview: Pit Manufacturing" (data for magazine publication, Los Alamos National Laboratory report LA-UR-20-28401, 2020).

501 Douglas D. Kautz, David B. Mann, Richard G. Castro, Lawrence E. Lucero, and Steven M. Dinehart, "The Pit Production Story," *Los Alamos Science* 28 (2003): 58; Maureen Elizabeth Lunn and Kevin Neil Roark, "National Geographic Interview: Pit Manufacturing" (data for magazine publication, Los Alamos National Laboratory report LA-UR-20-28401, 2020).

502 Maureen Elizabeth Lunn and Kevin Neil Roark, "National Geographic Interview: Pit Manufacturing" (data for magazine publication, Los Alamos National Laboratory report LA-UR-20-28401, 2020).

503 Herbert I. Miller and Ralph Carlisle Smith, *Memorandum on Los Alamos Operation: A Generalized Study of the*

Problem (Los Alamos Scientific Laboratory report LA-UR-00540-MS, 1947).

504 Maureen Elizabeth Lunn and Kevin Neil Roark, "National Geographic Interview: Pit Manufacturing" (data for magazine publication, Los Alamos National Laboratory report LA-UR-20-28401, 2020).

505 Douglas D. Kautz, David B. Mann, Richard G. Castro, Lawrence E. Lucero, and Steven M. Dinehart, "The Pit Production Story," *Los Alamos Science* 28 (2003): 58.

506 Maureen Elizabeth Lunn and Kevin Neil Roark, "National Geographic Interview: Pit Manufacturing" (data for magazine publication, Los Alamos National Laboratory report LA-UR-20-28401, 2020).

507 Douglas D. Kautz, David B. Mann, Richard G. Castro, Lawrence E. Lucero, and Steven M. Dinehart, "The Pit Production Story," *Los Alamos Science* 28 (2003).

508 Maureen Elizabeth Lunn and Kevin Neil Roark, "National Geographic Interview: Pit Manufacturing" (data for magazine publication, Los Alamos National Laboratory report LA-UR-20-28401, 2020).

509 Douglas D. Kautz, David B. Mann, Richard G. Castro, Lawrence E. Lucero, and Steven M. Dinehart, "The Pit Production Story," *Los Alamos Science* 28 (2003): 62.

510 Maureen Elizabeth Lunn and Kevin Neil Roark, "National Geographic Interview: Pit Manufacturing" (data for magazine publication, Los Alamos National Laboratory report LA-UR-20-28401, 2020).

511 Drew Kornreich, "The Strategic Path to 30 Pits per Year: How We Got Here, and Where We're Going" (presentation, Los Alamos National Laboratory report LA-UR-19-29999, 2019), 22–23.

512 U.S. Department of Energy, National Nuclear Security Administration, *Fiscal Year 2021 Stockpile Stewardship and Management Plan: Biennial Plan Summary; Report to Congress* (Washington, D.C.: U.S. Department of Energy, National Nuclear Security Administration, 2020), 3.4.

513 Los Alamos National Laboratory, "Milestone on Pit Production Project and Standing up the New Associate Laboratory Directorate for Plutonium Infrastructure," *LANLInside*, April 28, 2021, https://int.lanl.gov/news/news_stories/2021/april/0428-aldpi-announcement.shtml.

514 Los Alamos National Laboratory, "Pit Production Project Team Receives High Praise," *LANLInside*, February 17, 2022, https://int.lanl.gov/news/news_stories/2022/february/0217-pit-production-team.shtml.

515 Los Alamos National Laboratory, "An Abbreviated Guide to Pit Production," *LANLInside*, March 8, 2022, https://int.lanl.gov/news/news_stories/2022/march/0308-mission-focus-pits.shtml; Maureen Elizabeth Lunn and Kevin Neil Roark, "National Geographic Interview: Pit Manufacturing" (data for magazine publication, Los Alamos National Laboratory report LA-UR-20-28401, 2020).

516 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021).

517 Maureen Elizabeth Lunn and Kevin Neil Roark, "National Geographic Interview: Pit Manufacturing" (data for magazine publication, Los Alamos National Laboratory report LA-UR-20-28401, 2020).

518 Los Alamos National Laboratory, "Taking Care of Each Other: New Craft Worker Focus," *LANLInside*, February 24, 2022, https://int.lanl.gov/news/news_stories/2022/february/0224-craft-employees.shtml.

519 Los Alamos National Laboratory, "Taking Care of Each Other: New Craft Worker Focus," *LANLInside*, February 24, 2022, https://int.lanl.gov/news/news_stories/2022/february/0224-craft-employees.shtml.

520 World Health Organization, "Coronavirus Disease (COVID-19)," World Health Organization, https://www.who.int/health-topics/coronavirus.

521 Sara Elizabeth Pasqualoni and Dina Mary Siegel, "Industrial Hygiene and OEM: Optimizing Collaboration amidst the COVID-19 Pandemic" (presentation, AIHA ACOEM Webinar, Los Alamos National Laboratory report LA-UR-20-28695, 2020).

522 Sara Elizabeth Pasqualoni and Dina Mary Siegel, "Industrial Hygiene and OEM: Optimizing Collaboration amidst the COVID-19 Pandemic" (presentation, AIHA ACOEM Webinar, Los Alamos National Laboratory report LA-UR-20-28695, 2020); Governor of New Mexico, *Order Declaring a State of Public Health Emergency and Invoking the Powers Provided by the All Hazard Emergency Management Act and the Emergency Licensing Act. Executive Order 2020-0004.* Santa Fe, 2020.

523 Los Alamos National Laboratory, "Director's Memo: Telecommuting Is the Default; All Travel Restricted to Mission-Essential," *LANLInside*, March 16, 2020, https://int.lanl.gov/news/news_stories/2020/march/0316-directors-memo.shtml.

524 Sara Elizabeth Pasqualoni and Dina Mary Siegel, "Industrial Hygiene and OEM: Optimizing Collaboration amidst the COVID-19 Pandemic" (presentation, AIHA ACOEM Webinar, Los Alamos National Laboratory report LA-UR-20-28695, 2020).

525 Kelly Beierschmitt, "Solving National Security Challenges," (presentation, Triad Operations Committee Meeting, Los Alamos, NM, October 13–15, 2021, Los Alamos National Laboratory report LA-UR-21-29847), 30.

526 Los Alamos National Laboratory, *LANL Teleworking Initiative: Findings and Recommendations* (Los Alamos, NM: Los Alamos National Laboratory, 2021), 4.

527 Los Alamos National Laboratory, *LANL Teleworking Initiative: Findings and Recommendations* (Los Alamos, NM: Los Alamos National Laboratory, 2021), 26.

528 Los Alamos National Laboratory, *LANL Teleworking Initiative: Findings and Recommendations* (Los Alamos, NM: Los Alamos National Laboratory, 2021), 4–5.

529 Kelly Beierschmitt, "Solving National Security Challenges," (presentation, Triad Operations Committee Meeting, Los Alamos, NM, October 13–15, 2021, Los Alamos National Laboratory report LA-UR-21-29847), 30.

530 Los Alamos National Laboratory, *LANL Teleworking Initiative: Findings and Recommendations* (Los Alamos, NM: Los Alamos National Laboratory, 2021), 4.

531 Kelly Beierschmitt, "Solving National Security Challenges," (presentation, Triad Operations Committee Meeting, Los Alamos, NM, October 13–15, 2021, Los Alamos National Laboratory report LA-UR-21-29847), 30.

532 Sara Elizabeth Pasqualoni and Dina Mary Siegel, "Industrial Hygiene and OEM: Optimizing Collaboration amidst the COVID-19 Pandemic" (presentation, AIHA ACOEM Webinar, Los Alamos National Laboratory report LA-UR-20-28695, 2020).

533 Kelly Beierschmitt, "Solving National Security Challenges," (presentation, Triad Operations Committee Meeting, Los Alamos, NM, October 13–15, 2021, Los Alamos National Laboratory report LA-UR-21-29847), 34.

534 Sara Elizabeth Pasqualoni and Dina Mary Siegel, "Industrial Hygiene and OEM: Optimizing Collaboration amidst the COVID-19 Pandemic" (presentation, AIHA ACOEM Webinar, Los Alamos National Laboratory report LA-UR-20-28695, 2020).

535 Sara Elizabeth Pasqualoni and Dina Mary Siegel, "Industrial Hygiene and OEM: Optimizing Collaboration amidst the COVID-19 Pandemic" (presentation, AIHA ACOEM Webinar, Los Alamos National Laboratory report LA-UR-20-28695, 2020).

536 Kelly Beierschmitt, "Solving National Security Challenges," (presentation, Triad Operations Committee Meeting, Los Alamos, NM, October 13–15, 2021, Los Alamos National Laboratory report LA-UR-21-29847), 30–34.

537 Marc E. Clay and Stephen Rottler, *Triad Operations Committee Report to Board* (Los Alamos National Laboratory report LA-UR-21-21633, 2021).

538 Kelly Beierschmitt, "Solving National Security Challenges," (presentation, Triad Operations Committee Meeting, Los Alamos, NM, October 13–15, 2021, Los Alamos National Laboratory report LA-UR-21-29847), 32.

539 Craig Tyler, "Special Report: Los Alamos Versus the Virus," *1663* (August 2020), https://www.lanl.gov/discover/publications/1663/2020-august/covid-special-report.shtml.

540 Craig Tyler, ed., "COVID-19: Answering the Call," *1663* (February 2021), https://www.lanl.gov/discover/publications/1663/2021-february/covid-answering-the-call.shtml.

541 Craig Tyler, "Special Report: Los Alamos Versus the Virus," *1663* (August 2020), https://www.lanl.gov/discover/publications/1663/2020-august/covid-special-report.shtml.

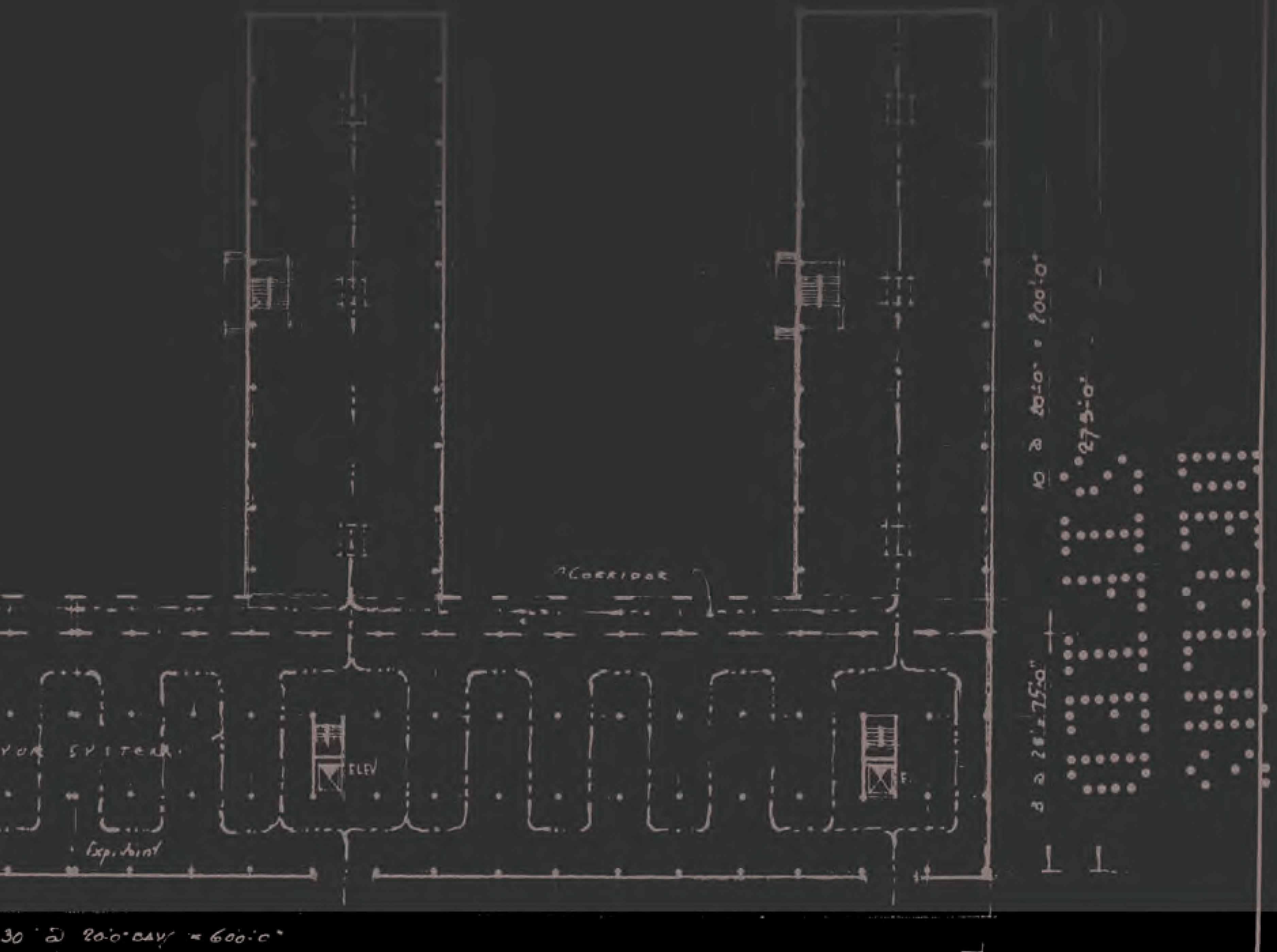
542 Sara Elizabeth Pasqualoni and Dina Mary Siegel, "Industrial Hygiene and OEM: Optimizing Collaboration amidst the COVID-19 Pandemic" (presentation, AIHA ACOEM Webinar, Los Alamos National Laboratory report LA-UR-20-28695, 2020).

543 Craig Tyler, ed., "What Happens Next," *1663* (February 2021), https://www.lanl.gov/discover/publications/1663/2021-february/what-happens-next.shtml.

544 Los Alamos National Laboratory, "Senate Recognizes More than 100 Los Alamos COVID-19 Researchers for Contributions to State and Nation," *LANLInside*, March 9, 2022, https://int.lanl.gov/news/news_stories/2022/march/0309-covid-recognition.shtml.

545 Los Alamos National Laboratory, "COVID-19: Earlier News Updates," *LANLInside*, March 16, 2022, https://int.lanl.gov/news/news_stories/2020/covid-19/earlier-updates.shtml.

546 Thomas Edward Mason, "Triad Three-Year Assessment" (presentation, Los Alamos National Laboratory report LA-UR-21-29032, 2021) 10.



- GROUND FLOOR PLAN -

SCALE 1/32" = 1'-0"

AREAS:	SQ FT
WAREHOUSE:	90,000
SHOPS & CORRIDOR	104,640
TOTAL:	194,640

U. S. ATOMIC ENERGY COMMISSION
OFFICE OF SANTA FE DIRECTED OPERATIONS

BUILDING TYPE STUDY III.

FILE
JOB
DRAWN H.G. & H.L.B.
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— Kelly Beierschmitt
Deputy Director for Operations

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