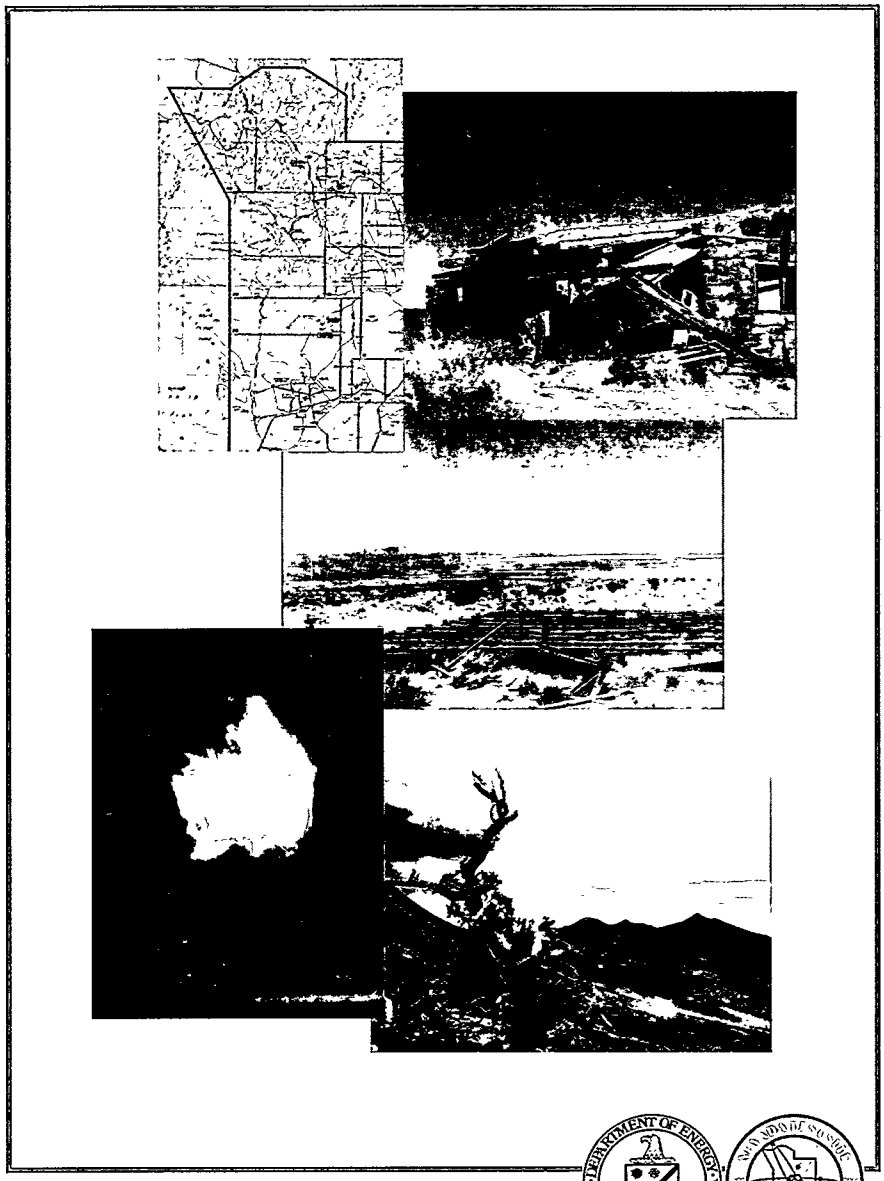
DOE/MA-0518

Origins of the Nevada Test Site



United States Department of Energy

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History Division
Executive Secretariat
Management and Administration
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DISCLAIMER

location for conducting nuclear weapons tests within the continental United States.

The history represents a unique partnership between a field office and two headquarters offices of the U.S. Department of Energy. The Department's Nevada Operations Office provided the initial impetus for the project and offered support and resources throughout the researching and writing of the history. The Office of Defense Programs of the Department's National Nuclear Security Administration provided funding for printing the history. The History Division of the Department's Executive Secretariat researched and wrote the history.

Terrence R. Fehner is a senior historian working in the History Division. F.G. Gosling is the Department's Chief Historian and Federal Preservation Officer. The authors wish to thank the many individuals who offered comments, support, and assistance. They made this work possible and helped make it a better and more complete history.

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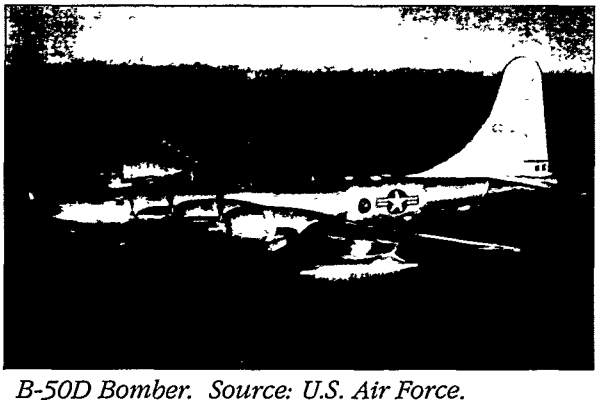
Dropping the Bomb: The Able Shot

Shortly after midnight on January 27, 1951, personnel from the Los Alamos Scientific Laboratory delivered a "nuclear capsule" to a heavily guarded Air Force B–50D sitting on a taxi strip at Kirtland Air Force Base outside Albuquerque, New Mexico. Already on the bomber was an assembled nuclear device, lacking only the nuclear capsule to make it an operative test weapon. Forty–five minutes later, the B–50D, with a crew of eleven, lifted off from the runway and headed west through the darkness at an altitude of 14,000 feet toward Frenchman Flat, a remote desert valley located on the newly established Nevada Test Site approximately sixty–five miles northwest of Las Vegas. Accompanying the nuclear device–laden aircraft was a second B–50 equipped with photographic equipment and a C–47 disaster assistance aircraft available in case of emergency.

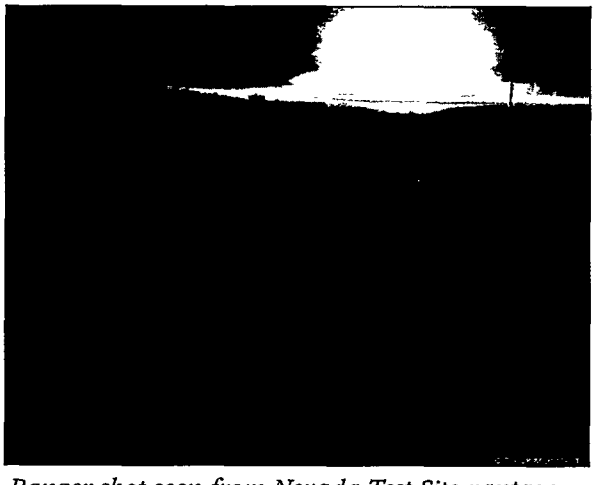
As the B–50D and its deadly cargo made its way toward the target, testing personnel



B-50D Bomber. Source: U.S. Air Force.

on the ground in Nevada feverishly attended to last-minute preparations. At Nellis Air Force Base near Las Vegas, officials tracked the westward progress of the B–50D and ordered into the air monitoring aircraft that would sample and trace the path of the radioactive cloud produced by the impending nuclear test. Following a 3:00 a.m. weather briefing, the test manager gave the final go–ahead for the test, codenamed Able. Officials also closed the air space surrounding the test site so that private and commercial pilots would not be blinded by the blast's fireball. Meanwhile, at the test site, security teams cleared the target area, and workers and technicians hurried to remove themselves from harm's way and headed to the control point nine miles south of ground zero.

The bomber and its two companions flew over Las Vegas and neared the test site at about 3:50 a.m. Descending to 10,000 feet,



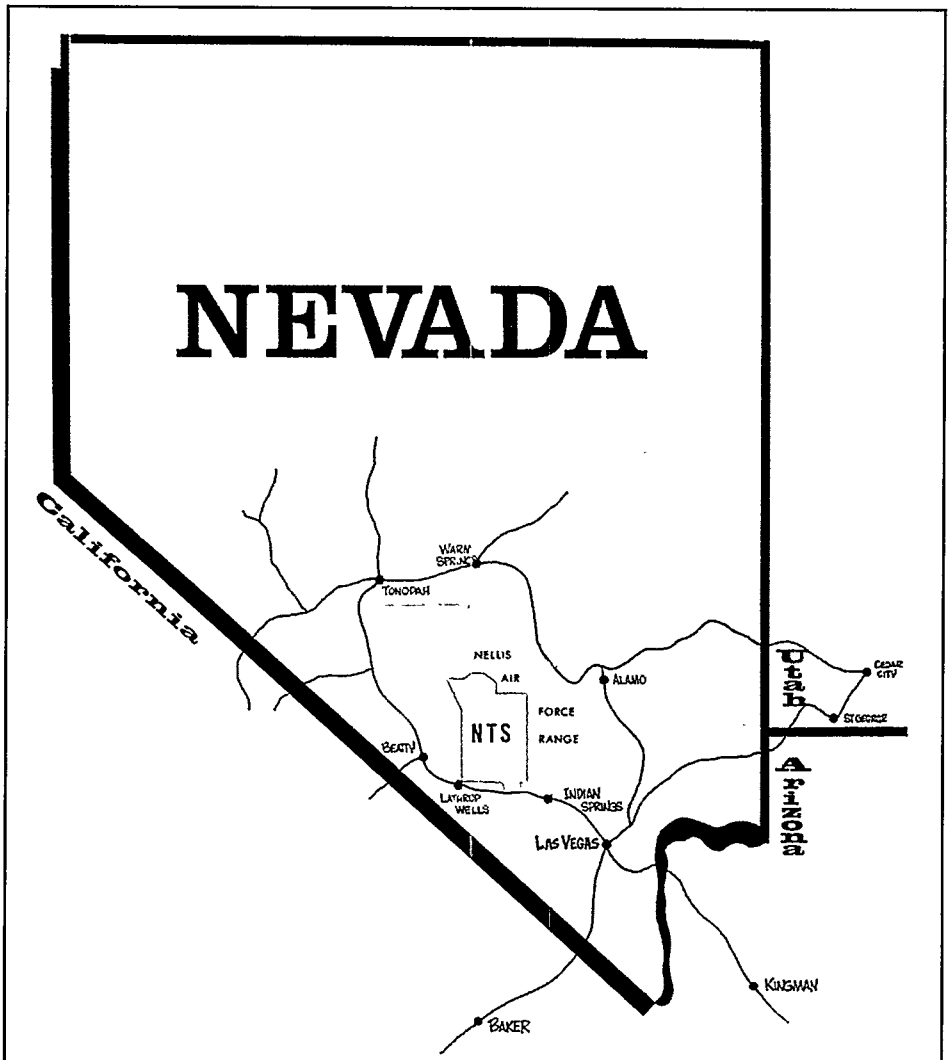
Ranger shot seen from Nevada Test Site vantage point. Source: Los Alamos National Laboratory.

the B–50D proceeded north to ground zero where the nuclear capsule was inserted and the device armed. The aircraft then climbed to its bombing height, 19,700 feet above the desert floor, entered a holding pattern, and

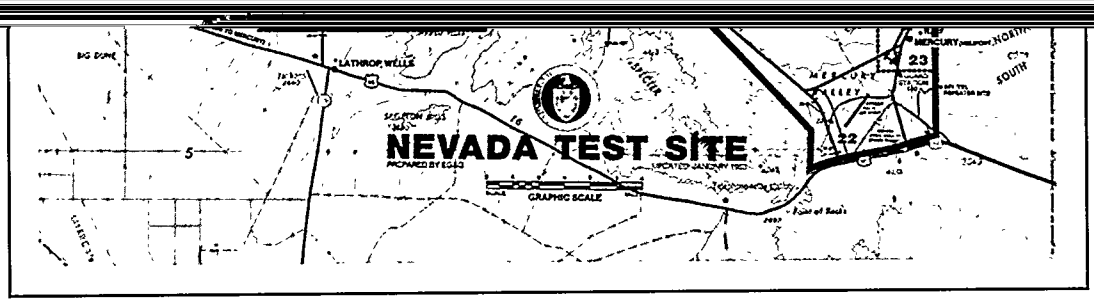
made two practice runs over the lighted target. After approval was radioed from test officials, the B–50D began its bomb run and, just as the first hint of morning light appeared in the sky, released the device.

Nine seconds prior to 5:45 a.m., the device exploded as planned at a height of 1,060 feet, some 100 feet off dead center. A brilliant ball of fire rose slowly from ground zero and then faded rapidly, dying out in a matter of a few seconds. A bluish-purple afterglow, visible for several more seconds, itself faded gradually into darkness. No mushroom head formed, but, as the light of dawn grew stronger, the fission-product cloud, a dirty yellowish brown, drifted eastward as it was broken up by the winds. The blast wave from Able struck the control point as the violet afterglow diminished. Consisting of a single, sharp, loud concussion, the blast wave shook the control point building. This was followed shortly by reverberating echoes from the surrounding mountains. In the target area, the shock wave raised a dust cloud that hung in stratified layers. The dust cloud slowly drifted to the west and the north into the valleys of the nearby mountains. Only after several hours did the dust cloud dissipate under the influence of the sun's heat and daytime surface winds.[1]

Able had been successfully detonated, and the Nevada Test Site had been officially christened.

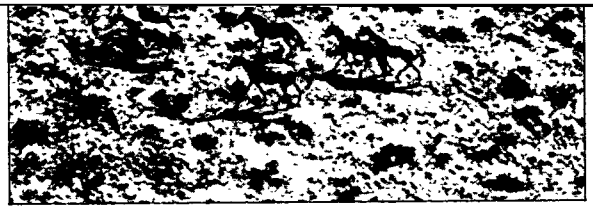


Location of the Nevada Test Site and surrounding communities. Source: REECO, Bechtel Nevada.


LATHROP WELLS
NEVADA TEST SITE
GRAPHIC SCALE
MERCURY
23
22

peaceful uses. The Nevada Test Site played a vital and central role in the development and maintenance of the Cold War nuclear arsenal. Although the site no longer plays host to nuclear weapons tests, the Department of Energy maintains the capability to resume testing should the necessity arise and continues to use the site for a variety of national security and other needs.

The Nevada Test Site consists of approximately 1,375 square miles of remote desert and mountain terrain owned and controlled by the Department of Energy and located in the southern part of the Great Basin northwest of Las Vegas. Elevations range from 3,080 feet at Frenchman Flat, where the Able shot was detonated, in the southeast corner of the site and at Jackass Flats in the southwest corner of the site to 7,675 feet on top of Rainier Mesa toward the northern border. The mountain ranges found on the site are generally lower in the south and higher in the north. Water—or the lack thereof—is the dominating climatic characteristic. The lower elevations have hot, dry summers and mild



Although not native, wild horses roam the higher elevations of the test site. Source: REECO , Bechtel Nevada.

between the Great Basin and Mojave deserts. Species from both deserts, including those native to one but not the other, are found in the area. Kit fox and the sidewinder rattlesnake, common only in the Mojave desert, live in the southern reaches of the site, and mule deer and the striped whipsnake, favoring a Great Basin desert environment, reside in the northern parts. Other animals found onsite include coyotes, golden eagles, wild horses, mountain lions, and an occasional bighorn sheep and antelope. The range in elevation also helps provide for a diversity in flora and fauna. Mojave desert plants such as

Native American petroglyphs can be found on the test site. Source: DOE, Nevada Operations Office.

that is now the Nevada Test Site has never been particularly conducive to human habitation and exploitation. The earliest cultural remains discovered on the site date back 10,000 to 12,000 years. In an era of cooler temperatures and increased precipitation, more moist periods over the past 4,500 years. Between 4,500 and 1,900 years ago, the climate was cooler and wetter than today. Notable hot and arid periods occurred between 1,900 and 1,000 years ago and 700 and 500 years ago, when a pattern of heavier winter precipitation began. Since the end of the Little Ice Age about 150 years ago, temperatures have gradually increased. During the cooler, wetter periods, the southern Great Basin experienced increased human populations corresponding with an expanded food supply.

Early explorers and immigrants in the mid–1800s encountered widely scattered groups of hunter gatherers currently known as Southern Paiute and Western Shoshone. Lieutenant George M. Wheeler, who headed an army mapping expedition through the

region in 1869, passing immediately south and east of the current test site, noted, in his own ethnocentric way, that the Native

Remains of a stone cabin at Cane Spring, top. Inscribed stone block used in the construction of the fireplace, bottom. Source: DOE, Nevada Operations Office and Desert Research Inistitute.

Americans "roamed at pleasure, eking out a purposeless existence." Whatever their lack of purpose, the Native Americans practiced a subsistence strategy designed to cope with a severe and unforgiving environment. During the second half of the nineteenth century, a communal group known as *Eso* (little hill), composed of members of both the Southern Paiute and Western Shoshone tribes and comprising little more than forty people, lived in the area around Rainier Mesa. They generally moved in search of food between the highlands and the lowlands, depending on the season, within an area with a radius of about twenty miles. They established winter camps at various springs across the site. The camps usually consisted of nuclear families and, in some instances, of extended families. Scarcity of game forced the population to subsist primarily on seeds and other vegetable foods. By the early twentieth century, most of the free–roaming Native Americans had moved to surrounding towns or relocated to reservations.[3]

Explorers and Forty–Niners

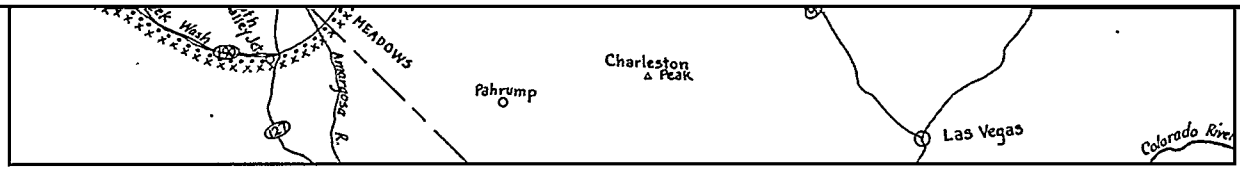
Not until the mid–1800s did explorers and pioneers first cross the area that became the Nevada Test Site. The Old Spanish Trail, which was neither old nor Spanish, passed through the Las Vegas Valley south and east of the site. First traversed in the winter of 1829–1830 by Antonio Armijo, a Santa Fe trader heading a commercial caravan of sixty men en route to Los Angeles, the Old Spanish Trail served as a primary means of reaching the Pacific Coast until the termination of the war with Mexico in 1848. Lieutenant John C. Frémont's wide–ranging U.S. Army Topographical Expedition in 1844 explored the parts of the trail running through California and Nevada. Frémont's detailed map showed a major mountain range running east and west in the vicinity of the test site but also cautioned that the area was "unexplored."[4]

Scant evidence exists that prior to 1849 any travelers ever deviated from the trail into the area of the site. A stone block inscribed with the name "F.O. BYOR" and the date "1847" was used in the construction of a fireplace in a stone cabin at Cane Spring located in the south central part of the site. The origin of the inscription remains a mystery. One theory is that it was carved by a member of the Mormon Battalion formed in 1846 to protect settlers in southern California during the Mexican War. In 1847, part of the battalion passed through the region and possibly through the test site on its way to the Salt Lake Valley in Utah.[5]

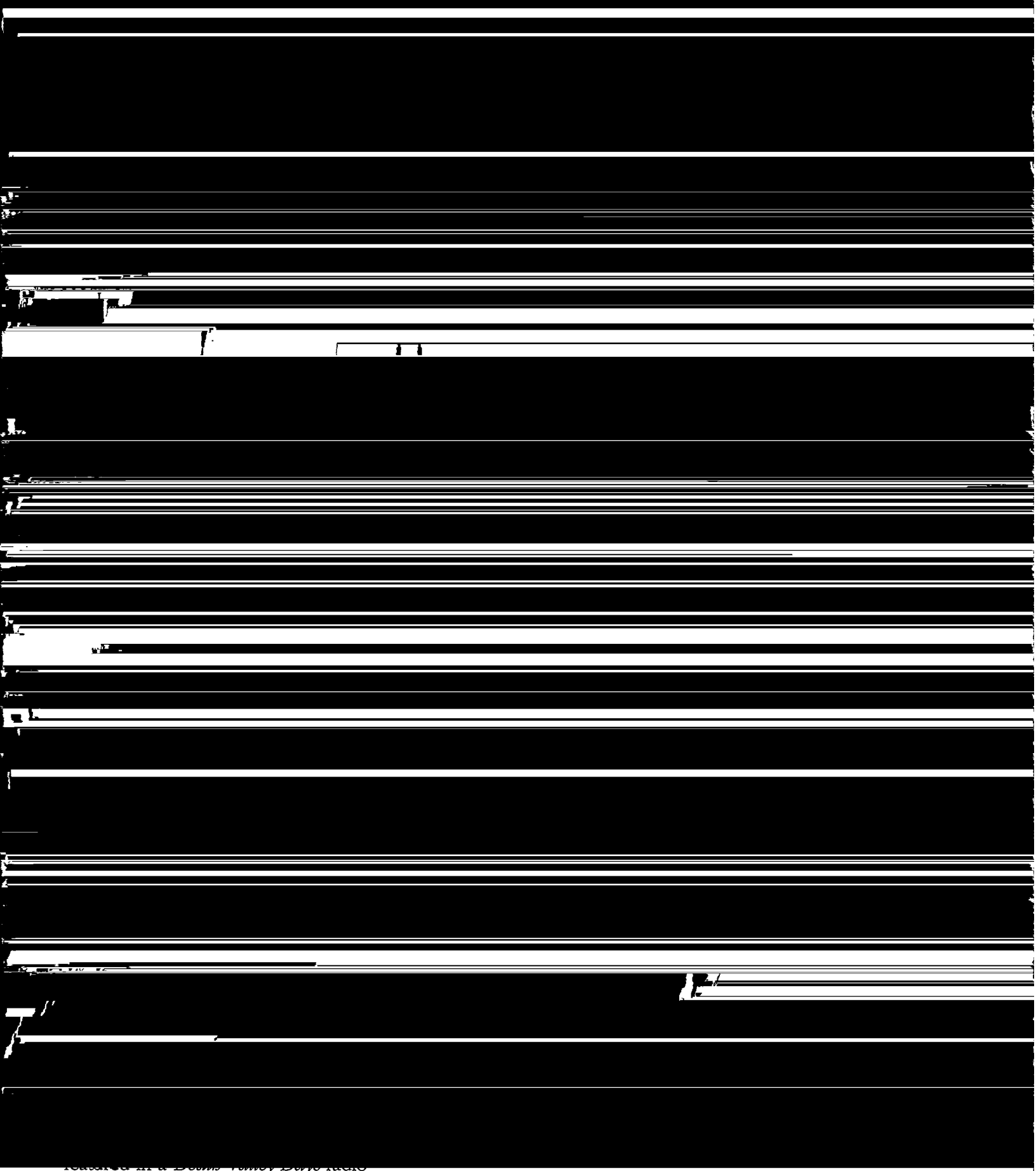
The earliest recorded entry on to the present test site was by an ill–fated group of emigrants known as the Death Valley '49ers. Bound for the California gold fields in fall 1849, a party of Mormon families left the Salt Lake Valley too late in the season to cross the Sierra Nevadas on the more direct route across northern Nevada. They elected instead to head first toward southern California on the Old Spanish Trail. Persuaded by rumors of a shortcut, possibly

western Nevada to the recently discovered silver fields in the Pahranagat Valley east of

and on for the next fifty years, with



Probable routes taken through the test site by the Death Valley '49ers. Note that on the map the entirety of what is now the Nellis Air Force Range is labeled as the "A.E.C. Test Site." Source: Reprinted from George Koenig, Beyond This Place There Be Dragons: The Routes of the Tragic Trek of the Death Valley 1849ers through Nevada, Death Valley, and on to Southern California *(Glendale, CA: The Arthur Clark Company, 1984).*



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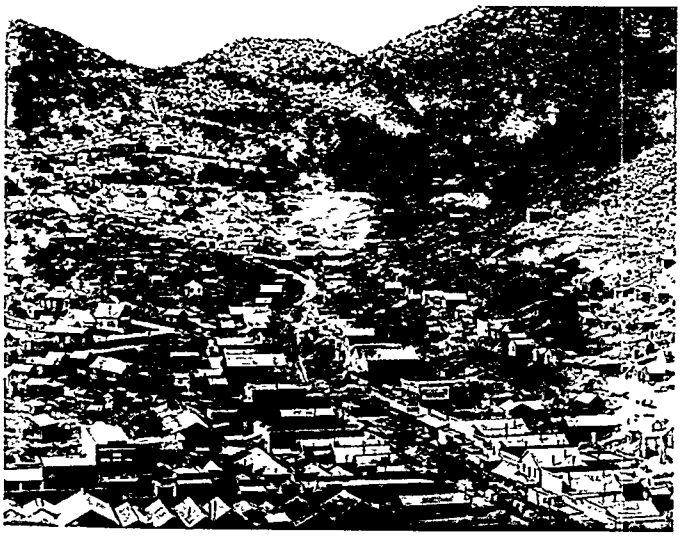
Stone cabin at Whiterock Spring, top, with the remains of a corral and abandoned 1928 Buick. Source: DOE, Nevada Operations Office.

Boom and Bust Towns



Pioche, Nevada, April 1873. Source: Nevada Historical Society.

Goldfield, Nevada, January 1904, in the early days of the gold rush. Source: Nevada Historical Society.

Goldfield, 1907, in its heyday. Source: Nevada Historical Society.

strike in May 1900 at Tonopah, some seventy miles northwest of the test site, rapidly changed the state's fortunes. Tonopah soon became the most important silver and gold producer in the nation and by 1902 was a sprawling city of 3,000. Late that same year, gold was discovered twenty–five miles south of Tonopah. Goldfield, the town that emerged from the strike, boomed furiously and, with a population estimated anywhere from 10,000 to 40,000, was Nevada's largest city for almost two decades. Goldfield mines produced over $86,000,000 in metals. In 1904, gold was discovered some seventy–five miles to the south of Goldfield—and thirty miles west of the site—in what became known as the Bullfrog District. By 1907, the district's major town, Rhyolite, boasted a population of perhaps 12,000.

As whirlwind as was the growth of these towns, their decline was inevitable as the mines played out. Tonopah and Goldfield hung on as county seats, with populations in 1950 of 1,375 and 336 respectively. Rhyolite by then had been for years little more than a ghost town.[12]

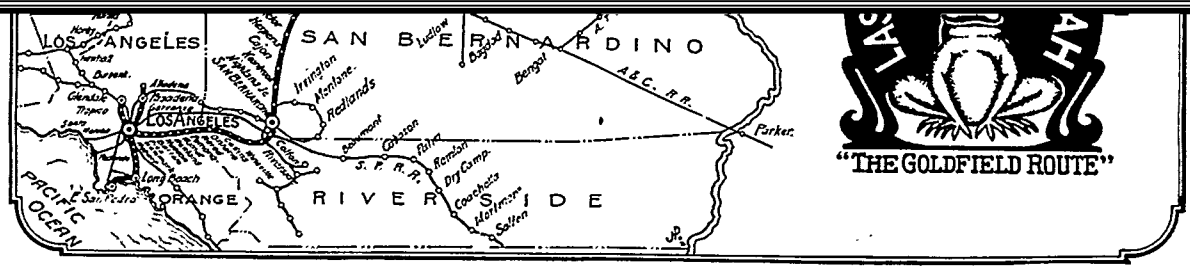
The rise and fall of the boom towns had little effect on the region of the test site itself, other than to increase the number of prospectors scouring the landscape and, more importantly, to lay the framework for the local transportation system. By the middle of the decade of 1900, competing railroads had pushed rail lines to the major gold and silver strike towns west of the site. The town of Beatty, a few miles east of Rhyolite, and the locus of three separate lines, billed itself as the "Chicago of the West." One line, the Las Vegas and Tonopah Railroad, ran northwest out of Las Vegas, where it tied in with the recently completed San Pedro, Los Angeles and Salt Lake Railroad, and skirted what is now the southern boundary of the

Las Vegas & Tonopah Railroad crew laying track, 1906. Source: Nevada Historical Society.

Railroad ceased operations and removed the rails in 1918. The following year, the Nevada Department of Highways purchased the right of way, removed the remaining railroad ties, widened the roadbed, and reconstructed bridges to meet highway standards. The road eventually became what is now U. S. Highway 95. In the 1950s, the portion of the road running from Las Vegas to the site became known as the Mercury Highway because it brought workers from their homes in Las Vegas to the test site headquarters at Mercury. As for the "Chicago of the West," the last rails were torn up in 1942, and in 1950 Beatty had a population of 487.[13]

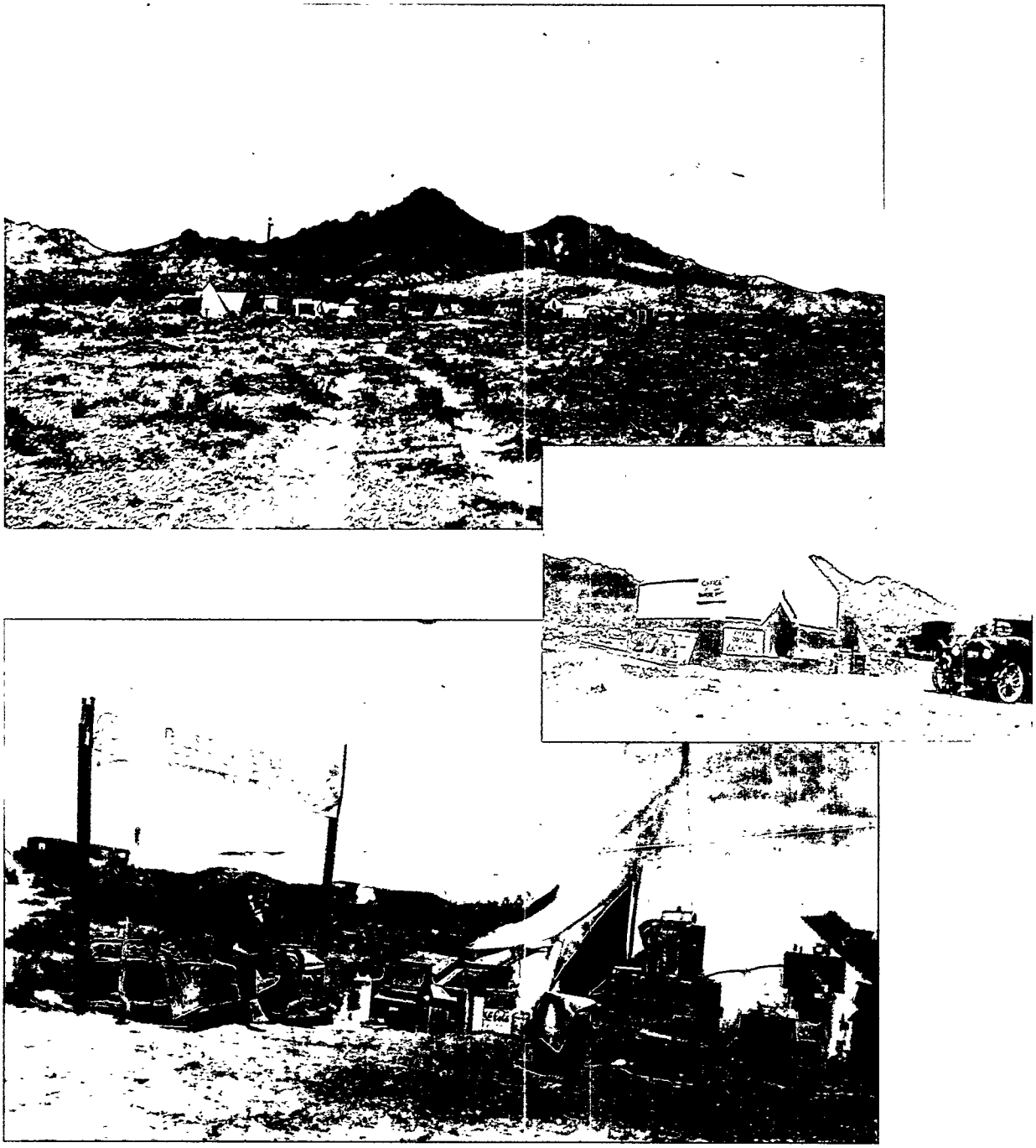
Wahmonie

Nevada's last major mining rush occurred in the late 1920s at Wahmonie, located on what is now the test site west of Cane Spring and on the eastern edge of Jackass Flats. Mining operations in the area dated back at least to 1905, but the area remained quiet until the discovery of high–grade silver–gold ore in 1927. Established in February 1928, the Wahmonie mining camp grew to a population of some 500 within a month. Some miners arrived hauling small houses on trucks. Others came in cars loaded with provisions or even on foot pushing wheelbarrows tied down with goods. Many miners lived in small tents, but Wahmonie soon had boarding houses, tent stores, and cafes. Thirsty miners could avail themselves at the Silver Dollar Saloon or the Northern Club.



FOR BEST SERVICE see that your Ticket reads and your Freight is Routed over the LAS VEGAS & TONOPAH R. R.

Las Vegas & Tonopah Railroad advertisement map. Source: Reprinted from David F. Myrick, Railroads of Nevada and Eastern California, Volume Two - The Southern Roads *(Berkeley, CA: Howell-North Books, 1963), p. 454.*

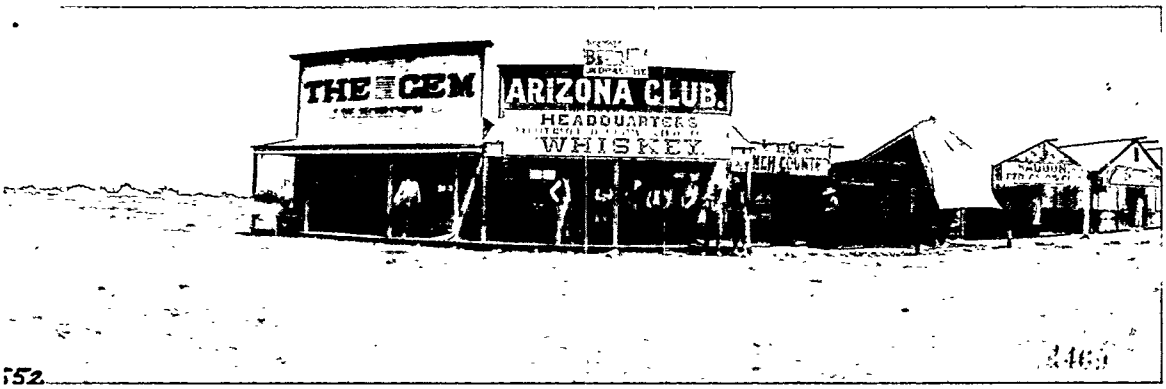


Wahmonie, Nevada, 1928: top, in the early days of the strike; middle, land claims office; Outdoor vendor supplying Wahmonie's miners. Source: top and bottom, Nevada Historical Society; middle, University of Nevada, Las Vegas, Special Collections.

crops to provision travelers, established an adobe fort four miles east of the springs. They abandoned the settlement three years

After the war, the burgeoning resort industry became the primary driver for the local

Early Las Vegas



Las Vegas, Nevada: top, block 16, 1907; middle, freight team, 1907; bottom, Fremont Street, looking east, 1912. Source: Nevada Historical Society.

Military photograph of Las Vegas, Nevada, 1942. Airfield can be seen in background. Source: University of Nevada, Las Vegas, Special Collections. Document declassified per E.O. 12958, Sec. 3-4.

Las Vegas Army Air Field flightline, 1945. Source: Nellis Air Force Base, History Office.

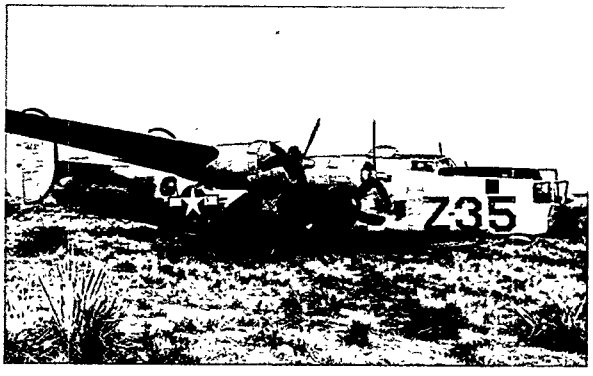
[redacted]

could cause collateral damage. Finally, as by far the largest town in the immediate area, Las Vegas became a potential target to be avoided for wind–blown debris and fallout moving offsite.

The Las Vegas Bombing and Gunnery Range

In the nearly hundred years since the '49ers first rumbled through on their way to Death Valley, not much interest had been shown, aside from the occasional prospector and intermittent grazing, in the area that would become the Nevada Test Site. In 1940, however, the precise characteristics that had made the region so unattractive—the desolation, lack of water, and general uninhabitableness—brought it to the attention of the federal government. With war looming on the horizon, the United States had begun a major rearmament program. Part of this program involved locating bombing and gunnery training ranges for the Army Air Corps. On October 29, 1940, President Franklin D. Roosevelt established the Las Vegas Bombing and Gunnery Range. Encompassing more than three–and–a–half–million acres north and west of Las Vegas, the range stretched [redacted] Operations began in October 1941 as the courts finalized the land condemnations and federal marshals cleared the remaining stragglers off the range.

The test site area's role was to serve as a setting for air–to–air gunnery practice. Gunners on airplanes used "frangible" bullets that broke upon impact, spattering paint so



B-24 following an emergency landing. Source: Nellis Air Force Base, History Office.

that gunners could see where their bullets had hit, as well as live fire against targets towed by other airplanes. This at times proved hazardous, especially for the planes

doing the towing, and the site's backup role was to provide emergency landing services. The Army set up four emergency landing strips on the range. One was on Groom Lake east of the site. Another was on Pahute Mesa toward the north and west part of the site. The remaining two landing strips were further to the north and west on the range. The dry lake beds at Frenchman and Yucca Flats could also serve as emergency strips. In addition, the Army established a forward base with a landing strip and other facilities at Indian Springs, a small hamlet with a service station and general store on the highway some ten miles southeast of the site.

The end of the Second World War closed out training activities on the bombing and gunnery range. The Las Vegas Army Airfield briefly deactivated before reemerging, in response to political pressure and the growing Cold War threat, as the Las Vegas Air Force Base in 1948, with a mandate to train pilots of single–engine airplanes. The following year, the Air Force expanded the base's functions by adding a gunnery school. In April 1950, the base was renamed Nellis Air Force Base. As for the bombing and gunnery range, it stood largely unused throughout much of the late 1940s.[16]

[redacted]

extremely light negatively charged particles, called electrons, in orbit around the much heavier positively charged nucleus. In 1919, the New Zealander Ernest Rutherford, working in the Cavendish Laboratory at Cambridge University in England, detected a high–energy particle with a positive charge being ejected from the nucleus of an atom. The proton, as this subatomic particle was named, joined the electron in the miniature

Argonne National Laboratory.

ment, identical in every other way, could vary slightly in mass.

The existence of a third subatomic particle, the neutron, so–named because it had no charge, explained the differences. First identified in 1932 by James Chadwick, Rutherford's colleague at Cambridge, neutrons within the nuclei of atoms of a given

radioactive isotope of barium. Even more significantly, the products of the experiment weighed less than that of the original uranium nucleus. From Albert Einstein's formula, $E=mc^2$, which states that mass and energy are equivalent, it followed that the loss of mass resulting from the splitting process must have converted into energy in the form of kinetic energy that could in turn be converted into heat. Calculations made by Hahn's former colleague, Lise Meitner, a refugee from Nazism then staying in

Einstein and Szilard. Source: Institute for Advanced Study.

stopped the sale of uranium and German physicists were engaged in uranium research.[18]

President Roosevelt responded quickly but cautiously to the Einstein letter. He appoint-

In response to Einstein's letter, President Franklin D. Roosevelt initiated government-sponsored research on uranium and fission. Source: Franklin D. Roosevelt Presidential Library.

ed an Advisory Committee on Uranium, headed by Lyman J. Briggs, director of the National Bureau of Standards, and tasked it with examining the current state of research on uranium and recommending an appropriate role for the federal government. The committee, for good reason, did not urge rushing headlong into an urgent, top priority bomb building project. No one as yet knew whether an atomic bomb was even possible

[illegible] thus approved only limited funding for isotope separation and chain reaction work.

Not until 1941 did prospects for a bomb brighten. A second possible path to a bomb had gradually emerged. Researchers studying uranium fission products at the Radiation Laboratory at the University of California in Berkeley discovered another product, a new transuranium, man–made element, named neptunium, with an atomic number of 93, created when uranium–238 captured a neutron and decayed. Neptunium itself decayed to yet another transuranium element. In February, the chemist Glenn T. Seaborg

Discovery of plutonium by the University of California, Berkeley, chemist Glenn T. Seaborg suggested a second path toward building an atomic bomb. Source: Department of Energy.

identified this as element 94, which he later named plutonium. By May he had proven that plutonium–239 was 1.7 times as likely as

took this information to the White House and emphasized the continuing uncertainty involving a bomb. Realizing that German research was ongoing, Roosevelt instructed Bush to move as quickly as possible on research and development. Following a year of furious activity, Bush reported to the president that atomic bombs possibly could be available by the first half of 1945. On December 28, 1942, Roosevelt authorized the construction of full–scale production plants with an initial expenditure of $500 million.[19]

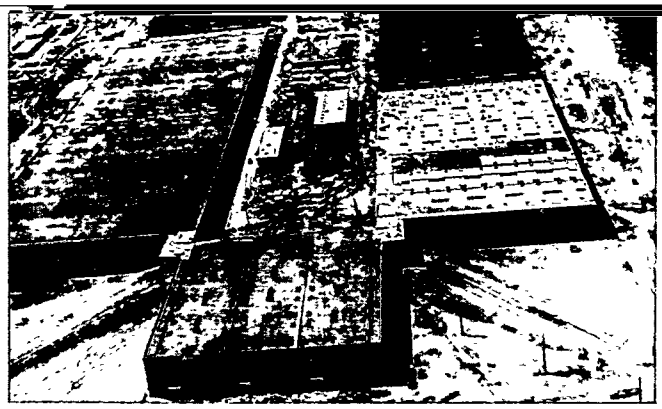
The Manhattan Project

Security requirements suggested placing the atomic bomb project under the Army

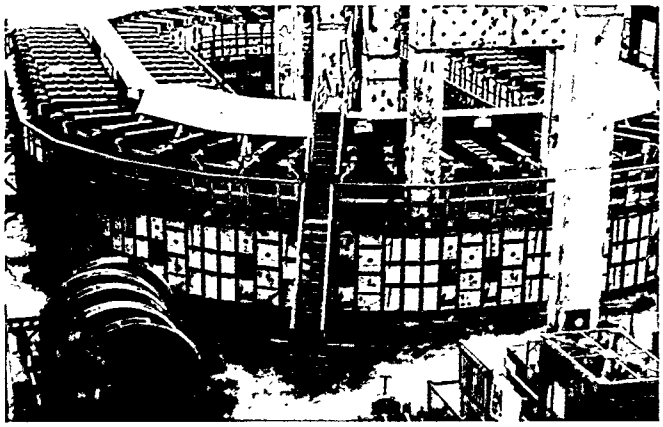
James Chadwick and General Leslie R. Groves. Source: Department of Energy.

um–235. Groves located the production facilities for isotope separation at the Clinton Engineer Works, a ninety–square–mile parcel carved out of the Tennessee hills just west of Knoxville (the name Oak Ridge did not come into usage until after the war). Groves placed two methods into production: 1) gaseous diffusion, based on the principle that molecules of the lighter isotope, uranium–235, would pass more readily through a porous barrier; and 2) electromagnetic, based on the principle that charged particles of the lighter isotope would be deflected more when passing through a magnetic field. Later, in 1944, Groves approved a production plant using a third method, liquid thermal diffusion, in which the lighter isotope concentrated near a heat source within a tall column.

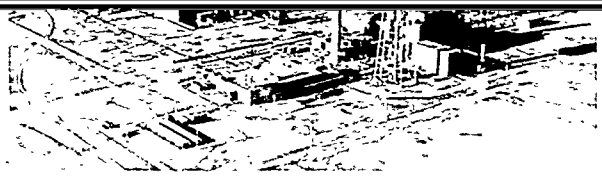
The second path chosen to build the bomb focused on producing large amounts of fissionable plutonium in a uranium pile. On December 2, 1942, on a racket court under the west grandstand at Stagg Field of the University of Chicago, researchers headed by the Italian-emigré physicist Enrico Fermi achieved the first self–sustaining chain reaction in a graphite and uranium pile. Groves built a pilot pile and plutonium separation facility at the X–10 area of Clinton. Space and power generating limitations, however, precluded building the full–scale production



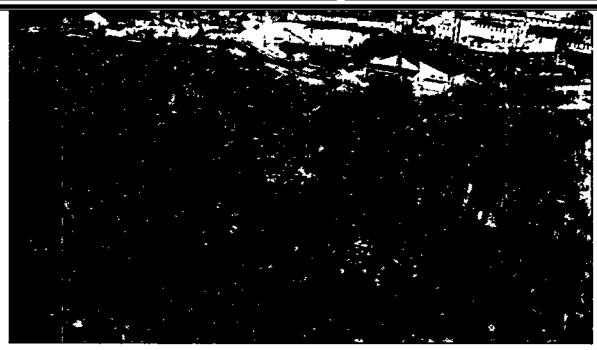
K-25 from opposite end. White building in center of previous picture is discernible at far end. Source: Department of Energy.



Y-12 Alpha Racetrack, at Clinton, used the electromagnetic method to separate uranium isotopes. Spare magnets in left foreground. Source: Department of Energy.



Pile D at Hanford. Pile in foreground, water treatment plant in rear. Source: Department of Energy.



Los Alamos Laboratory ca. mid-1940s. Source: Los Alamos National Laboratory.

West end of Stagg Field at the University of Chicago. Location of CP-1, the world's first nuclear pile or reactor. Source: Argonne National Laboratory.

ignated by the letters B, D, and F, and corresponding separation facilities were built at the Hanford Engineer Works.

Much of the research work on producing plutonium, including design of the piles, took place at the Metallurgical Laboratory (Met Lab) in Chicago. Design and fabrication of the first atomic bombs were the responsibility of the newly established Los Alamos Scientific Laboratory, located at a virtually inaccessible site high on a mesa in northern New Mexico. The laboratory, headed by J. Robert Oppenheimer, attracted a remarkable array of scientists from universities across the United States.[20]

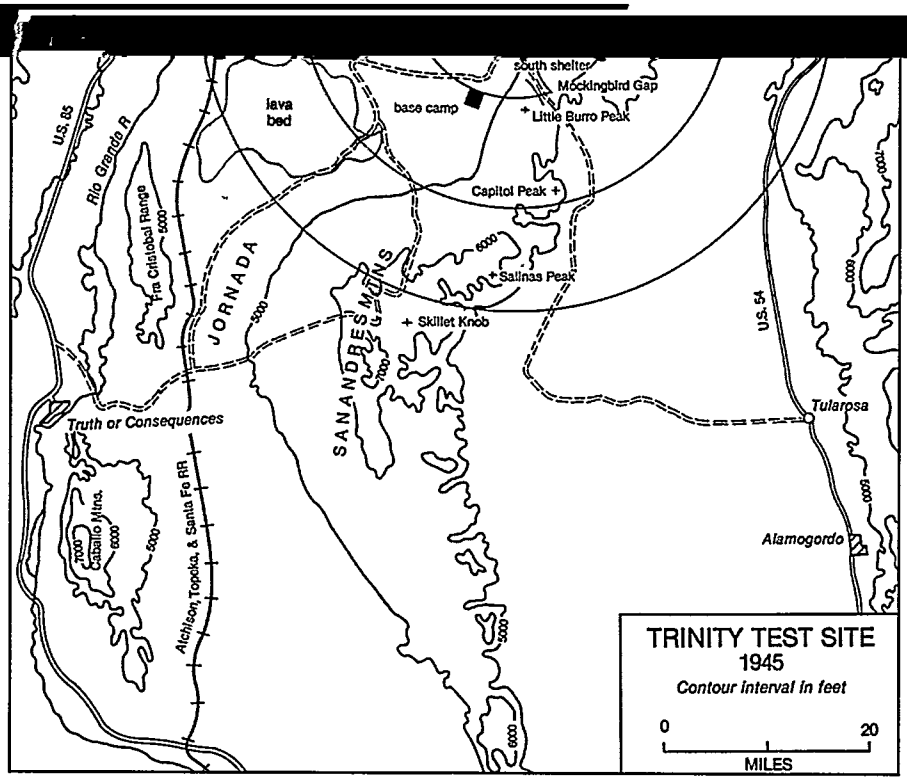
Bomb Design

Designing the bomb, or "gadget" as it came to be known, was not an easy task. Precise calculations and months of experimentation were required to obtain the optimum specifications of size and shape. For the bomb to work, sufficient fissionable material needed to be brought together in a critical mass, which would ignite a chain reaction that would release the greatest possible amount of energy before being blown apart and dispersed in the inward would compress a subcritical mass of plutonium, releasing neutrons and causing a chain reaction.

Los Alamos, working with the Army Air Force, developed two bomb models by spring 1944 and began testing them, without the fissionable materials, with drops from a

J. Robert Oppenheimer. Source: Reprinted by permission of the J. Robert Oppenheimer Memorial Committee.

B–29 bomber. The plutonium implosion prototype was named Fat Man, after Winston Churchill. The uranium gun prototype became Little Boy. Field tests with the uranium prototype eased remaining doubts about the artillery method. Confidence in the



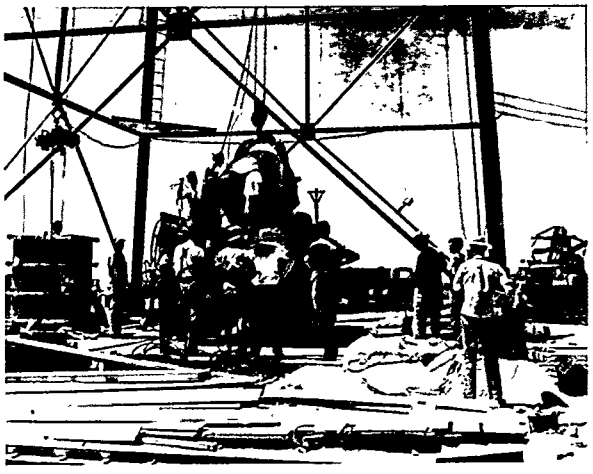
Trinity Test Site. Source: Reprinted from Vincent C. Jones, Manhattan: The Army and the Atomic Bomb *(Washington, D.C.: Government Printing Office, 1985).*

apprehension existed that there would be a large–scale catastrophe. Los Alamos scientists discussed the possibility that the atmosphere might be ignited and the entire earth annihilated but dismissed this as extremely remote.

Tower for Trinity test. Source: Department of Energy.

Dangers from blast, fragments, heat, and light, once one was sufficiently removed from ground zero, evoked little concern.

Not so with radiation. Prior to Trinity, scientists were well aware that the blast would create potential radiation hazards. Plutonium in the device would fission into other radionuclides. Neutrons would strike various elements on the ground and turn some into active nuclides. This radioactive debris would be swept with fission products into a growing fireball and lifted high into the air. Once in the atmosphere, they would form a cloud of intense radioactivity. Immediate radiation from the explosion and residual radioactive debris initially caused faint worry because of dilution in the air and the isolation of the site, but as the test drew closer planners realized, with some sense of urgency, that radioactive fallout over local towns posed a real hazard. Groves, in particular, feared legal culpability if things got out of hand. As a result, Army intelligence agents located and mapped everyone within a forty–mile radius. Test planners set up an elaborate offsite monitoring system and prepared evacuation plans if exposure levels became too high.[22]



Trinity device being readied. Source: Department of Energy.

On July 16, 1945, the Trinity device detonated over the New Mexico desert and released approximately 21 kilotons of explosive yield. The predawn blast, which temporarily blinded the nearest observers 10,000 yards away, created an orange and yellow fireball about 2,000 feet in diameter from which emerged a narrow column that rose and flattened into a mushroom shape. The blast scoured the desert floor, leaving a shallow crater, 10 feet deep and some 400 yards across, in which radioactivity far exceeded pretest estimates. More efficient than expected, the shot dropped little fallout on the test site beyond 1,200 yards of ground zero. Most radioactivity was contained within the dense white mushroom cloud that topped out at 25,000 feet. Within an hour, the cloud had largely dispersed toward the north-northeast, all the while dropping a trail of fission products. Offsite fallout was heavy. Several ranch families, missed by the Army survey, received significant exposures in the two weeks following Trinity. The families, nonetheless, evidenced little external injury. Livestock were not as fortunate, suffering skin burns, bleeding, and loss of hair. The test, as Stafford Warren, the Manhattan District's chief medical officer, informed Groves, had been something of a near thing.

[redacted]

Energy.

almost 90 miles northeast of the site." The Alamogordo site, Warren concluded, was "too small for a repetition of a similar test of this magnitude except under very special conditions." For any future test, he proposed finding a larger site, "preferably with a radius of at least 150 miles without population."[23]

War's End

The Trinity test proved the plutonium device. This meant that a second type of atomic bomb could be readied for combat use. Germany would not be the target, having surrendered in May. The Germans at the end of the war were little nearer to producing atomic weapons than they had been at the beginning. German scientists pursued research on fission, but the government's attempts to forge a coherent strategy met with little success. The United States nonetheless had little reliable intelligence on the German bomb effort until late in the war. Allied fears were not quelled until late 1944 when the ALSOS counterintelligence mission determined that the German program had not proceeded beyond the laboratory stage and had foundered by mid–1942.

In the end, Little Boy, the untested uranium bomb, was dropped first at Hiroshima, Japan, on August 6, 1945, while the plutonium weapon, Fat Man, followed three days

[redacted]

Trinity and the two bombs dropped on Japan strongly influenced the decision to locate Crossroads at Bikini atoll in the Marshall Islands, which was far from population centers in the middle of the Pacific. Bikini was a typical coral atoll. With a reef surrounding a lagoon of well over 200 square miles, the atoll offered ample protected anchorage for both a target fleet and support ships. As a test site, Bikini held two drawbacks. The distance from the continental United States made extraordinary logistical demands, and the humid climate created numerous problems for sophisticated electronic and photographic equipment. The military removed the native population of 162 to another atoll and brought in a large, invited audience of journalists, scientists, military officers, congressmen, and foreign observers.

Shot Able, a plutonium bomb dropped from a B–29 on July 1, performed as well as the two previous plutonium devices, at Trinity and Nagasaki. Able nonetheless failed to fulfill its pretest publicity buildup. Partly this was because expectations had been too extravagant and observers were so far from the test area that they could not see the target array. Partly it was because the drop had missed the anticipated ground zero by some distance and the blast sank only three ships. In any event, the general conclusion reached by the media at Bikini was that the "atomic bomb was, after all, just another weapon."

Oak Ridge workers celebrate the end of World War II. Source: J.E. Westcott.

[redacted]

ships "became radioactive stoves, and would

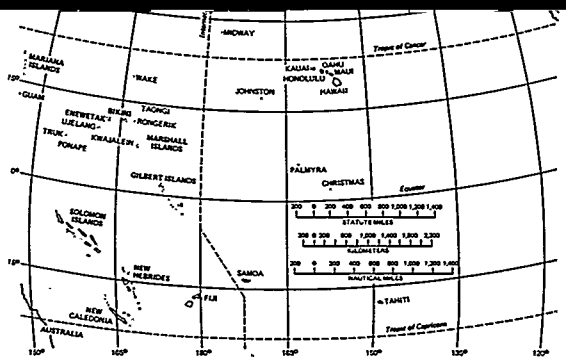
Energy Act of 1946 transferred authority from

possess the power to license and inspect all other nuclear projects. Once such an authority was set up, he declared, no more bombs should be built and existing bombs should be destroyed. Abolishing atomic weapons, Baruch noted, could lay the groundwork for reducing and subsequently eliminating all weapons, thus outlawing war altogether. The plan, which Baruch described as "the last, best hope of earth," set specific penalties for violations such as illegally owning atomic bombs. The plan also would not allow permanent members of the United Nations Security Council to use the veto to protect themselves from penalties for violations.

Winston Churchill warned of an "iron curtain" that had descended on Eastern Europe as the Soviet Union sought to expand its influence. A year later, President Truman proclaimed the Truman Doctrine and asked for funds for overseas military assistance. On the issue of control of nuclear weapons, the United States, believing that Soviet troops posed a threat to Western Europe and recognizing that American conventional forces had rapidly demobilized, refused to surrender its atomic deterrent without adequate controls. In an atmosphere of mutual suspicion, the Cold War set in.[27]

Commission Chairman David E. Lilienthal told President Truman on April 2, none of these were assembled. The paucity of bombs was partly attributable to the scarcity of weapons–grade fissionable materials. Theoretical advances made by Los Alamos bomb designers suggested ways to use these materials more efficiently—and thus provide for more weapons—but confirmation could only come from full–scale testing. Los Alamos therefore proposed a three–test series to the Atomic Energy Commission. Unlike Crossroads, the series would concentrate on bomb performance and the validation of three new weapon designs and not on weapon effects.

The location for the test series, called Sandstone, fostered some debate. The Marshall Islands in the Pacific again seemed the logical choice, but the State Department, for good reason, feared foreign criticism. Administered by Japan between the two world wars under a mandate from the League of Nations, the Marshall Islands were now a trust territory of the United States under an agreement with the United Nations. The agreement allowed military use of the islands but also imposed special responsibilities for native welfare. It was hard to argue that relocation of the natives and nuclear weapons testing was to their benefit. The Bikini islanders had been moved to Rongerik atoll, which was too small and barren to support them, and the United States apparently had done little to help. Indeed, when the poor record of American stewardship



The Central Pacific. Source: Reprinted from Kaman Tempo, Operations Crossroads, *1946, by L.H. Berkhouse, et al., DNA 6032F (Santa Barbara, May 1, 1984), p. 20.*

event, whatever the public and foreign relations ramifications, few alternatives to the Marshall Islands existed. The Joint Chiefs of Staff strongly opposed a return to the Trinity

Bikini islanders loading their gear into a transport ship in preparation for evacuation prior to Crossroads. Source: DTRA/Navy.

[redacted]

force, carrying its precious cargo of fissionable material and most of the nation's skilled bomb designers, sailed on near–war footing, complete with destroyer screen, constant air cover, zigzag course off the main sea–lanes, and crews on round–the–clock alert. Growing tensions with the Soviet Union following the communist coup in Czechoslovakia and the impending crisis over Berlin raised fears of a surprise attack, a possibility that seemed not entirely groundless after unidentified submarines were sighted in the area. The task force was given orders to use depth charges against any undersea intruders. Officials in Washington even discussed postponing Sandstone and returning both bombs and scientists to the United States.

Sandstone test at Enewetak. Source: REECO, Bechtel Nevada.

Amidst such distractions, the test series, conducted from April 15 to May 15, 1948, proved an overwhelming success. The three tests performed as expected and fallout remained largely localized. The second shot, Yoke, at forty–nine kilotons provided the largest explosive yield yet achieved, over twice the size of the Trinity test. More importantly, the new bomb designs translated into more efficient use of fissionable materials. From 1947's thirteen weapons, the nuclear stockpile increased to fifty in 1948. As for Enewetak, despite the expressed intent to make it a permanent proving ground, the task force left few structures standing. For security reasons, work crews systematically destroyed anything providing evidence of possible test results. Upon leaving, the task force arranged to keep the area

With the completion of Sandstone, temporary structures were torn down and burned. Source: Reprinted from Clarence H. White, ed., Operation Sandstone: The Story of Joint Task Force Seven *(Washington: Infantry Journal Press, 1949), p. 64.*

closed and secure, guarded by a fifty–man garrison.[29]

Continental Test Site Reconsidered

As successful as Sandstone was, logistics, weather, and security and safety concerns during the operation revived thinking about a continental test site. The logistical problems associated with transporting, supplying, and housing a nuclear testing task force in the middle of the Pacific were self–evident. From the viewpoint of a weather expert, Enewetak did not seem "a particularly good [choice] . . . as a permanent atomic weapons proving ground." The region was too cloudy, with a complicated wind structure, and there were few nearby weather stations. Security, with war threatening and the vast, surrounding ocean veiling unknown dangers, commanded significant military resources and required constant vigilance. Likewise, safety was made more difficult by the tropical marine environment, with its constant heat and humidity. Before Sandstone was even over, these considerations prompted Admiral William S. Parsons, who had directed ordnance development of the wartime weapons at Los Alamos and was a member of the Military Liaison Committee, to recommend to Lt. General John E. Hull, head of Army forces in the Pacific and commander of the joint task force, that a continental test site be investigated. Among the obvious pluses of a continental site, Parsons also cited the "neb-

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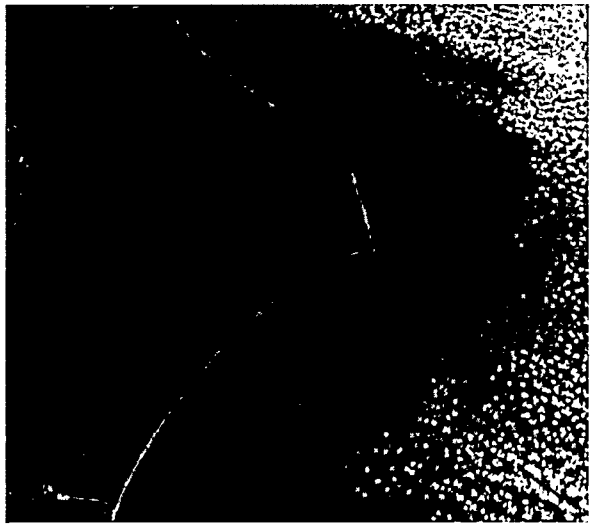
had been measured within a radius of 600 miles and never exceeded "conservative values of human tolerance" except where rain water concentrated activity at the ground surface. Besides precipitation, wind conditions and atmospheric stability determined meteorological suitability for testing. Under suitable conditions, Hutchinson stated, it did "not seem probable that harmful concentrations of soluble radio isotopes" could result from nuclear testing.



Apollo 9 photo of Cape Hatteras, North Carolina, jutting far out into the Atlantic. Cape Lookout is at the bottom left. Cape Fear is about the same distance further to the southwest. Source: NASA.

Determining that testing would not be harmful, Hutchinson turned to locating the optimal continental site. He narrowed his analysis down to the arid southwest and the humid southeast. Of these two areas, he thought the southwest was "more favorable" for "purposes of planning and logistics." Sites remote from population centers and with sufficient surrounding uninhabited space could be chosen so that tests could be conducted "during two–thirds of the year, fully 40% of the time, in perfect safety."

Sandia outside Albuquerque.

The arid southwest, however, possessed one major drawback. A "certain amount" of radioactivity, Hutchinson noted, would fall out of the atmosphere to the eastward, offsite, following atomic tests due to prevailing winds. This would not, he reiterated, "harm the population, the economy nor the industry of the nation." If "this negligible possibility" of fallout on inhabited areas nonetheless could not be accepted for sites in the southwest, he reasoned, the eastern coast of the United States offered suitable sites where radioactivity would be harmlessly blown out to sea. A testing site could be located on the coasts of Maine, Delaware, Maryland, or Virginia, but the relatively denser populations, currents that would keep deposited radioactivity closer to shore, and economically valuable fisheries in these states and off their shores favored choosing a site further south on the Carolina coast. Most ideal would be a site somewhere between Cape Hatteras and Cape Fear where "the population is not dense, meteorology is favorable during two–thirds of the year between 20% and 30% of the time, and the waters of the Gulf Stream will remove the waste products to the open Atlantic with no possibility of second order effects through biological processes."[32]

The Project Nutmeg report proposed no specific location as a test site. Nor did it consider in detail, as one official noted, problems involving "real estate, public relations, soil composition, safety, physical security and logistics." Although in agreement with the general conclusions of the study that, at least as far as meteorological and oceanographic factors were concerned, tests could be conducted safely on the Carolina coast, the Atomic Energy Commission remained wary. As Acting Chairman Sumner T. Pike noted, flights over the Carolina coast by officers of the Commission's Division of Military

officials such as Vannevar Bush had contended any nation with good scientific and technical resources—including the Soviet Union—could produce a bomb within three or four years, General Groves considered twenty years a likelier figure. When airborne sampling, a process that had been proven during the Sandstone test series, revealed the Soviet bomb test, it surprised even some high government officials, with Secretary of Defense Louis A. Johnson for a while refusing to believe the evidence.

The Russian test prompted government officials to look for measures to counter the

Edward Teller and Louis Strauss successfully pressed to accelerate the development of the thermonuclear weapon. Source: Department of Energy.

restore the absolute advantage. Following an intense internal governmental debate on the possibility, wisdom, and morality of the Super, in which Lilienthal and the Oppenheimer–led General Advisory Committee opposed while Strauss, the Hungarian–emigré physicist Edward Teller, and key members of Congress favored moving forward, Truman on January 29, 1950, approved accelerating development of the thermonuclear weapon. Although the concept, in which a nuclear fission bomb would serve as detonator to ignite fusion, dated back to early in the Manhattan Project, no one knew if a thermonuclear weapon could be built due to the formidable technical difficulties that remained.

Nuclear testing would be essential in determining the feasibility of the Super. Planning for a new test series in the Pacific had begun shortly after Sandstone ended. By January 1950, test planners envisioned a four–shot series, codenamed Greenhouse, to be conducted at Enewetak in spring 1951. Greenhouse would not involve the testing of a thermonuclear device. But two of the four planned tests would explore some of the principles of fusion. One would demonstrate that small amounts of thermonuclear fuel could boost the yield of a fission bomb. The second would prove that a fission explosion could trigger a thermonuclear reaction. As

conflict, the logistics of fighting a war in far–off Korea caused severe strains on the military. Greenhouse seemed unlikely to survive as support for testing appeared far less urgent than the demands of combat. The Atomic Energy Commission asked Los Alamos to justify Greenhouse "in light of the immediate shortage of shipping and particularly air transport in the Pacific and in light of uncertainties in predicting the situation which may prevail at the scheduled time of the tests." The lab defended both the Pacific testing site and the test series. Atomic Energy Commission Chairman Gordon E. Dean, who had replaced Lilienthal, informed Secretary of Defense Johnson that Greenhouse was vital for upgrading the weapons stockpile and acquiring new data on blast and radiological effects. More importantly, Greenhouse, Dean observed, was "expected to make a direct and significant contribution to our understanding of the technical and economical feasibility of a thermonuclear weapon, which is now inadequate."

Prospects for Greenhouse remained bleak. In his response to Dean in early August, Johnson noted that the Joint Chiefs had requested a review of Greenhouse costs and schedules. On the basis of the review, Johnson explained, the Joint Chiefs would consider the "necessity for postponement" of Greenhouse given the "necessity for reallocation of both shipping and personnel from the tests, as originally scheduled, to the support of operations in the Far East." The Joint Chiefs would also examine the possibility of

weeks following the outbreak of hostilities in

Gordon Dean, chairman of the Atomic Energy Commission, 1950-1953, at a press conference. Source: Department of Energy.

Korea, the Atomic Energy Commission asked the Department of Defense to join in a renewed study of a continental test site. "We now feel," Chairman Dean stated, "that a national emergency is, at least, possible." The Commission did not want to seem "unduly pessimistic," Dean continued, but believed it would be "wise to reexamine the question of a continental site with the objective of having available a definite and specific site which could be recommended for use if needed." Although the Commission was

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of Mexico coast in Texas made the final five list of potential sites but were of lower

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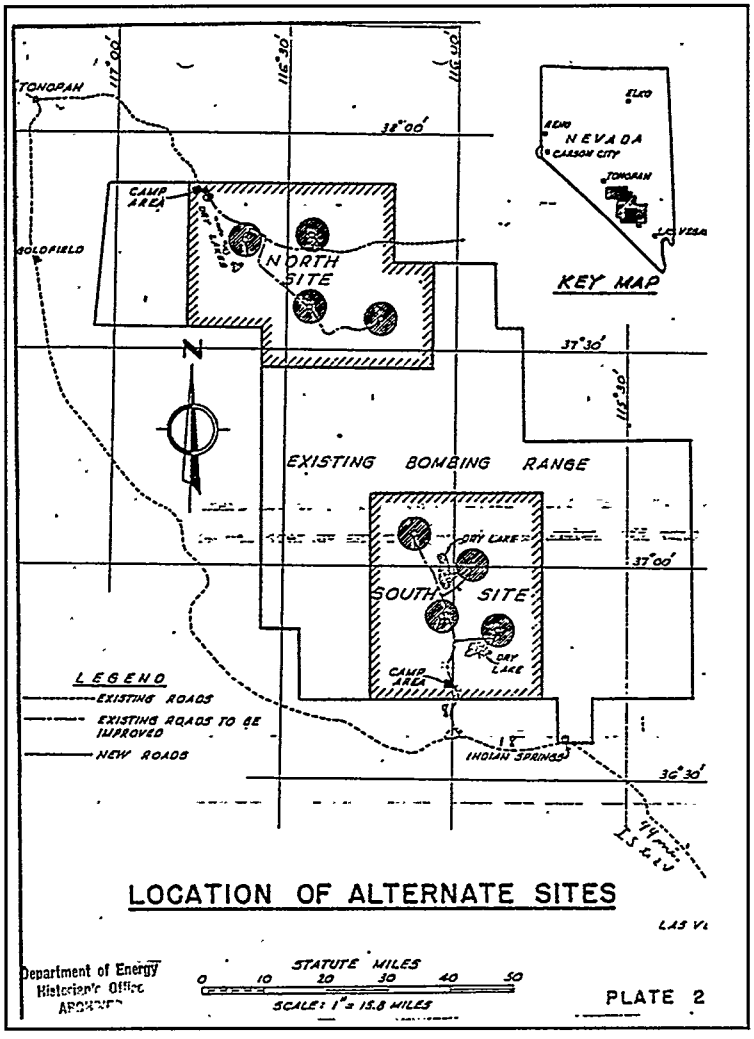
ipated direction might blow without drop-

ping fallout on any nearby town. These initial considerations led Bradbury in late July to confidently predict that tests in Nevada could be conducted with "a degree of public radiological safety which would considerably *exceed* that of the Alamogordo operation."[38]

Holmes and Narver, its contractor for operations at Enewetak, to perform a quick survey to locate a specific testing site within the range and estimate the costs of shifting Greenhouse to the continental site. The company found "two general areas," designated as the "North Site" and the "South Site,"



Holmes and Narver map showing the location of the North and South sites. Source: Holmes & Narver, "Report Covering the Selection of Proposed Emergency Proving Ground for the United States Atomic Energy Commission," August 14, 1950.

The Nevada site also held other advantages. Immediately to the south of the bombing and gunnery range was a government–owned airfield at Indian Springs, with runways 6,600 feet in length and housing for about 300 to 500 people. Convinced of the viability of the Nevada site, the Atomic Energy Commission asked meeting the general criteria for a proving ground. Located in the extreme northwest corner of the gunnery range approximately 35 miles southeast of Tonopah, the North Site was situated in a basin known as Cactus Flat, at an elevation of about 5,330 feet, with the Kawich Valley adjoining it on the southeast. The South Site consisted of two large

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added, could be "made at a later date." With the South Site at the bombing and gunnery range remaining the preferable site, the Atomic Energy Commission arranged in mid–September for the Army Corps of Engineers to conduct a thorough topographical survey and investigate sources of water supply. The Corps was also tasked with locating a one–mile square "camp area to house approximately 1500 men."[41]

Commission and the Departments of State and Defense and tasked with locating a continental test site. The search, however, was essentially over. The major participants were already predisposed toward selecting the South Site.[42]

A week later on November 22, Los Alamos test officials recommended the Nevada site in glowing terms. They noted that the

"assurance of safety," population density was "so very small" that suitable controls could be established with "very little logistic effort." The site offered "no foreseeable radiation hazards," the Los Alamos testers observed, for shots "possibly as high as 50 KT and certainly none for a 25 KT detonation." In addition, the knowledge gained from "small yield weapons" might extend "maximum allowable yield." Logistics also posed "no operational limitations." Nearby Las Vegas possessed all of the facilities required for "transient living and general construction," with a sizeable labor pool, contractors with equipment, and rail and air terminals. A black–topped highway, U.S. Highway 95, passed only seven miles south of the "target area," allowing easy access from Las Vegas. The government–owned air base at Indian Springs, eighteen miles from the site, would allow "air traffic direct from Los Alamos" and could accommodate a peak load of over 1000 personnel. "It is recommended," the testers concluded, that "this [redacted] considered a completely satisfactory alternate" to overseas sites, the Nevada location "most nearly satisfies all of the established criteria." The "most critical" of these criteria, he noted, dealt with radiological safety. "Not only must high safety factors be established in fact," he observed, "but the acceptance of these factors by the general public must be insured by judicious handling of the public information program." McCormack stated that the Nevada site would "permit a substantial improvement in predicted safety over the Trinity shot," and he recommended that it be selected for "immediate development and early use as a continental atomic test site." The Commission quickly accepted the recommendation, and three days later the Special Committee of the National Security Council followed suit. On December 18, President Truman approved the choice. He directed that any "publicity attendant on the establishment" of the site be coordinated by the National Security Council.[44]

Part IV:
Preparing to Test, December 1950–January 1951

The Need for an Immediate Testing Series

The fast–track decision–making process for selecting a portion of the Las Vegas Bombing and Gunnery Range for the continental test site was fortunate and perhaps not entirely inadvertent. Before President Truman even signed off on the new test site, the Los Alamos laboratory and the Atomic Energy Commission were laying plans to conduct nuclear weapons tests there sooner than anyone imagined or thought possible.

Already in November 1950, Los Alamos bomb designers realized that possible design flaws existed in the implosion devices slated to be tested during the Greenhouse series. They concluded that several test detonations needed to be made, if at all possible, prior to Greenhouse in order to "protect the Eniwetok program." By mid–December, "very intensive planning" was underway at Los Alamos for a series of three to five shots at the new test area—usually referred to as the Nevada Test Site, but sometimes as Site Mercury*—to be conducted in mid–January or early February 1951. Insufficient lead time existed to prepare for tower shots, so the tests would be "air bursts" dropped from an airplane. As initially envisioned by the Los Alamos test planners, the series would be of a "secret nature" with no outside agency, other than a small Air Force group, participating. The planners were also aware that an "enormous amount of preparation" was necessary in a very short period of time. If these preparations could not be completed by early February, they concluded, the tests would be of no use for Greenhouse and would be canceled.[45]

The Atomic Energy Commission moved quickly on the new test series, which Schlatter dubbed the "Hurry–Up Operation" but officially became Ranger. On December 20, Dean informed the Military Liaison Committee of the proposed series. Although no operational plan yet existed, he assured the committee that Ranger would be a "relatively simple operation, requiring minimum support of a special or critical nature." Dean noted that the expected explosive yields from the tests would be relatively low, "in the range of a few KT, perhaps less that 1 KT in some instances." Ranger, nonetheless, could not be taken lightly. As Schlatter observed, some concern existed that "a small shot is not necessarily an equally small rad safety problem compared to former big shots." This meant, he continued, that "for complete safety (Public Relations) it may be well to organize a high capability for rad safety despite a low probability of needing same."[46]

The more immediate question, however, was what role the military would play in Ranger. Air Force Lt. General Elwood R. Quesada, commander of Joint Task Force 3 for the Greenhouse operation, contended that the test series should be the responsibility of his task force. The Atomic Energy Commission disagreed. Schlatter argued that the task force was "neither necessary nor sufficiently flexible" for the purposes of the test series. McCormack stated that this was a responsibility that the Commission could not "appropriately share" through the mechanism of a task force. In the end, with the relative proximity of Los Alamos and much reduced logistical and security requirements, task

**The name Mercury predates the test site and is derived from the Mercury Mine, which was located at the southern end of the site.*

[redacted]

title to the Nevada Test Site. On December 19 and 21, 1950, following President Truman's approval of the continental site, agency officials met with representatives of the Air Force to reach an agreement on the "joint use" of the Las Vegas Bombing and Gunnery Range. Air Force officials pointed out that continued use of the eastern portions of the range for the gunnery training of

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Barracks and a mess building would be made available for 200 to 250 people. The Air Force representatives acknowledged that the facilities being assigned were of a "temporary type only" and in poor condition, with "tar paper torn off [and] roofs blown off." The Commission would have to perform the necessary repairs to "make them habitable." The Air Force officials also made

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This was not an idle concern. On January 2, 1951, a headline in the Las Vegas *Review-Journal* speculated about the planned "Big Indian Springs Plant." Noting that details had not been revealed because of "security regulations," the newspaper reported that the project would be one of the largest ever established in Clark County and might involve the building of three separate new town sites. A contract for the project, the newspaper stated, had been awarded to the McKee Construction Company, which built the "Los Alamos 'A' Plant in New Mexico" and was setting up offices on South Main Street. Construction was expected to begin "within the next couple of weeks." The *Review-Journal* said that, according to the Air Force at Nellis, the project was "classified as Top Secret" and no official information would be released. The newspaper added that "for the past two or three weeks, plane loads of Federal officials have been [redacted] United States and make the public feel at home with atomic blasts and radiation hazards." The "most important angle to get across," they concluded, was the "idea of making the public feel at home with neutrons trotting around."

The field had public information ideas of its own. On January 3, Tyler cabled headquarters with the operations office and laboratory's views on "national and local Nevada public relations." Tyler noted that the "semi-secrecy" surrounding the Greenhouse series and other Pacific tests could "not be applied in this instance." The close proximity of the Ranger series to populated areas and "the public fear of atomic weapons" would likely give rise to "considerable public concern." This concern, he stated, could be countered and "any national reaction" could be "conditioned" by holding all public

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testing program. The entire second page of the release discussed radiological safety requirements for which "full consideration" had been given. Stressing the extensive monitoring that would be done and the various committees and panels that had given the test site a seal of approval, the release listed those individuals, including Fermi and

On January 4, Dean sent formal requests to the Special Committee, under separate cover, for approval of the testing program and the press release. In his test approval request, Dean laid out for his fellow committee members the proposed five–shot program, describing in some detail the nature of

the shots and what hopefully would be accomplished. He assured the committee that the radiological safety program had received "expert approval" and that, from a safety perspective, the test series would "go forward shot by shot, the decision on each one being based on observations of the results of the preceding shots." Dean singled out the fifth shot, "Item F," for special attention. He stated that the fifth shot presented a "different radiological problem" because its yield, projected at thirty to forty kilotons, would be significantly higher, by a magnitude of three or four times, than any of the other four shots. Noting that Item F was "tentative," he said that its firing would "depend on favorable radiological data from preceding shots, assuring acceptable radiological safety standards."[55]

Four days later, Dean learned that the press release and the test program were both in trouble. Two experts on the radiological safety panel, one of whom was Fermi, did not want their names listed on

Secretary of Defense George C. Marshall and Secretary of State Dean G. Acheson. Source: U.S. Department of State.

the release. More worrisome, Secretary of Defense George C. Marshall, who had replaced Johnson in September, did not want to approve the press release without a meeting with Dean and Secretary of State Dean Acheson. Marshall questioned the wisdom, in a tense international situation, of revealing that the United States had small nuclear weapons. In addition, the Joint Chiefs of Staff, Dean was informed, had "some very slashing recommendations" on the release. They wanted to eliminate all reference to both radioactive danger and any "intensive" effort. The Joint Chiefs also opposed the fifth test in the series, not because of what it would reveal about small weaponry but because it was too big. Apparently they had promised Truman that there would be no big tests at the continental site. They did not, as Dean put it in his diary, "like the big 'F' test but they did like the little ones."

Dean was dismayed. On the press release, he believed strongly that "we have a public relations problem here . . . that the JCS don't appreciate." Fearing a decision for no press release, however, he acquiesced to a rewrite of the release that was "somewhat misleading" in that it contained no reference to intensive tests and eliminated the list of names and the radiological safety information on page two. On Item F, Dean was less certain from a technical standpoint—"What does that 5th shot do?" he asked McCormack—but willing to fight for it if his advisers deemed the "big bang" essential. He let McCormack document what would happen if the fifth shot was left out of Ranger. Dean, meanwhile, focused on the radiological safety aspects of the test. He asked Charles L. Dunham, medical branch chief in the AEC's Division of Biology and Medicine, if there were any other radioactive hazards other than potential exposure to sheep. Dunham responded that with "a pretty good sized burst" there might be trouble if it rained heavily over a populated area within two hours of the shot. When Dean asked if that would mean minor skin burns, Dunham replied that this "would be the worst thing that could possibly happen to the people."[56]

The following day, Dean met with Marshall and Acheson. Dean stated that the Commission felt "very strongly" that there must be a public announcement. He defended the original two–page draft, noting that the "real public relations problem" would come "when we have to admit that we have fired the first of a series of atomic explosions." The "real reason" for these tests is a "speed–up of our weapons program," Dean observed, and "we must put it on this basis and the Military should back us in that." Dean's argument apparently swayed the military. The next day, Marshall approved the

release, which excluded the material on rad safety but reinstated the clause on the speed–up of the weapons development program. The Special Committee also approved forwarding to President Truman a Ranger series proposal that included the fifth shot. On January 11, Truman officially approved both the test series, with the fifth shot, and the press release.[57]

Going Public

The Atomic Energy Commission went public with the press release on January 11, 1951, at 3:00 p.m., Eastern Standard Time. In conjunction with the release, the Atomic Energy Commission initiated a concerted effort to individually inform—"tipping them off two or three hours in advance," as Dean put it—members of Congress and state and local officials having special interest in the new Nevada Test Site and the impending series. "We must touch base," Dean noted, "with many people who, if not taken into

Nevada Senator Pat McCarran. Source: Nevada Historical Society.

our confidence, would misinterpret the whole program."[58]

In the nation's capitol, informing the Nevada congressional delegation was top priority. On the morning of January 10, Dean called Senator Pat McCarran (D), senior senator from the state, and asked to meet with him, and possibly the entire Nevada delegation, that same day. McCarran responded that he and Senator George Malone (R) "didn't always see eye to eye." Dean thus saw McCarran alone, reporting that the meeting was "very pleasant," and met with Malone and Nevada's lone congressman, Walter S. Baring (D), the following morning.

All eighteen members of the Joint Committee on Atomic Energy had already been informed by memorandum hand–carried to each member. On the afternoon of January 10, Dean asked William L. Borden, executive director of the Joint Committee, if any of the committee members had expressed reservations concerning the testing issue. Borden replied that some were "glad that it isn't where 'I live'" and there was some "feeling of concern about the hazards of it." He noted that Representative Henry M. Jackson (D–WA) questioned the wisdom of having a pre–test announcement because it could only compromise security. Borden commented that the "good briefing" of the influential McCarran, eighteen years in the Senate and Chairman of the Judiciary Committee, was a "good omen." Borden added that he thought it "amazing" that news of the continental tests had "not leaked out yet."[59]

In Nevada, informing newly elected Governor Charles Russell (R) took precedence. The AEC organized a special delegation consisting of Tyler, Bradbury, and several others to fly to Carson City and inform the governor of only one week that his state had been chosen to host a nuclear weapons test site. This was a somewhat touchy matter. As one AEC official put it, "it may be advisable to indicate that the project to be discussed is not a 'plum' for the State of Nevada." Despite the importance of the briefing mission, bad weather prevented the delegation from reaching its destination. As a fall–back, Dean called Russell, and Tyler had a "public relations man" explain the situation to the governor over the phone.

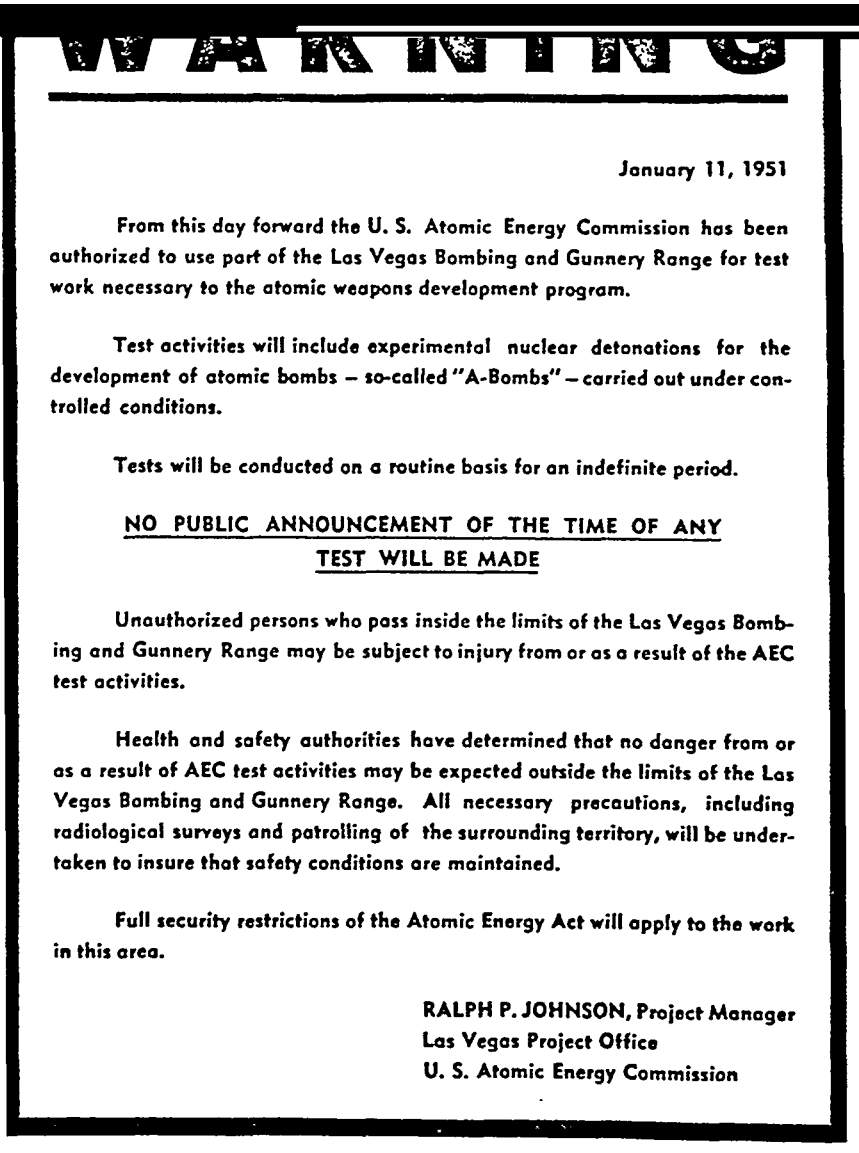
Nevada Governor Charles Russell. Source: Nevada Historical Society.

and contamination of water supplies. Dunham had assured Dean that no hazards were "likely to occur." Tests would only be conducted when the wind was from the southwest, away from California, Dunham observed, and "there couldn't possibly be any damage" to Colorado River water from fallout. Dean, in turn, attempted to notify and reassure California officials. He was unable to complete a call to Governor Earl Warren (R), but he did talk with Los Angeles Mayor Fletcher Bowron. Dean told the mayor that the Atomic Energy Commission would "perform a few explosions" at the new Nevada site. Noting that "there might be some rumors to the effect that these explosions will contaminate [the] Los Angeles water supply," Dean stated that "in fact . . . they will not be harmful." Bowron thanked Dean and assured him that "he would see

Ralph P. Johnson as the manager of the field office, Alvin C. Graves, chief of the test division at Los Alamos, as director of "technical operations" at the site, and Thomas L. Shipman, chief of the laboratory's health division, as director of radiological survey work. A separate release issued at Los Alamos indicated that the field office would be located at the South Main Street site. Later, when testing began, a room was rented at the El Cortez Hotel on Fremont Street to serve as a public information office. Finally, the AEC posted warning signs at the site and issued handbills. The handbills, headlined in big, black lettering with the word **WARNING**, stated that "NO PUBLIC ANNOUNCEMENT OF THE TIME OF ANY TEST WILL BE MADE."[61]

Public and Press Reaction

On January 12, 1951, the day after going public on the Nevada Test Site, Chairman Dean undoubtedly felt pleased. Not only had President Truman approved in full the testing program but there had been "no adverse comments" to speak of from public officials or the press. Dean's public relations people in Nevada reported overwhelmingly favorable reaction at the local level. City and county officials in Las Vegas "appeared very



WARNING

January 11, 1951

From this day forward the U. S. Atomic Energy Commission has been authorized to use part of the Las Vegas Bombing and Gunnery Range for test work necessary to the atomic weapons development program.

Test activities will include experimental nuclear detonations for the development of atomic bombs – so-called "A-Bombs" – carried out under controlled conditions.

Tests will be conducted on a routine basis for an indefinite period.

NO PUBLIC ANNOUNCEMENT OF THE TIME OF ANY TEST WILL BE MADE

Unauthorized persons who pass inside the limits of the Las Vegas Bombing and Gunnery Range may be subject to injury from or as a result of the AEC test activities.

Health and safety authorities have determined that no danger from or as a result of AEC test activities may be expected outside the limits of the Las Vegas Bombing and Gunnery Range. All necessary precautions, including radiological surveys and patrolling of the surrounding territory, will be undertaken to insure that safety conditions are maintained.

Full security restrictions of the Atomic Energy Act will apply to the work in this area.

RALPH P. JOHNSON, Project Manager
Las Vegas Project Office
U. S. Atomic Energy Commission

Warning handbill distributed by the Atomic Energy Commission on the day of the continental test site announcement. Source: REECO, Bechtel Nevada.

satisfied" with the information supplied to them, and a two–hour press conference held at the El Cortez by Tyler, Bradbury, Johnson, Graves, and Shipman was "largely a get–acquainted session." Officials in Tonopah and Pioche who were contacted by phone rather than in person because of the adverse weather seemed "satisfied and disclosed no sense of uneasiness about the announcement." As for Governor Russell, Tyler and Bradbury offered to come to Carson City as soon as the weather permitted, but the governor said he did not think this was necessary and he was "very happy

with the AEC's cooperation with him." An Atomic Energy Commission public information official in Carson City did speak with a number of Nevada legislators and reported "no difficulty . . . nor did there appear to be any sign of uneasiness that might crop up in the future."[62]

The press generally reported the unveiling of the continental test site as a major story. The staid New York *Times* ran a small head-

Postcard of the El Cortez Hotel on Fremont Street in Las Vegas. Site of the Atomic Energy Commission's public information office during the Ranger series. Source: University of Nevada, Las Vegas, Special Collections.

line—"Atomic Bomb Testing Ground Will Be Created in Nevada"—over a two–column article, but other newspapers, especially those in the southwest, featured front–page stories with eye–popping headlines. The Salt Lake City *Deseret News*'s banner headline declared "Atom Blast Site Set Near Vegas." In an inch–and–a–quarter type, the Los Angeles *Times* announced "U.S. TO SET OFF ATOMIC BLAST NEAR LAS VEGAS." The Las Vegas *Review–Journal* headline simply said "Test A–Bombs at Indian Springs." Most of the articles were basically rewrites of the Atomic Energy Commission's press releases, but there was some speculation that the testing plan heralded "new atomic techniques." The Washington *Post* mentioned the possibility of "small scale atomic explosions," and Joseph Myler, a reporter for United Press, noted that the fact that the Atomic Energy Commission would continue to use Enewetak, presumably for hydrogen bomb weapons tests, indicated that the Nevada tests would be "special purpose" devices that were "more compact and more deliverable," such as "atomic missile and atomic artillery warheads" or "an atomic mortar shell."[63]

The local press in southern California and Nevada, understandably, delved into more detail on the potential personal impact of the tests on their readers. The Los Angeles *Evening Herald Express*, citing Mayor Bowron and Metropolitan Water District officials who had been brought into the Atomic Energy Commission's confidence, reported that the tests would have no effect on Los Angeles drinking water. The *Review–Journal*, reporting on the El Cortez press conference, told Las Vegas residents they could "sit back and relax" because the government scientists had stated that they probably "won't see or feel the effects." The mountains between Las Vegas and the testing grounds would, the newspaper reported, "shield the city and its citizens." The Atomic Energy Commission/laboratory delegation at the conference stressed that a major reason for choosing southern Nevada for the test site was the lack of rain. "Ironically," observed the *Review–Journal*, "hardly had these words been spoken than the Las Vegas area got its first taste of rain in months." Shipman then explained how "radioactive rain drops" after the Trinity test had caused the hides of a herd of cattle to "become mottled" but that after over five years of observation the herd was now "fat and sleek [and] apparently unaffected by their atomizing." "Another item," commented the *Review–Journal*, "to assure local residents they need not harbor fear of any projected test."[64]

Despite the admonition not to worry, the Atomic Energy Commission's announcement apparently prompted a degree of unease among the local citizenry. On January 15, the *Review–Journal* editorialized that the "furore occasioned" by the impending atomic bomb detonation was "entirely uncalled for." So far as Las Vegas was concerned, the newspaper opined, "the citizens need have no fears that the explosions will affect them in any way." Noting that the majority of Las Vegas had "welcomed the AEC project with open arms," the *Review–Journal* contended that Nevada could "contribute much to the war effort by having the atomic project with-

Announcement of the continental test site made big headlines.

in its boundaries." Nevada had "always been in the vanguard support of such warfare," the newspaper concluded, "and the citizens will be proud of their ability to serve." Beyond appeals to simple patriotism, the local press also readily pointed out the potential material benefits for the community. Although most of the initial workforce at the site consisted of McKee employees with security clearances who had been brought in from outside the area, the Las Vegas *Morning Sun* reported that local contracts

Pulitzer Prize-winning editorial cartoonist Bruce Russell's take on the new continental test site. Soviet leader Josef Stalin, lower left, comes up snake eyes with testing in Nevada. Source: Los Angeles Times, *January 13, 1951.*

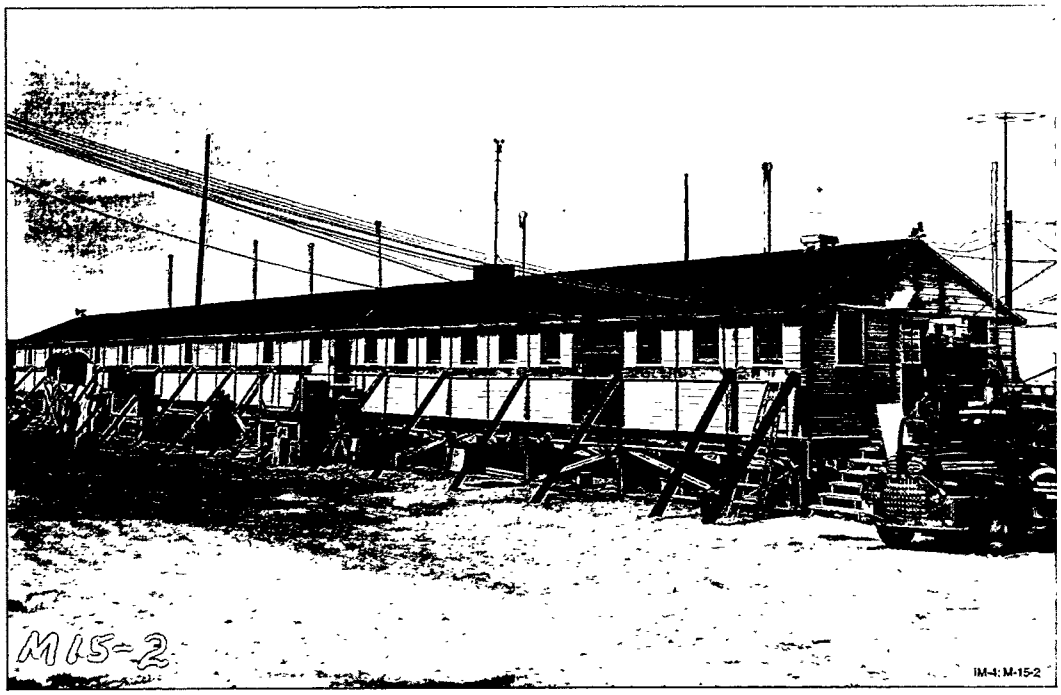
bomb." The mayor was the only Alamogordo resident to voice some jealousy. "I believe Alamogordo deserves the right to continue to be the testing center for any bomb project," he argued, "in view of the fact that the first explosive was tested near here."[66]

Part V:
The Ranger Series, January—February 1951

The Test Site Takes Shape for Ranger

Conducting a nuclear weapons test series, from conception through the final test, in only two months proved a daunting but not insurmountable task. Made all the more difficult by the total security and secrecy that surrounded the first month of the project, preparations were nonetheless well under way by the time President Truman approved Ranger and the impending use of the Nevada Test Site was made public. Following a visit to Los Alamos and the new test site in mid–January, Atomic Energy Commission testing chief George Schlatter pronounced the preparations for Ranger "definitely under control." All major problems were being met, he noted, and "minor soft spots" were being quickly corrected. "I see no reason why," he stated, "the tentative dates cannot be met very closely." Schlatter predicted that the McKee Company would complete site construction by January 20, at which point Los Alamos technicians, assisted by personnel from Edgerton, Germeshausen and Grier, Inc. (EG&G), would arrive for final installation of diagnostic and experimental equipment.[67]

Facilities at the test site were primitive at best. No existing structures were available for test personnel to use, so everything had to be brought in or built from scratch. Workers "re–erected" a surplus frame build-



South side of the control point building. Entrance to the control room is at right. Men on porch are looking north toward ground zero. Note braces shoring up the building. Source: Los Alamos National Laboratory.

View toward the south and the control point from the top of the blockhouse at ground zero. Note the entrance ramp to the shelter. Dry Frenchman Lake is to the distant left. Source: Los Alamos National Laboratory.

Instrument room in interior of blockhouse. Source: Los Alamos National Laboratory.

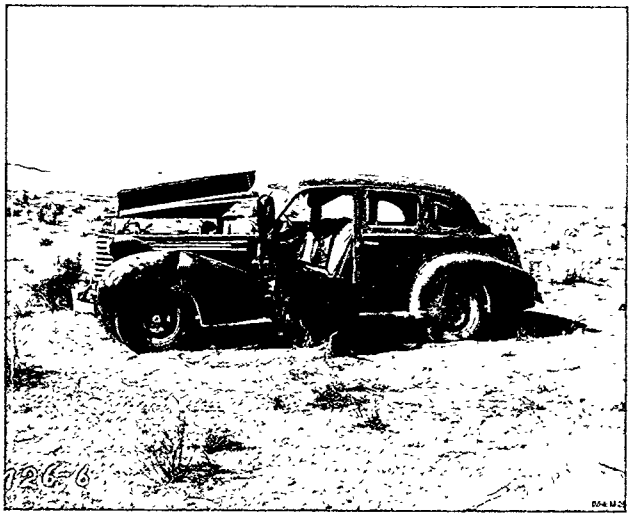
Generator building under high tension wires. Blockhouse is in the distance toward the very center of the picture. Source: Los Alamos National Laboratory.

Panel two of forty-eight panels with samples of various materials. Source: Los Alamos National Laboratory.

as shelters during an atomic attack. Five 1936 to 1939 sedan–model automobiles—a Buick, Oldsmobile, Chevrolet, Lafayette, and

single most difficult task of the Ranger series. John C. Clark, who as deputy test director took charge of the Nevada program while Graves concentrated on Greenhouse, remarked that it was "not exactly an experience [one] would like to repeat once or twice each year." Everything needed to be thought out, precisely coordinated, and implemented in a matter of weeks. The test group, forming the core of Ranger, consisted of the experimental program, radiological

Oldsmobile four-door sedan placed at one mile from ground zero, oriented at about a 45-degree angle to the blast. The windows on the blast side were broken. One was blown in and the other badly crushed. The windshield was cracked. The paint and tires on the blast side were charred, but the tires remained inflated. The side facing the blast was bashed in. The hood was lifted but not blown off. Apparently the door on the blast side had been left open, because there was a sharp line of demarcation of charred area visible on the upholstery. The motor seemed undamaged, as was the battery, given that the horn still operated. Source: Los Alamos National Laboratory.



Chevrolet two-door sedan placed one-and-a-half miles from ground zero still burning four hours after the shot. Oriented at about 60 degrees from the blast, the car was completely burned. The glass was destroyed as a result of the fire. The headlights were not broken, and the chrome was not charred. The top was warped. The front tires remained inflated and intact. Source: Los Alamos National Laboratory.

[redacted]

days. Communications, personnel, and public information were major tasks in and of themselves.[70]

Official Visitors

Handling of official visitors was a relatively minor component of the test series that consumed major amounts of time and effort. Initially, Tyler and Bradbury stressed that there would be "no press or other non–technical visitors" during Ranger. This should be, they recommended, "an absolute prohibition, not to be breached." Although excluding the press was easy, keeping away important personages from Washington—members of Congress and top Atomic Energy Commission and Department of Defense officials—simply was not realistic. Not count-

Visitor seating for Frenchman Flat events. Source: DOE, Nevada Operations Office.

"heavy flight clothing" and protective glasses, the visitors were bused to a guard post about one–quarter mile from the control point from which they viewed the test. They were not, Clark later noted, "taken to the target area." Bused back to Indian Springs for breakfast, the visitors were then taken to Nellis. Some complications arose at Nellis when certain dignitaries requiring "special transportation by aircraft to various destinations" could not leave because the aircraft

Thomas L. Shipman, chief of the Los Alamos Scientific Laboratory's health division and director of radiological survey work for the Ranger series. Source: Los Alamos National Laboratory.

sion" for the radiological safety of all participating personnel as well as the "surrounding population, livestock, crops, and water supply" but also determining, through "facts and

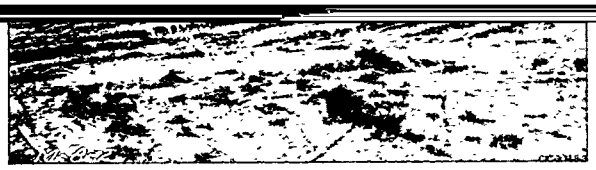
were particularly well suited" to continental testing, Clark later observed, and the "fact that all the shots were air detonations greatly simplified the operations and minimized the radiological fall–out problems." Partly the confidence was attributable to the geographical and meteorological conditions existing at the test site. These conditions were the primary reasons the site was located where it was, and "hypothetical tests" conducted on December 30 and January 8 helped confirm the belief that safe tests could be conducted under appropriate weather conditions. In any event, Shipman felt assured enough to set "permissible levels of exposure to external radiation" for personnel at less than half that allowed in the already completed Greenhouse plans. Greenhouse permitted weekly exposures of up to 0.7 roentgen.** Ranger allowed only 0.3 roentgen.[72]

**The roentgen (R) measured exposure and, with some conversion, could be used to determine dose. By 1950, scientists had determined that a one–time, whole body dose of up to 25 roentgens would usually result in "no obvious injury." Doses up to 50 R would result in "possible blood changes but no serious injury." Between 200 and 400 R, injury and disability would be certain, with "death possible." 400 R would be fatal to 50 percent of the population. 600 R would be fatal to all. Higher total doses could be tolerated if stretched out over a period of time. Barton C. Hacker,* Elements of Controversy *(Berkeley: University of California Press, 1994), pp. 1–2; Samuel Glasstone, ed.,* The Effects of Atomic Weapons *(Los Alamos, NM: Los Alamos Scientific Laboratory, September 1950), p. 342.*

such an eventuality. The plans centered on protecting people from "undue hazard due to fallout" by removing them from "such areas as may be contaminated." If found necessary, removal would be accomplished by a special Army unit brought in and bivouacked near Nellis. With ten large trucks substituted for use as personnel carriers, the unit could move 200 people per trip. Evacuees would be brought to Las Vegas where they would become the Atomic Energy Commission's temporary guests. Las Vegas had the "attractive capability of tripling its population overnight, due to its many motels, hotels, and hospitals," the evacuation plan stated. "Normally the population of Las Vegas doubles on the week–end."[74]

On the Eve of Able

As construction workers and technicians completed efforts to prepare the Nevada Test Site for nuclear weapons testing, attention



Blockhouse looking toward the southeast following the "dry run" on January 25, 1951. Source: Los Alamos National Laboratory.

off the bombing and gunnery range. The second stated that the Atomic Energy Commission, with the assistance of the Civil Aeronautics Administration and the Air Force, would "control air flights" over the test site.[75]

Any lack of public interest in test site activity ended when test officials conducted a "complete dry run" in the early morning hours of January 25. Test officials designed the dry run to provide operational experience to all test personnel and to assure themselves that all plans had been properly

[redacted]

any difference between the dry run and the actual tests to follow, and, as a result, the Commission's Las Vegas Information Office would only say that it was in agreement with the governor's statement. The press was not so reticent. The Las Vegas *Review-Journal* ran a banner headline that declared in huge two-inch letters, "VEGAS A-BOMB POPS!" The accompanying article was less certain, admitting that it was unclear whether or not the detonation was nuclear.[76]

Despite the unwanted publicity, the dry run, as Clark observed, "proved very useful to everyone involved" but particularly to the radiological safety group, which was "not well organized." Shipman agreed with this assessment. Communications with field monitors were "shown to be unsatisfactory," and at the control point "complete confusion was the order of the day."[77]

Ranger series detonation. Source: Los Alamos National Laboratory.

any prior shot and, as a result, provided a "lesser show." The "visual effects," according to one observer, seemed "less spectacular than those reported for previous detonations, with shorter duration of luminosity of the

Headlines proclaimed the advent of the Ranger series.

fireball, slower rise, faster cooling, no real thermal column formed, no mushroom head, and the fission–product cloud rising only to a fairly low altitude." Physical damage consisted of the breaking of some, but not all, of the target lights as well as two windows in the generator building and of the scorching of the sagebrush for several hundred yards in the vicinity of ground zero. Although an explosion equivalent to one thousand tons of TNT still demanded respect, radiological safety hazards were also

minimal. Minutes after the test, the first survey team, riding in a jeep, headed in toward the target area. At about two miles from the drop site, they encountered the first traces of radioactivity, and, arriving at ground zero an hour and a half after the detonation, they found only relatively minor levels registering no higher than 0.75 roentgen per hour. Offsite monitors faired even better, obtaining few readings above the background level. This might have been "somewhat disappointing to those who were looking for excitement," Shipman noted, "but thoroughly reassuring to all people with the responsibility for the safety of the public and for the continuation of the operation itself." The radiological safety success of Able also allowed officials to relax the "rather strict meteorological criteria" that a shot could not be fired unless the winds were blowing from a point somewhat to the south of due west. Now planners were given much greater leeway concerning wind direction.[79]

Whatever panache Able might have lacked for veteran test observers, the news media appeared impressed enough. For officials watching the sky from Nellis sixty–five miles away, it had been "immediately obvious" that Able was no dud, so there was no hiding this test from the public. The Las Vegas *Review–Journal* once more trotted out the two–inch type and proclaimed, "VEGANS 'ATOM–IZED'," with a sub–heading claiming, "Thousands See, Feel Effects Of Detonation." Convinced by now that the dry run had been non–nuclear, the newspaper reported that this was "the real thing." The "super solar light" generated by the blast, the *Review–Journal* noted, "lighted the sky so brilliantly that residents of southern Utah, scores of miles away, saw the flash." The paper also reported "'rumblings'—presumably the muffled sound of the distant blast" and related the vivid description provided by a truck driver who was at the top of Baker grade on the highway to Los Angeles as Able detonated. "A brilliant white glare rose high in the air and was topped a few instants later by a red glow which rose to great heights," the truck driver observed. "The bright flash blinded me for a few seconds and gave me quite a scare." In Las Vegas, the flash was followed by a mild earth tremor and a "blast of air like a windstorm" that was felt in "an irregular pattern" throughout the city.

Las Vegas residents nonetheless evinced little concern. Most slept through the early Saturday morning blast, and, although there was a "half–hour deluge" of calls to the Las Vegas police, the test, according to the Salt Lake City *Deseret News*, caused "little stir" in the town. A "prominent local citizen" stated that while residents were not exactly "blase about it," there was not "any panic or anything like that." As an example of the gambling community's relaxed attitude, the *Review–Journal* cited a crap player at the Golden Nugget in downtown Las Vegas who, upon feeling the shock from Able, paused, looked around, said "Must be an atomic bomb," turned back to the table, and went on with the game.[80]

Baker Is Bigger

With weather conditions cooperating and minimal radiation levels in the target area so that technicians could "reestablish" experimental and diagnostic equipment, Atomic Energy Commission and Los Alamos officials decided to push ahead with Baker on January 28, only twenty–four hours after the Able test. Detonated, as with Able, at first light at a height slightly over a thousand feet, Baker with a yield of eight kilotons was

View from top of blockhouse on January 27, 1951, following Able shot, as workers prepare for Baker. Source: Los Alamos National Laboratory.

[redacted]

from the surrounding mountains.

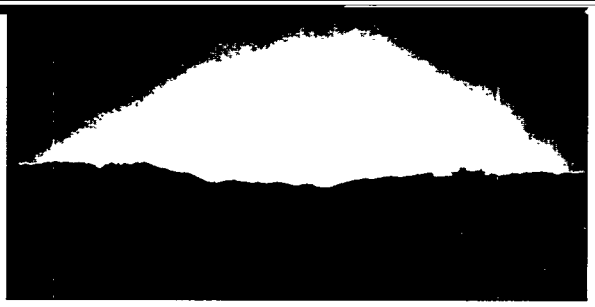
Monitors reached ground zero about ninety minutes after the detonation and, at sixteen roentgens per hour, found much higher levels of radiation than they had at the Able test. Subsequent checks indicated about an

"danger." Las Vegas *Morning Sun* publisher Hank Greenspun, who over the next four decades would become something of a local institution, sought to quiet the "irresponsible and hysterical utterances." He admonished residents to "feel proud to be a part of these history–making experiments." Las Vegas, he

Workers repairing the blockhouse on January 31, 1951, following Baker. Note the protective masks and foot coverings. Source: Los Alamos National Laboratory.

of the nation's defense, the national press speculated that the Atomic Energy Commission was experimenting with devices "much smaller than those employed heretofore." Smaller devices meant bombs and projectiles that could be used "against limited targets and for tactical purposes." This was, the Washington *Post* editorialized, "a most hopeful development." Bombs the size of the one dropped on Hiroshima could be used only for "indiscriminate mass destruction." Their impact, observed the *Post*, could not be "localized." Smaller weapons, by contrast, could be used against combat troops and might "prove to be a decisive weapon of defense." As a defensive rather than an offensive weapon, they could, the Post concluded, put a "stop to aggression [and] be . . . an effective deterrent to war."[83]

The Atomic Energy Commission soon learned, however, that the effects of even small devices like Able and Baker could not



Time-sequence photos taken of the Easy shot, February 1, 1951, by a Life *magazine photographer near U.S. Highway 95, thirty-five miles southeast of the test. First two photos are within the first second of the blast. Third photo is fifteen minutes later in the fuller light of dawn. A "thin wisp" of smoke can be seen rising over the mountain ridge. Source: TimePix.*

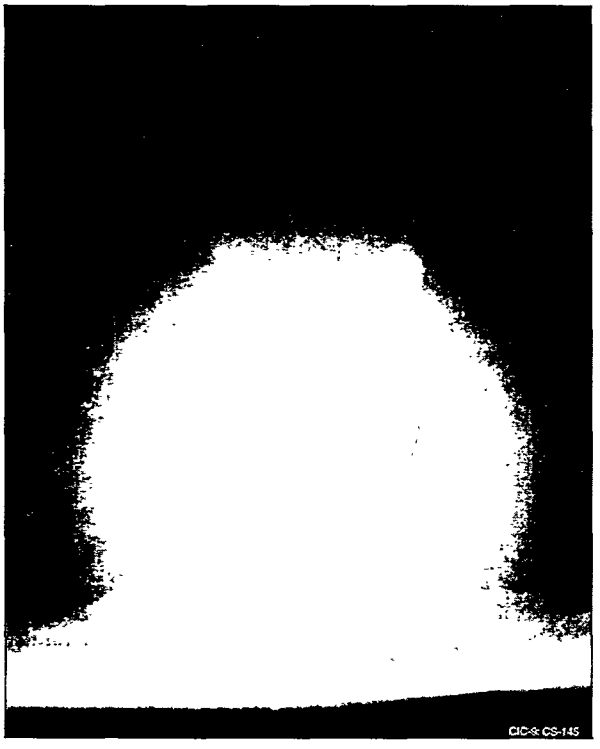
[redacted]

cloud passed. Baker Two also produced at least two broken store windows in Las

[redacted] above the target. The target area itself was

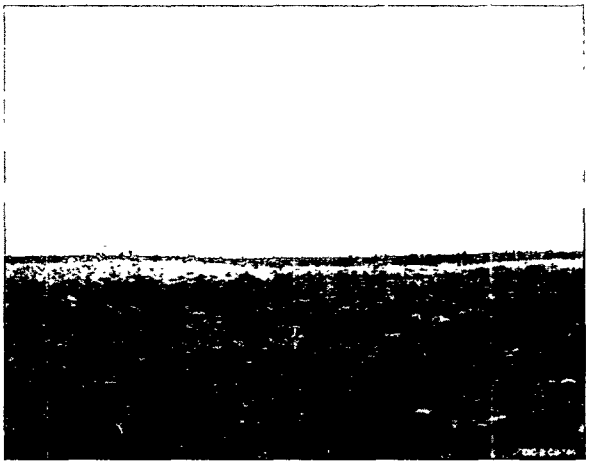
moved 500 feet to the west. This was done to minimize damage to the ground zero blockhouse, so as not to jeopardize diagnostics and to "get a better spread of data" for measuring the effectiveness of the detonation. The bomb detonated approximately 300 feet south of the new zero point.

Fox produced a somewhat less than expected yield of 22 kilotons. The "visual show" provided by the test was still "very spectacular" compared to the preceding four detonations. Observers at the control point,



Fox shot, February 6, 1951. Source: Los Alamos National Laboratory.

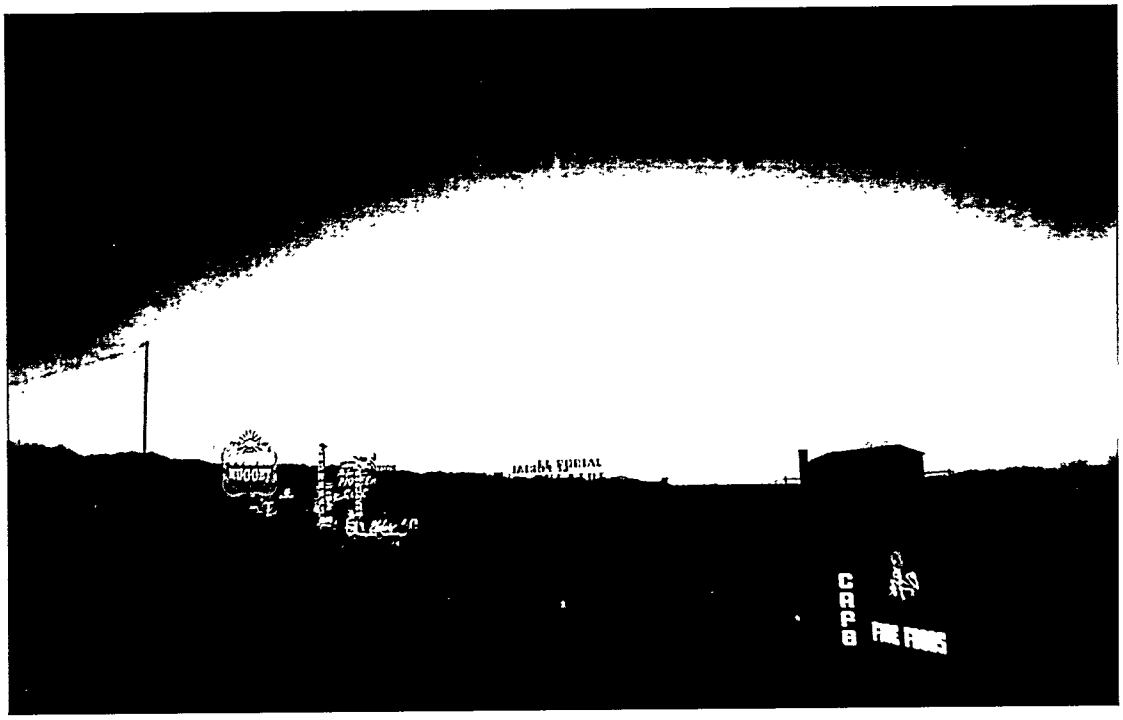
8.9 miles to the south, felt a "distinct heat flash" at the instant of the burst. The surrounding mountains, from 20 to 50 miles distant, were "illuminated by blinding whiteness which was far more intense than noon daylight." The two "very solid shock waves" felt at the control point less than a second apart "produced about the same sensation as standing in the open next to a 16–in. coast–defense gun when it is fired." Although the control building had been rigidly braced, the blast wave knocked most of the equipment and clothing off the shelves inside the building. Following the blast, a dense dust cloud filled the entire valley. With visibility reduced to about 100 yards, the dust cloud persisted over the tar-



Dust cloud over Frenchman Flat from Fox, two hours after the blast. Source: Los Alamos National Laboratory.

get area until late morning. Due to the increased height of the burst, induced radiation in the target area was somewhat less than for Baker and Baker–Two. The top of the mushroom cloud soared to 43,000 feet and then drifted south toward the Spring Mountains where its lower portion "practically invested Charleston Peak." Radiation levels, again, quickly fell when the cloud passed.[87]

Las Vegas escaped with limited damage. The blast wave, arriving not quite six minutes after the actual detonation, "splintered" big show windows in two automobile dealerships but did little more than shake buildings and frighten citizens. Gamblers reportedly ducked under tables in one casino, and some witnesses said they were temporarily blinded by the brilliant flash. Indian Springs, however, 25 miles from ground zero and with a range of intervening hills, was particularly hard hit. More than 100 windows were broken. Doors were blown open and, in a few cases, were completely off the hinges. All equipment on shelves weighing as much as 5 pounds was thrown to the floor. A nearby house received an estimated $4,000 worth of damage that included windows broken, doors blown entirely out of casements, and roof damage. In the bathroom of the house, the blast wave knocked the plumbing fix-



Fox shot seen from downtown Las Vegas, top, looking west over Fremont Street. Ranger shot seen from the roof of the Herald-Examiner building, Los Angeles, California, bottom. Source: AP/Wide World Photos and Los Angeles Public Library.

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Atomic Energy Commission officials negotiat-

ed with the Air Force for continued use of the Indian Springs facilities as well as the building at Nellis. The Atomic Energy Commission also had to deal with claims for offsite damages from the tests. Of the 131 claims received, the Atomic Energy Commission settled the vast majority of these by May with expenditures of slightly more than $14,000. Total estimated costs for the entire Ranger series were approximately $2 million. This, Clark concluded, was "certainly only a fraction of that required for tests conducted at the Eniwetok Proving Grounds."[92]

[redacted]

Yucca Flat. They thus sought to avoid the blast effects "noticed" at Las Vegas during Ranger by moving ground zero further away. They located the control point on the north

[redacted] 1,100 residents, including both Atomic Energy Commission and military personnel as well as a large number of construction

Mercury, main base camp of the Nevada Test Site. Source: REECO, Bechtel Nevada.

workers. Following Buster–Jangle, the Atomic Energy Commission expanded the camp facilities, adding more barracks, a second mess hall, a recreation facility, and warehouse, office, and laboratory space. Eventually, as testing became routine and more or less year round, Mercury developed most of the amenities found in a typical small town, including a hospital, fire station, post office, police station, movie theater, bowling alley, and a fine dining establishment.[94]

Atoms for War and Peace

For over four decades, the Nevada Test Site served as the nation's principal proving ground for nuclear weapons. Most of the very largest tests, those in the megaton range, took place in the Pacific or, later, underground at Amchitka far out in the Aleutian Islands, but almost ninety percent of the 1,053 tests since Trinity have been conducted at the Nevada Test Site. During the 1950s, atmospheric testing was the rule at the site. This made for some spectacular visual performances but also sent radioactive clouds beyond the test site boundaries and sometimes over inhabited areas. Increased concern regarding radioactive fallout helped spur international test ban negotiations that eventually culminated in the Limited Test Ban Treaty of 1963.

The test ban treaty banned atmospheric testing but legitimized underground testing. During the 1960s, weapons development and testing became largely routinized. Underground testing dampened much of the concern with blast effects and radiological safety. Full–time professional test personnel constantly occupied themselves with either testing or preparing for the next test.

testing. In 1996, international negotiations produced a Comprehensive Test Ban Treaty. The Senate has not ratified the treaty, but the moratorium on testing remains in effect.

At the same time that the primary mission of the Nevada Test Site has historically been the testing of nuclear weapons, the site also has served as a testing station for other projects, some military oriented and some designed to support and promote peaceful uses of the atom. Beginning in the late 1950s, the test site played host to the Pluto ramjet and the Rover rocket programs for which the AEC designed and tested the nuclear reactors. The Pluto program, funded by the Air Force, sought to produce a system

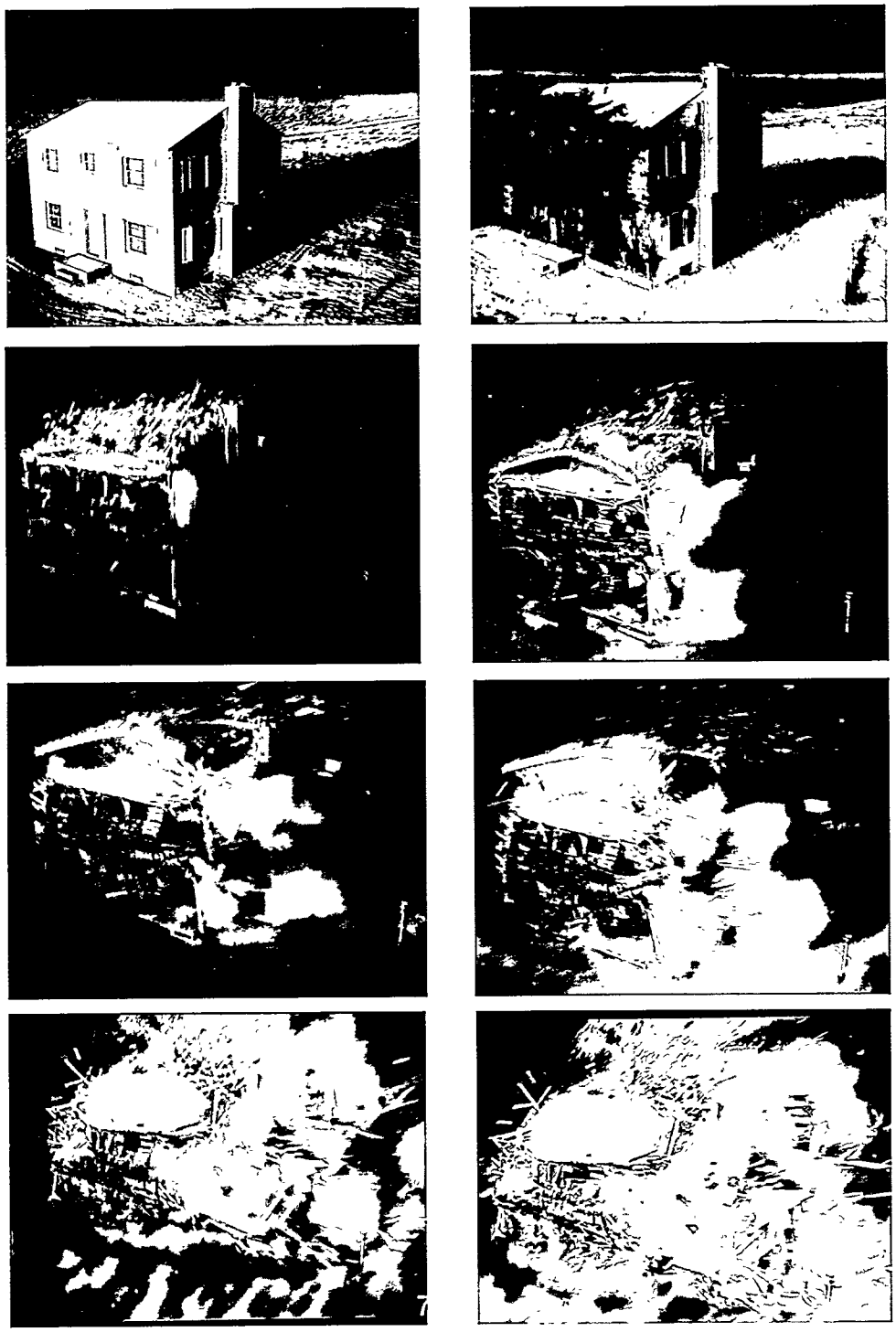
Nuclear ramjet engine on its test bed facility, a railroad flatcar. Source: REECO, Bechtel Nevada.

The Plowshare program, begun in 1957, sought to develop peaceful uses for nuclear explosives. Over the next fifteen years, the Atomic Energy Commission conducted thirty–five Plowshare tests. The excavation tests, designed to demonstrate that nuclear devices could quickly and cheaply move massive amounts of earth in the digging of canals and harbors, were conducted at the test site. Most spectacular was the 1962 Sedan test. Buried 635 feet below ground level at a site in the far north end of Yucca Flat, the 104–kiloton blast lifted a huge dome of earth 290 feet in the air, moved 6.5 million cubic yards of earth and rock, and left a crater 1,200 feet across and 320 feet deep. The lip of the crater towered as high as 100 feet into the air. Sedan also sent a cloud of radioactivity off in the direction of Salt Lake City, creating a brief scare when radioactive iodine–131 turned up in the local milk supply. Inability to totally contain the radioactivity coupled with disappointing results eventually signaled the death knell of the program in the mid–1970s.

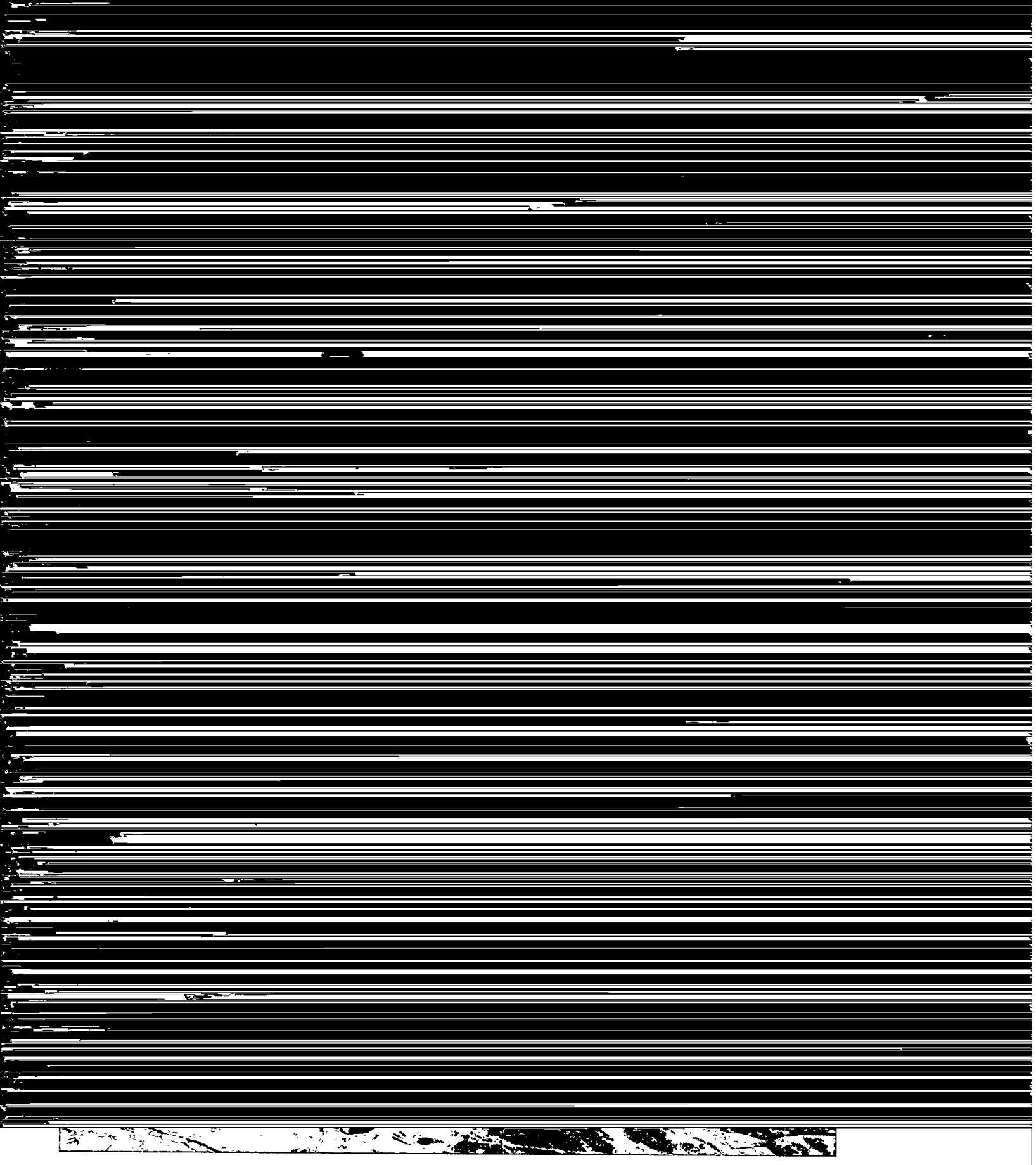
Expanded missions also meant an expanded test site. From the original 16– by 40–mile rectangular tract, land to the west of the site was added to accommodate the Rover program in the Jackass Flats area. An irregular–shaped parcel encompassing Pahute Mesa at the northwest corner was taken over in the 1960s and used for high–yield underground and Plowshare tests.

July 6, 1962, Sedan Plowshare test. Source: REECO, Bechtel Nevada.

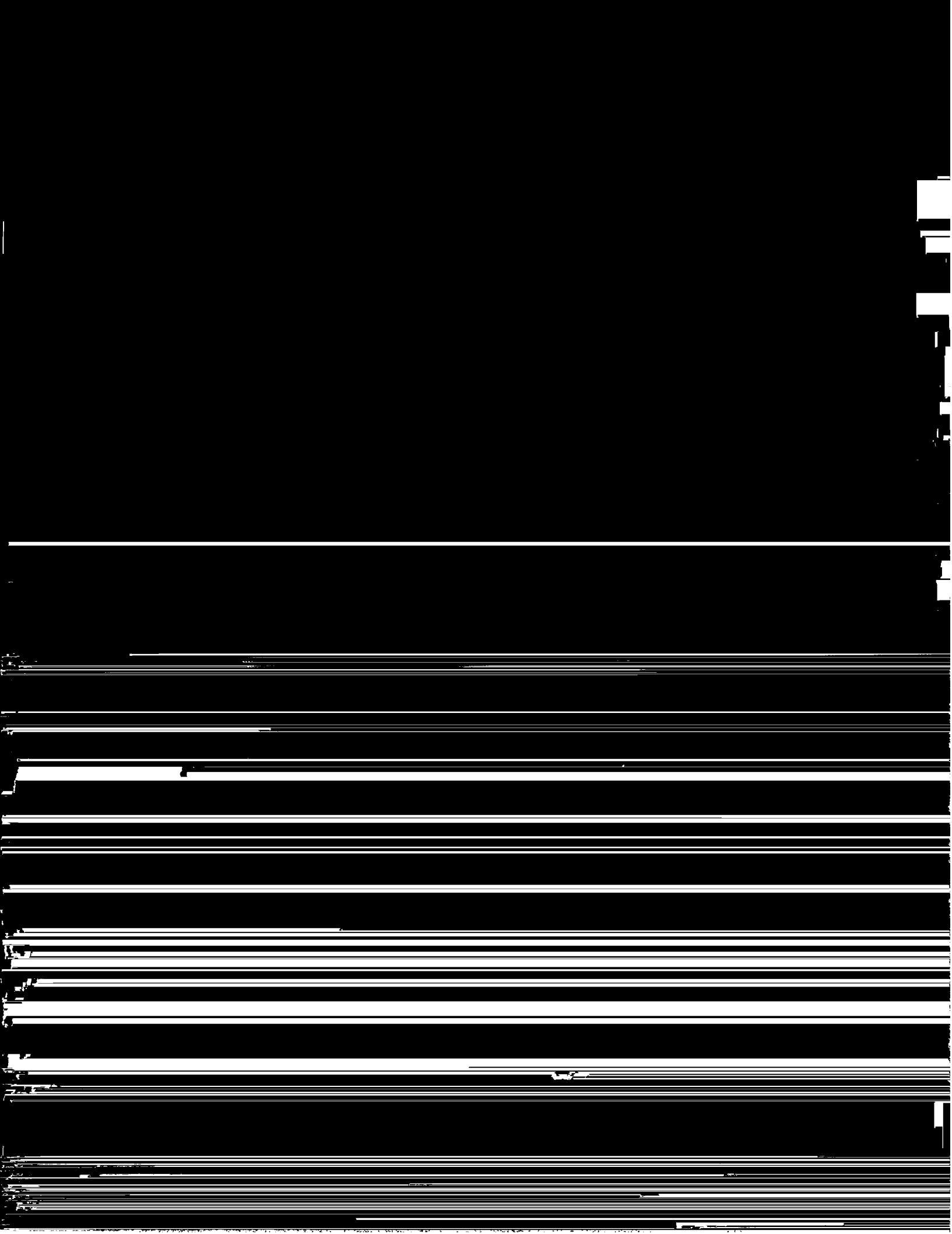
President John F. Kennedy being briefed at the Nuclear Rocket Development Station at Jackass Flats, December 8, 1962. To the President's right is Atomic Energy Commission Chairman Glenn T. Seaborg. Source: REECO, Bechtel Nevada.



Time-sequence photos of a house 3,500 feet from ground zero during a March 17, 1953, weapons effects test at Yucca Flat. Shooting 24 frames per second, the time from the first to last picture was two-and-one-third seconds. The camera was completely enclosed in a two-inch lead sheath as a protection against radiation. The only source of light was that from the blast. In frame 1, the house is lighted by the blast. In frame 2, the house is on fire. In frame 3, the blast blows the fire out, and the building starts to disintegrate. Frames 4 through 8 show the complete disintegration of the house. Source: REECO, Bechtel Nevada.



Subsidence craters left from underground nuclear testing at the north end of Yucca Flat on the Nevada Test Site. Source: DOE, Nevada Operations Office.



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23. *Ibid.*, pp. 75–78, 84–86, 89–93 98–108; Rhodes, *The Making of the Atomic Bomb*, pp. 664–65; Gosling, *The Manhattan Project*, pp. 48–49.

24. Gosling, *The Manhattan Project*, pp. vii, 49–54, 59.

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30. Hacker, *Elements of Controversy*, pp. 26–27, 40; Hewlett and Duncan, *Atomic Shield*, pp. 75, 130; Preuss to Russell, February 10, 1949; AEC 141, Location of Proving Ground for Atomic Weapons, September 15, 1948; 30th AEC–MLC Meeting, September 16, 1948; Lilienthal to Chairman, Military Liaison Committee, September 24, 1948.

31. Hacker, *Elements of Controversy*, pp. 13, 40; W.S. Parsons to Director, AEC Division of Military Application, August 17, 1948; Howard B. Hutchinson, "Project Nutmeg," January 28, 1949.

32. Hutchinson, "Project Nutmeg."

33. Hacker, *Elements of Controversy*, p. 40; Preuss to Russell, February 10, 1949; Sumner T. Pike to Chairman, Military Liaison Committee, March 8, 1949.

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