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Tech Area II: A History

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Sandia Contract No. SA-0004A

Abstract

This report documents the history of the major buildings in Sandia National Laboratories' Technical Area II. It was prepared in support of the Department of Energy's compliance with Section 106 of the National Historic Preservation Act. Technical Area II was designed and constructed in 1948 specifically for the final assembly of the non-nuclear components of nuclear weapons, and was the primary site conducting such assembly until 1952. Both the architecture and location of the oldest buildings in the area reflect their original purpose. Assembly activities continued in Area II from 1952 to 1957, but the major responsibility for this work shifted to other sites in the Atomic Energy Commission's integrated contractor complex. Gradually, additional buildings were constructed and the original buildings were modified. After 1960, the Area's primary purpose was the research and testing of high-explosive components for nuclear weapons. In 1994, Sandia constructed new facilities for work on high-explosive components outside of the original Area II diamond-shaped parcel. Most of the buildings in the area are vacant and Sandia has no plans to use them. They are proposed for decontamination and demolition as funding becomes available.

Acknowledgments

I would like to thank Kris Mitchell of Battelle-Pantex, and George T. West, Jerry Burling, and Leigh Bratcher of Mason & Hanger–Silas Mason Company for providing a tour of the Pantex assembly buildings and information about both Pantex and Burlington. I am also grateful to Frank Bacon, Paul Cooper, Phil Dailey, Roy LeBlanc, Harold Rarrick, Lucien Rice, and Anita Renlund—Sandia employees and retirees who provided information about the work they did in Area II. Thanks also to Rod Curtis for allowing access to Building 904 and explaining the work done there. Finally, I am particularly grateful to Lloyd Bonzon, Manager of Explosive Projects/Diagnostics for extensive advice on the first draft of this report, as well as suggestions for contacts among former Area II employees.

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Terms, Abbreviations, and Acronyms

AEC	Atomic Energy Commission
AFSWP	Armed Forces Special Weapons Project
DOE	Department of Energy
ECF	Explosive Components Facility
GAC	The Atomic Energy Commission’s General Advisory Committee
HE	high explosive
LANL	Los Alamos National Laboratory
LLNL	Lawrence Livermore National Laboratory
NHPA	National Historic Preservation Act
NOTS	Naval Ordnance Test Station, Inyokern, California
Royal	Kansas City production plant for non-nuclear components of nuclear weapons
SHPO	State Historic Preservation Officer
SLR	Sandia Laboratory, Road Department, 1948-1949
SNL	Sandia National Laboratories
SNL/NM	Sandia National Laboratories/New Mexico site
Sugar	Burlington, Iowa production plant for high-explosive lenses and weapon assembly
WWII	World War II
Z-Division	A division of Los Alamos formed in 1945. In 1948, Z-Division became Sandia Laboratory, a Branch of Los Alamos; in 1949, Sandia Laboratory was separated from Los Alamos and was operated by Sandia Corporation, a wholly owned subsidiary of Western Electric.

1.0 INTRODUCTION

Sandia National Laboratories (SNL) is a national security laboratory currently operated for the U.S. Department of Energy (DOE) by the Sandia Corporation, a Lockheed Martin Company. Sandia's primary mission has always been to design the non-nuclear components for U.S. nuclear weapons. As the requirements for the stockpile have changed over the years, Sandia has been involved in a variety of activities related to, and spinning off from, the core of its nuclear weapons responsibilities. Nevertheless, the bulk of the work done at Sandia, and certainly the work reflected in most of its properties, has always been related to the non-nuclear aspects of nuclear weapon design. This work includes weapon design, component design and testing, production engineering, stockpile maintenance, and stockpile surveillance.

Technical Area II is one of five technical areas at the SNL/NM site. It currently encompasses approximately 208 acres roughly bounded by 9th Street on the west; R Avenue and the extension of R Avenue on the south; Harden Avenue on the north; and Eubank Boulevard turning into Tijeras Arroyo on the east. This area includes several new buildings and is much larger than the area initially considered Tech Area II, which it includes. The original site of Tech Area II is a diamond-shaped piece of land of approximately 45 acres, surrounded by a 10-foot high chain link fence, with one guard tower standing outside the gate at the western point of the area. The area is located about 1/2 mile south of the fenced portion of SNL's main work area, Tech Area I. The diamond-shaped parcel is approaching 50 years of age and is currently being evaluated for its historical significance. Figure 1 is a plan of the original area encompassed by Tech Area II, with the existing buildings identified.

Between 1948 and 1952, Tech Area II was the primary assembly site for America's nuclear weapons. The area was designed and constructed in 1948 specifically for the assembly of the non-nuclear components of nuclear weapons, and both the architecture and location of the oldest buildings in the area reflect their original purpose. Weapon assembly continued in the area after 1952, but the major responsibility for assembling War Reserve, or stockpile, weapons shifted to other sites in the Atomic Energy Commission's (AEC) integrated contractor complex.

It is important to realize what "weapon assembly" meant in this early period. Although the Little Boy gun-type nuclear weapon received some research and development attention after World War II, the majority of the early postwar nuclear weapons were implosion weapons, based on the Manhattan Project's World War II Fat Man design. In essence, the implosion weapon consisted of a central core of nuclear material surrounded by a sphere of high explosive (HE). Detonation of the high explosive squeezed the central core of nuclear material, compressing it to a supercritical mass. Introduction of neutrons to the highly compressed core initiated the nuclear chain reaction.

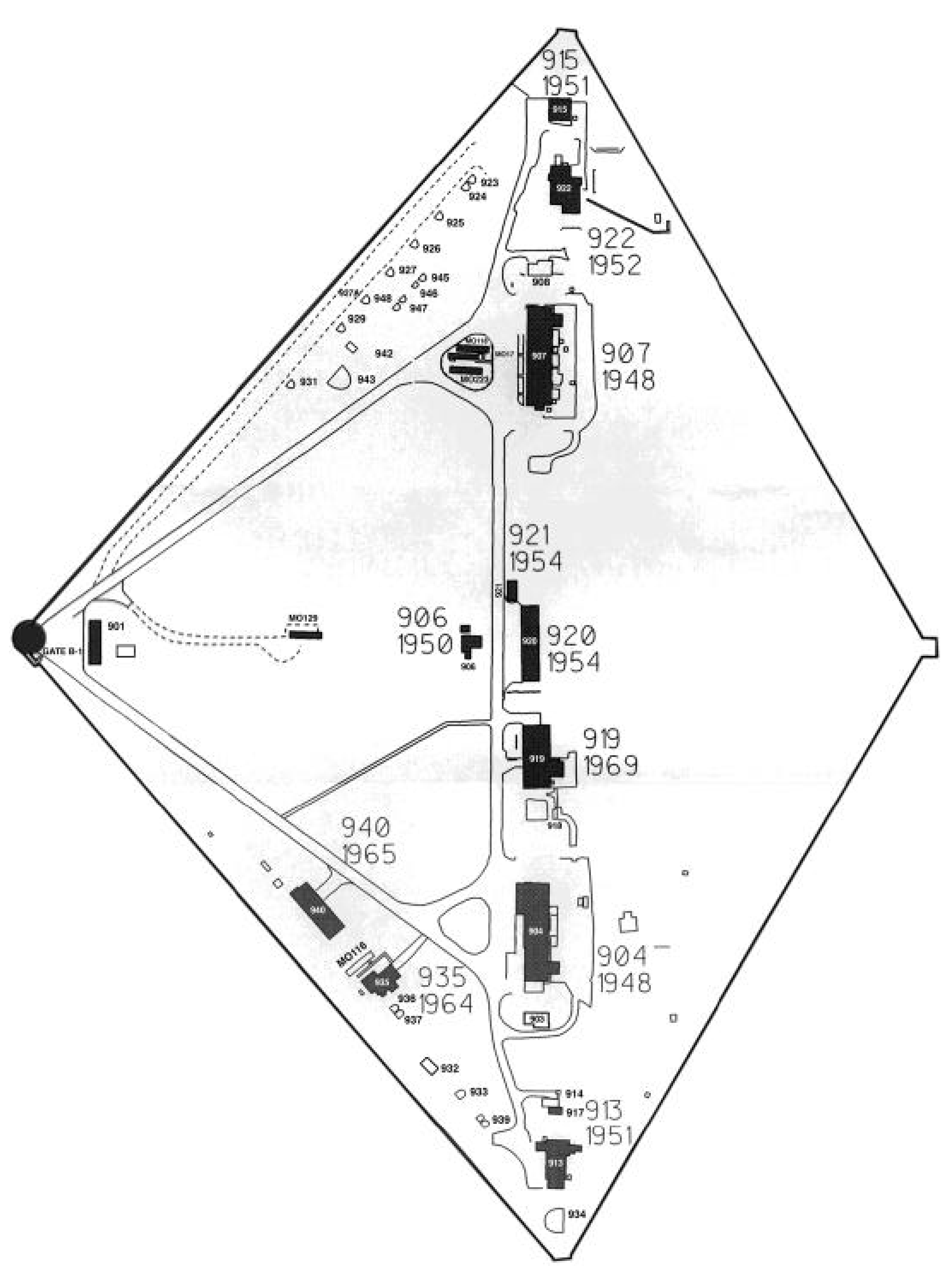

Figure 1. 1996 drawing of diamond-shaped parcel that was originally designated Tech Area II. Buildings are identified by building number and, for larger structures, the date they were built.[1]

[1] Plot Plan provided by SNL Sites & Space Planning Department, drawn by Karen Lahde, 9/25/96.

These early weapons were assembled without their nuclear physics packages, or capsules. The non-nuclear components, including the large high-explosive lenses, were assembled and stored separately from the nuclear material and components that turned them into nuclear weapons. The devices, assembled without their nuclear cores, were known as sub-assemblies or mechanical assemblies. Were a weapon to be used, it had to be partially disassembled, the nuclear core inserted, and the weapon reassembled. Sealed-pit weapons—weapons with their nuclear components installed during assembly—did not enter the stockpile until 1957. Although the possibility of assembling sealed-pit thermonuclear weapons in Area II in an emergency was discussed, it was never actually done.[2]

The period 1952-1959 represents a transitional period for Area II. Weapon assembly was gradually moved out of the area at the same time that a growing interest in using explosives in a variety of weapon components caused a search for appropriate facilities in which to conduct such research. The former assembly buildings were modified to accommodate the new work and new buildings were also constructed. The work consisted of both basic research—in an effort to better understand how energetic materials operate—and the design and testing of new components.

The push for new components was driven in part by the increasing demands for a variety of new weapon designs to meet the capabilities offered by new delivery systems, including missiles. New explosive components were also the result of internal research developments. Both the need for basic research to better understand energetic materials and the effort to apply the possibilities of explosive designs in a variety of components demanded research and testing facilities. The facilities for small explosive component research and testing were established in Area II in the second half of the 1950s and the early 1960s, when existing buildings were modified and new facilities constructed. After 1960, the Area's primary purpose was the research and testing of high-explosive components.

1.1 Purpose and Plan of Report

This history is part of the documentation collected by SNL to assist the Department of Energy (DOE) and the New Mexico State Historic Preservation Officer (SHPO) in deciding which Tech Area II properties are eligible for inclusion on the National Register of Historic Places. The other documentation collected includes a cultural resources report on the area;[3] an architectural historian's report on Buildings 904 and 907 as the two obviously significant buildings in the area;[4] State of New Mexico building inventory forms for the major structures in

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[2] R. P. Lutz to Frank C. DiLuzio, September 1956, subject: "Final Weapon Assembly at ALO Prime Contractor Plants in 1957 and Beyond," copy from the DOE Nevada Office's Coordination and Information Center, Las Vegas, Accession Number NV0135057.

[3] Steven R. Hoagland, "A Cultural Resources Survey and Review for Sandia National Laboratories, Area II, Kirtland Air Force Base, New Mexico," CGI Report 8067AC (Albuquerque: Chambers Group, Inc., 1990).

[4] David Kammer, "An Architectural Description and Discussion of the Historical Significance of Buildings 904 and 907, Tech Area II, Sandia National Laboratories/New Mexico," prepared for Sandia National Laboratories/New Mexico, Organization 7258 and submitted by David Kammer under subcontract to Advanced Sciences, Inc., Contract 434-2300 (Albuquerque, NM: Sandia National Laboratories, 1994).

Area II; mylar copies of as-built architectural drawings of Buildings 901, 904, and 907; medium-format photographs of the exteriors of the major buildings in the area; and large-format photographs of the interiors and exteriors of Buildings 901, 904, and 907.[5]

Appendix I of this report addresses the historic significance of the buildings in Area II and their eligibility for the National Register of Historic Places. Buildings 901, 904, and 907 were the original buildings associated with assembly in the area and they appear to be eligible for the National Register. Buildings 904 and 907 were built for the final assembly of the non-nuclear portion of nuclear weapons, specifically the incorporation of high explosives into the weapons. Building 901 served as the "hot line" for the area—workers changed into work clothes on their way into the area, took breaks there, and changed out of their work clothes and showered on their way out of the area. The appendix also discusses Area II as a historic district.

Beginning with a brief summary of the Cold War context for the work in Area II, this report presents a history of the area in roughly chronological order starting with Sandia's origins and the development of nuclear weapons in the United States in the period immediately following World War II (WWII). The future of nuclear weapons was uncertain in the first two years following the end of the war. Gradually, a policy was carved out of competing interests for control of the weapons and different visions of their role in U.S. defense and international relations. The decisions to place nuclear matters under civilian control, to build a stockpile of nuclear weapons, and to pursue a variety of weapon options all had an impact on the development of Sandia and its various activities, including weapon assembly. Tech Area II was created because American policy dictated the need for a War Reserve, or stockpile, of nuclear weapons. Its activities also changed because of policy decisions about Sandia's mission and the demand to mass-produce nuclear weapons at a pace requiring larger and more dedicated facilities than Area II offered.

Following the origins of Sandia is an account of the decision to establish Area II and the work to be done there. The architect, construction, and early activities in the buildings are discussed, as is the growth of the Atomic Energy Commission's (AEC) integrated contractor complex—the large array of institutions and manufacturers that created and maintain America's nuclear stockpile. The chronicle of the activities in Area II for the period 1948-1952 is followed by a discussion of the transition of weapon assembly out of Area II and the subsequent activities undertaken in the Area.

From 1952 to1959, while Sandia was moving away from weapon assembly, there was a rapid increase in the number of different types of nuclear weapons designed for America's stockpile. The variety of different delivery systems, as well as the tactical options requested by military and AEC planners, pushed the development of new and improved components for the weapons. In turn, new developments in component design led to new weapon designs and options. The environmental testing groups and the component design groups at Sandia argued for more space and newer facilities to handle the new developments. Environmental testing never had

[5] Copies of all items are stored in the SNL Corporate Archives, as are the negatives of all of the photographs taken of Area II. The SNL Corporate Archives stores drawings on paper, not mylar. Mylar copies were submitted to the SHPO.

a large presence in Area II as new facilities were developed elsewhere at Sandia to address those needs. However, the introduction of more and varied explosive components in weapon designs and the need for facilities to design and test these new components, led to the conversion of Area II's existing buildings as well as new construction. From 1960 until 1994, activities related to the testing and design of small explosive devices were concentrated in the area. Thus, Area II continued to feed America's Cold War policies. Indeed, since the decision to move the work on explosive components out of the original diamond-shaped parcel of Area II coincided with the end of the Cold War, the area's entire history was tied to its Cold War context.

2.0 OVERVIEW: THE COLD WAR CONTEXT

The history of Tech Area II, and of Sandia itself, is inextricably woven into the history of the Cold War. The creation of Tech Area II, the weapon assembly work originally performed there, and the transition into explosive research and testing in the area, are all direct results of America's Cold War policies. The area's early mission to assemble nuclear weapons was both a product and stimulus of early Cold War policies. In particular, the rapid deployment of weapons at the onset of the Korean War was directly facilitated by Sandia's ability to speed up weapon assembly and provide the emergency capability weapons. Later, when Area II was no longer used for weapon assembly, the research and testing of explosive components continually contributed new weapons to the stockpile, making America's Cold War policies possible.

Winston Churchill's "iron curtain" speech of 1946 is generally identified as the beginning of the Cold War. It was the first clear articulation of the fact that increasing tension between the Soviet Union and its World War II allies had seriously damaged East-West relations, and that viewpoints on both sides had hardened into outright animosity. Although efforts continued, particularly through the United Nations, to achieve international disarmament in the postwar period, there was little progress. The increasingly cold relations between the Soviet Union and the United States doused initial hopes that nuclear weapons could be controlled by international agreement. America's responses to the Soviet Union's blockade of Berlin in 1948 included an increase in the production of nuclear weapons, a drive that was heightened further with the 1949 detonation of Joe I, the Soviet's first atomic device.

After 1949, the U.S. and USSR entered a period of outright confrontation, marked in the nuclear weapons arena by a rapid escalation in weapon production. This arms race was fed on the American side by the Atomic Energy Commission's growing production complex, itself a product of that race. The AEC expected to build duplicate plants for all production activities in locations scattered around the country to enhance security. New weapon designs were emerging from Los Alamos Scientific Laboratory, and Sandia was engineering them for production. Building the new designs in large numbers required a large production capability. By 1951, the AEC was expecting high explosive fabrication and weapon assembly alone to require five facilities. Tech Area II was still assembling weapons, although the plan was to get Sandia out of the business of directly producing weapons. That Tech Area II was still assembling weapons in 1951 at all was a direct result of the pressure to bolster the stockpile quickly in the early, confrontational years of the

Cold War. The Burlington Plant in Iowa was already fabricating and assembling weapons and the Pantex Plant, near Amarillo, Texas had been selected but was not yet in operation. The additional three sites were never actually built, since by 1953 the Burlington site had undergone an expansion and weapon production had settled into a fairly reliable schedule.[6]

Tech Area II was only replaced as the primary assembly site for nuclear weapons when production at Burlington was going smoothly. Test devices and weapon prototypes continued to be assembled in Area II for several years. Sandia's final move away from production had been anticipated since 1947, before Tech Area II was even built. However, the demand for a larger nuclear stockpile, fueled by the early years of the Cold War, kept Sandia assembling weapons until the production complex was completely in place.

Getting out of production did not end Area II's affiliation with the Cold War. In the 1950s, the world witnessed a massive growth in the types and number of nuclear weapons at the superpowers' disposal. America's nuclear build-up was a deliberate part of the Eisenhower administration's "New Look"—the attempt to contain defense costs and ensure a frugal continuity in military strategy. John Foster Dulles, Eisenhower's Secretary of State, announced in 1954 that the administration would be proceeding with a policy of massive retaliation in dealing with Soviet military threats. While President Eisenhower himself pursued the possibility of nuclear disarmament, the type and number of nuclear weapons in the U.S. stockpile grew drastically.

From 1953 through 1961, Sandia began work on 22 new bomb programs, some of which did not make it to the stockpile, and at least as many warhead designs. The variety of weapons under development resulted from (1) the introduction of new delivery systems, particularly missiles; (2) the demand for a wider variety of capabilities to suit different potential uses of the weapons (including warheads for strategic defense forces, for tactical forces deployed in overseas theaters, and for the long-range missiles being developed for all three services); and (3) the new weapon design possibilities growing out of the research conducted at Los Alamos, Lawrence Livermore, and Sandia.

The move out of production coincided with a growing interest in explosive components and Area II was converted into an explosive devices research and development area. Efforts to make weapons smaller and lighter, to make them easier to handle and more reliable, combined with the belief that explosives would make components more precise and predictable to push explosive research and development efforts. Area II became a small explosive devices development laboratory by 1960 and remained so until 1995, when the explosive activities were all moved out of the area. However, not all of the design and development work on explosive components was done in Area II, as most groups associated with this work had labs and offices in other areas and used the Area II facilities for testing energetic materials.

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[6] For a discussion of early AEC expectations and attempts to get the production complex going, see Richard G. Hewlett and Francis Duncan, *Atomic Shield, 1947/1952*, vol. II of *A History of the United States Atomic Energy Commission* (University Park and London: The Pennsylvania State University Press, 1969); and George T. West, *United States Nuclear Warhead Assembly Facilities (1945-1990)* (Amarillo: Mason & Hanger - Silas Mason Co., Inc., Pantex Plant, March 1991).

Cold War demands for more types and numbers of weapons were the impetus behind the explosive work done in Area II and the explosive work served to support American aims and policies in the Cold War. However, it is difficult to demonstrate that any given component changed the course of the Cold War, or even to identify how all of the explosive work in Area II over the years might have influenced American policy. The explosive research and testing is best viewed as enabling U.S. policies and practices.

3.0 SANDIA'S ORIGINS, 1945-1949

Sandia National Laboratories has its roots in World War II's Manhattan Project. Originally part of the Los Alamos Scientific Laboratory, Sandia began as Z-Division, created in July of 1945 to perform the ordnance engineering and assembly aspects of Los Alamos' design work. This was part of the initial effort of J. Robert Oppenheimer, Director of Los Alamos, to plan for the postwar period. Not much happened with Z-Division in the first few months after it was established, however. Los Alamos was involved in the rush of activities to prepare the Little Boy and Fat Man weapons for use against Japan and postwar planning was not a high priority.

Jerrold Zacharias was appointed to head Z-Division (hence the Z). In August of 1945, he submitted to Oppenheimer a proposed outline of Z-Division's possible organization. He suggested sub-divisions in charge of Experimental Systems Engineering, Assembly Factory and Procurement (including weapon assembly), Electrical Engineering, Mechanical Engineering for Production, and Electronic Engineering. In essence, Z-Division was responsible for the design and production—whether through internal assembly or procurement—of all non-nuclear components of nuclear weapons. He also proposed that only about half of the Z-Division personnel should actually move out of Los Alamos to Sandia Base near Albuquerque, because "it would seem that only the groups for the production of Detonators, firing circuits, fuses, and informers should go to Sandia and that the developmental groups should remain at Site Y [Los Alamos]."[7]

3.1 The Move to Albuquerque

In June of 1945, the Manhattan Engineer District had begun looking for a new home for the nuclear weapon engineering activities, especially the field testing and weapon assembly operations. Los Alamos was crowded and suffered periodic water and other utility shortages. In addition, materials and equipment had to be trucked to and from the airfield in Albuquerque or the rail depot in Lamy. The airfield in Wendover, Utah, which served as the headquarters of the 509th Composite Group, responsible for testing weapon shapes and training for weapon drops, was too far from Los Alamos to be convenient. Instead, a site adjacent to Kirtland Field, near Albuquerque, was chosen. East of Kirtland Field were the remains of the old municipal Oxnard

[7] J. R. Zacharias to J. R. Oppenheimer, August 6, 1945, Collection A-84-019, 7-3, Los Alamos Archives.

airfield. Known as Sandia Base, the site had been a convalescent center for wounded airmen in 1944 and was used as a dismantlement center for surplus aircraft immediately after the war. During the summer of 1945, military men from Los Alamos and Wendover transferred to Sandia Base, bringing along the weapon parts that had not been used in the weapons headed for Japan. Bomb parts ordered during World War II but undelivered at war's end were shipped to Sandia Base and stored in the open until warehouses could be built.[8]

Z-Division began moving to Albuquerque in September of 1945, with the field testing organization leading the way and the final group arriving in February of 1947. Roger Warner replaced Zacharias as Z-Division leader in the fall of 1945. The group immediately began testing to improve the Fat Man design, and initiated development efforts for the new Mk IV, the first new weapon designed in the postwar period. However, planning for Operation Crossroads, the first postwar nuclear test, interrupted this work. Held in the summer of 1946, Crossroads absorbed the attention of Los Alamos and Z-Division for months before the actual tests.[9]

Nevertheless, Dale Corson (leading Z-Division while Warner was involved in Crossroads) was able to report to Norris Bradbury (Oppenheimer's replacement as Director of Los Alamos) in the spring of 1946 that progress was being made on testing, development, stockpile assembly, and bomb assembly. In his report, Corson distinguished between stockpile assembly and bomb assembly. Stockpile assembly included "the modification testing, packaging, storing and surveillance of all components, except the high explosive pit assembly."[10] Bomb assembly, on the other hand, was done by a

> … group trained in, and responsible for, the assembly and testing of mechanical, electrical and high explosive bomb components. This group makes whatever bomb assemblies are required. At the present time this includes only test assemblies. However, should a national emergency arise, this is the only organization, other than the temporary Crossroads group, capable of assembling and testing bombs.[11]

This group was the beginning of the high explosive assembly operation at Z-Division.

In 1946, there was no stockpile of weapons ready for immediate use. Nor was there a policy directed toward creating one immediately. Further, Corson warned that, with Z-Division's

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[8] For a detailed presentation of Z-Division's move to Albuquerque and Sandia's early history, see Necah Furman, *Sandia National Laboratories: The Postwar Decade* (Albuquerque: University of New Mexico Press, 1990); for a shorter overview of Sandia's history, including these early years, see Leland Johnson, *Sandia National Laboratories: A History of Exceptional Service in the National Interest* (Albuquerque: Sandia National Laboratories, 1997).

[9] Crossroads consisted of two test shots in the Bikini atoll to assess the effects of nuclear weapons on ships at sea. Shot Able was an airdrop, while Shot Baker was an underwater detonation of a device suspended below a ship.

[10] Dale R. Corson to N. E. Bradbury, "Future Z Division Program," 11 April 1946, p. 1, in Collection A-84-019, 7-3, Los Alamos Archives.

[11] Dale R. Corson to N. E. Bradbury, "Future Z Division Program," 11 April 1946, p. 2, in Collection A-84-019, 7-3, Los Alamos Archives.

strength sapped by Crossroads and the personnel leaving the project to return to their pre-war lives, Z-Division might soon be unable to assemble any atomic bombs.

> [I]f the personnel situation continues to deteriorate at the present rate there will not only be no personnel trained in bomb assembly and testing, but there will be no one capable of teaching the art to new personnel. The gravity of the situation from a national security standpoint is obvious.[12]

Corson himself left Z-Division in July of 1946.

In spite of Corson's rather dire predictions, Z-Division survived and retained its ability to assemble nuclear weapons, but it would be another year before a consistent approach to weapon assembly was developed, and two years until there were facilities available specifically designed for weapon assembly.

3.2 Mission Definition

In the two years immediately following the end of World War II, there was no clear U.S. policy on the development of, or strategic planning for the use of, nuclear weapons. While the appropriate home—civilian or military—for the management of nuclear matters was debated at the federal level, the nuclear scientists and engineers made an effort to reorganize their facilities and advance the designs and availability of nuclear weapons without any clear policy directives.

Congress, the military, and civilian scientists and engineers struggled with the issue of military vs. civilian control of atomic energy. The debate was long and acrimonious, and resulted in the Atomic Energy Act of 1946, signed by President Truman on August 1, 1946. The Atomic Energy Act left atomic energy in civilian hands, but required close cooperation and interaction with the military. The debate over the custody of actual weapons has continued.[13]

The Act created the Atomic Energy Commission (AEC) to oversee atomic energy in the United States. All Manhattan Project efforts were transferred to the AEC and policy began to be implemented through it. On January 1, 1947, all property and personnel of the Manhattan Project were transferred to the Atomic Energy Commission.

Also driving the nuclear weapon mission at this point was the increasing tension in U.S.-Soviet relations. By 1947, international disarmament efforts were foundering; the Soviet Union began the Berlin Blockade in August of 1948; and in 1949 the Soviets detonated their first atomic device. The Berlin Blockade alone resulted in a revised production schedule that aimed to

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[12] Dale R. Corson to N. E. Bradbury, "Future Z Division Program," 11 April 1946, p. 3, in Collection A-84-019, 7-3, Los Alamos Archives.

[13] For a discussion of the Atomic Energy Act and the history of the early years of the Atomic Energy Commission, see Richard G. Hewlett and Francis Duncan, *Atomic Shield, 1947/1952*, vol. II of *A History of the United States Atomic Energy Commission* (University Park and London: The Pennsylvania State University Press, 1969).

quadruple the U.S. stockpile. The AEC was determined to create an organized system of nuclear weapon production and to have a nuclear stockpile available to meet U.S. policy needs.

3.3 Weapon Assembly

Until late 1947, the major assembly job for Z-Division was to collect, inspect, and assemble into bombs the various weapon parts that remained at the end of World War II.[14] High-explosive assemblies were created for tests, but not for stockpiling. In June of 1947, the production average for nuclear weapons was not even one bomb every two months. And, in the period from September 20, 1947, to October 20, 1947, only two units "were repaired, papered, and shipped to the Hill [Los Alamos] for … tests."[15] This was a slow process relative to the pace that would be demanded as the Cold War heated up. The Joint Chiefs expected to have 400 bombs in the stockpile by January 1, 1951, but that number pales next to the thousands of weapons introduced in the 1955-1967 period when U.S. nuclear weapon production reached its peak.[16]

The Armed Forces Special Weapons Project (AFSWP) was established in early 1947 under the command of General Leslie Groves, former head of the Manhattan Engineer District. Groves planned that the AFSWP would be responsible for the military's participation in developing military uses for atomic energy. This group included the individuals trained in weapon assembly, maintenance, and testing. They worked closely with the Z-Division assembly group, receiving their training and direction from Z-Division and, initially, doing the actual assembly work. Assembly was done by teams of 6-8 military enlisted men, in a Kirtland building under the control of the AFSWP.[17]

In April of 1947, a meeting was held at Los Alamos between representatives of the AEC, Los Alamos (including Z-Division), and the commanding officer of Sandia Base. The responsibilities of the different organizations was discussed and clarified. A quality inspection routine for high-explosive lenses was established and the responsibility of Z-Division for the "perfection of assembled charges" was clarified. In addition, it was stated that the "actual work

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[14] Robert W. Henderson, "Nuclear Weapon Production Practices," a talk delivered to a New York meeting of the American Ordnance Association, December 7, 1960, copy in Collection 76, Speeches by Sandia Management, SNL Archives.
[15] "Z-Division Progress Report, 20 September 1947-20 October 1947," p. 38, in SNL Technical Library, Central Technical File, Archive Reel 1513, p. 457.
[16] Necah S. Furman, "Sandia National Laboratories: A Product of Postwar Readiness, 1945-1950," SAND86-2145J (Albuquerque: Sandia National Laboratories, 1986), p. 14.
[17] Summaries of AFSWP origins and early assembly activities are included in Necah Furman, *Sandia National Laboratories: The Postwar Decade* (Albuquerque: University of New Mexico Press, 1990); Richard G. Hewlett and Francis Duncan, *Atomic Shield, 1957/1952*, vol. II of *A History of the United States Atomic Energy Commission* (University Park and London: The Pennsylvania State University Press, 1969); and Don E. Alberts and Allen E. Putnam, *A History of Kirtland Air Force Base, 1928-1982* (Albuquerque: Kirtland Air Force Base, 1982).

of assembly shall be carried out by AFSWP personnel under the direction of a Z-Division representative."[18]

3.4 Larsen's Reorganization

In February of 1947, Robert W. Henderson moved the last of Z-Division down from Los Alamos. Henderson served as acting director of Z-Division after Roger Warner left the organization in November of 1946 until the appointment of Paul Larsen as director in December of 1947. Under Henderson's management, the organization gained stability, but was still hampered by lack of facilities, insufficient personnel, and a general inability to overcome those difficulties. In addition to these burdens, another weapon test, Operation Sandstone, was scheduled for April of 1948 and the early preparations for Z-Division's participation fell under

If the Atomic Energy Act and the creation of the Atomic Energy Commission were the beginnings of a national atomic energy policy, that did not mean the weapon design and production facilities were in place to support such policy. The AEC commissioners visited Los Alamos and Z-Division in November of 1946 to assess the nature of the task they had been assigned. While they were impressed with Los Alamos, they found Z-Division in some disarray. Most importantly, they were shocked to discover that America had essentially no stockpile of War Reserve weapons ready to use if needed. David Lilienthal, Chairman of the AEC, reported on his visit to Los Alamos.

> The result was a shock. The substantial stockpile of atom bombs we and the top military assumed was there, in readiness, did not exist. Furthermore, the production facilities that might enable us to produce quantities of atomic weapons, and weapons so engineered that they would not continue to require a Ph.D. in physics to handle them in the field, likewise did not exist. No quantity production of these weapons was possible under the existing 'handicraft' setup.[19]

The AEC's General Advisory Committee (GAC), led by Oppenheimer, also paid a visit to New Mexico to assess the nuclear weapon situation. They arrived in April of 1947 and toured both Los Alamos and Z-Division. Z-Division's facilities were underwhelming, but the enthusiasm and enterprise among employees encouraged the GAC's members.

Z-Division was not the only place to worry about. Brigadier General James McCormack, the AEC's first Director of Military Application, had as his purview responsibility for the weapon production programs. A new plant was being built in Miamisburg, Ohio to produce weapon components, but it was not ready and there were procurement delays. The high- explosive lenses

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[18] R. W. Henderson, Acting Leader, Z-Division, to the Commanding Officer, Sandia Base, Albuquerque, New Mexico, 17 April 1947, p. 1, in Collection 322 Sandia, B-9, D-58, Los Alamos Archives.
[19] David E. Lilienthal, "The Kind of Nation We Want," *Colliers,* June 14, 1952, p. 49.

made at the Salt Wells Pilot Plant at the Naval Ordnance Test Station (NOTS), Inyokern, California, were suffering quality problems and the construction of additional facilities was slow.

In spite of the difficulties, there was room for optimism as some progress was being made.

> By the end of April, 1947, McCormack had reason to believe that he had taken the first important steps toward creating an arsenal of atomic weapons. If the plans born in that hectic month reached fulfillment, the United States would soon have at its disposal the unprecedented military power which all the world assumed lay behind President Truman's stiffening foreign policy in the face of communist aggression.[20]

Sandia kept hiring to try to meet the demand for testing, design, and assembly, but when John Manley visited the site in November of 1947 at the request of the AEC, his resulting report was still highly critical. His overriding observation reflected the concerns of other observers about the inability of Z-Division to keep up with the amount of work required.

> Z Division operation is a shoestring operation—too few people, inadequate physical plant, inadequate information, inadequate procurement and stocks. In practically every case of an unsatisfactory situation in the writer's opinion, the reason for failure to resolve such a situation was not ignorance of its existence but simply that there is no one who has yet been able to get at it.[21]

Paul Larsen was placed in charge of Z-Division in December of 1947 with the hope that his research and production backgrounds would help organize and increase production at the site.[22] He pushed hard to get Z-Division the facilities and personnel appropriate to its task, and was assisted by the recent spate of high-ranking visitors and their concerns. On April 1, 1948, Z-Division was reorganized. It was elevated to a separate branch of Los Alamos, named Sandia Laboratory, Branch of Los Alamos. Nine departments were carved out of Z-Division's thirteen groups.[23] The department known as "Road"[24] (SLR) was responsible for overall production of

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[20] Richard G. Hewlett and Francis Duncan, *Atomic Shield, 1947/1952*, vol. II of *A History of the United States Atomic Energy Commission* (University Park and London: The Pennsylvania State University Press, 1969), p. 65.

[21] J. H. Manley, "Report on Z-Division, Prepared for the General Advisory Committee," November 10, 1947, thru 11/48, Los Alamos Archives.

[22] Larsen's background included work with the Marconi Wireless Telegraph Company, Bell Laboratories, Warner Bros., and the Johns Hopkins Applied Physics Laboratory, where he had been in charge of production engineering for the proximity fuze. See Frederic C. Alexander, Jr., *History of Sandia Corporation through Fiscal Year 1963* (Albuquerque: Sandia Corporation, 1963), p. 15.

[23] "Monthly Progress Report of Sandia Laboratory for the Period March 18, 1948 to April 18, 1948," p. 4, in SNL Technical Library, Central Technical File, Archive Reel 1513, p. 815.

[24] "Road" was the code name for Sandia's production activities, it apparently derives from the phrase "let's get this show on the road," or perhaps because weapons were transported via road. See Frederic C. Alexander, Jr., *History of Sandia Corporation through Fiscal Year 1963* (Albuquerque: Sandia Corporation, 1963); Necah Furman, *Sandia National Laboratories: The Postwar Decade* (Albuquerque: University of New Mexico Press, 1990); and "Birth and Demise of the Manufacturing Development Engineering Technical Organization at Sandia," manuscript in Collection 57, History of Design Engineering Services, SNL Archives.

nuclear weapons, although high explosive assembly was only moved under Road to become SLR-6 on June 7, 1948.[25] Prior to that move, assembly was part of the Training Liaison Department.

Plans were also underway beginning in April of 1948 to double the size of the high explosive assembly group to keep up with the assembly demands as well as inspection requirements. The Personnel Division was sent out to recruit the necessary applicants.[26]

One of the major programs undertaken under Larsen's leadership was construction. A memo from Larsen on the subject of Sandia's construction program and construction budget, dated December 23, 1947, indicated 28 buildings were planned for fiscal years 1948, 1949, and 1950. While that number includes temporary structures as well as permanent buildings, it is an impressive indicator of the growth Z-Division was facing.[27] It was also the first comprehensive plan for construction created for the division. Robert Henderson later enthused about Larsen's achievements.

> Let me mention when Paul Larsen came in here to take over the laboratory … he was a breath of fresh air… So he started a building program that wouldn't quit and if it hadn't been for him at that point in time Lord knows when we would have ever gotten any buildings. We put up 14 permanent buildings, 610,000 sq. ft., between the spring of 1948 and October of 51.[28]

There was so much construction going on at the Sandia Laboratory Branch of Los Alamos that the architect had an office at the site. Building could not keep up with the Laboratory's growth, however, and there were ongoing complaints of the lack of space available to meet production goals.[29]

The space issue was further exacerbated by the ever-increasing expectations for the stockpile. A mid-1948 AEC meeting with Los Alamos and Sandia to outline proposed production schedules for War Reserve weapons resulted in a plea from Larsen for an appropriate budget increase to meet the new expectations.

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[25] "Monthly Progress Report of Sandia Laboratory for the Period May 18, 1948 to June 18, 1948," p. 13, in SNL Technical Library, Central Technical File, Archive Reel 1513, p. 1053.
[26] "Monthly Progress Report of Sandia Laboratory for the Period March 18, 1948 to April 18, 1948," p. 15, in SNL Technical Library, Central Technical File, Archive Reel 1513, p. 827.
[27] P. J. Larsen, Associate Director, Los Alamos Scientific Laboratory, to C. L. Tyler, Manager, SFDO, USAEC, 23 December 1947, from Collection 322 Sandia, B-9, D-58, Los Alamos Archives.
[28] Robert W. Henderson, Sandia Colloquium, May 29, 1987, p. 28, transcript in Collection 164, Oral History Collection, SNL Archives.
[29] The monthly progress reports to Los Alamos throughout 1947 and 1948 repeat the need for more space, reiterating the complaint that work was hampered by insufficient space. See, for example, "Monthly Progress Report of Sandia Laboratory for the Period June 18, 1948 to July 18, 1948," p. 4, in SNL Technical Library, Central Technical File, Archive Reel 1513, p. 1071.

> It is hoped that an early decision can be obtained with respect to this production requirement in order that we may properly plan for increased facilities in personnel and procurement to meet contemplated directives.[30]

Sandia was also expanding rapidly, and was up to 719 employees by July 15, 1948.

3.5 AT&T

Sandia's expansion and emphasis on ordnance engineering and production did not please the University of California, which held the management contract for Los Alamos and, hence, for Sandia. The University of California Regents felt that they were equipped to manage only research and development activities. Los Alamos Director Bradbury also felt that he was no longer able to oversee Sandia's activities properly, while Larsen envisioned a drastic change in

> Referring to your personal, confidential memorandum to me dated 7 October 1948, this is to advise that I agree fully with the philosophy as to the future planning for Sandia Laboratory. You will recall that I have planned the establishment of Sandia Laboratory on the basis that it is to be a research and development laboratory, with eventual segregation of the production activities from Sandia Laboratory.[31]

In spite of the almost unanimous view that Sandia and production should be separated, it took several more years before the Laboratory was able to shed all of its production and assembly functions. And even then, Sandia continued to have oversight for the production of weapons as part of its "cradle to grave" responsibility for weapons in the stockpile. The AEC's growing contractor complex was gradually taking over the production of components. In 1948, a former Pratt & Whitney airplane-engine plant in Kansas City was selected to manufacture weapon components and code named "Royal." NOTS Inyokern continued to supply explosive lenses and the Iowa Army Ammunition Plant near Burlington, Iowa (code named "Sugar") was undergoing renovation to begin producing high-explosive lenses. But in 1948 there was not another site prepared to conduct the high-explosive stockpile assembly of the weapons.

Instead, after a variety of proposals were explored, the University of California gave up management of Sandia and was replaced by AT&T. Sandia Corporation, a wholly owned subsidiary of Western Electric was formed on October 5, 1949. On November 1, 1949, the new corporation took over the management contract of the Laboratory, and Sandia became a Laboratory separate from Los Alamos. Paul Larsen left the Laboratory and George Landry was appointed as the first president of Sandia Corporation.

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[30] "Monthly Progress Report of Sandia Laboratory for the Period June 18, 1948 to July 18, 1948," p. 4, in SNL Technical Library, Central Technical File, Archive Reel 1513, p. 1071.
[31] Paul J. Larsen, Director, Sandia Laboratory, to N. E. Bradbury, Director, Los Alamos Scientific Laboratory, 25 October 1948, in Collection 322 Sandia, B-9, D-58, Los Alamos Archives.

4.0 AREA II, 1948-1952

Plans to construct high explosive assembly buildings at Z-Division began before Paul Larsen's appointment as director and the subsequent construction boom he oversaw. By October 20, 1947, a preliminary design for an explosives assembly building to replace the AFSWP facilities used by Z-Division had been completed and submitted to the Operations Office at Los Alamos.[32] The AFSWP assembly building at Kirtland was P605, which no longer exists.[33] Early photographs indicate it was an unreinforced wooden building, although no information is available on its design.

The staff of Z-3, the assembly group led by Art Machen, had contributed to the design of the floor plan for the new assembly building and the equipment required for assembly (e.g., the size of the cranes needed to lift the partially completed and completed weapons). However, they did not speak to the design of such building features as the blast walls.[34] It is not clear how the architect arrived at the interior blast wall design, although calculations based on the thousands of pounds of high explosive contained in each weapon of the period must have been done, either by the architect or an engineer affiliated with the project.

There was a great deal of pressure on Z-Division to get its own assembly buildings because as early as July of 1947 the AFSWP had asked to be relieved of its high explosive assembly responsibilities in providing both high-explosive handlers and the assembly building.

> The early completion of the HE assembly building to replace the AFSWP facilities now being used by Z-Division continues to be of high importance. General Groves has signified his intention of pulling AFSWP out of the HE assembly business by March 1948. From a Z-Division personnel viewpoint this is well within reason. In fact, Z-Division could take over these duties entirely as of this date if the space were available. However, AFSWP will not give Z-Division the unqualified use of the present building since they will not agree to split the command in the present ordnance area.[35]

By August of 1947 the Z-Division personnel office had a recruiter in the field looking for individuals with high explosive handling experience. By September the assembly group had begun to hire explosives handlers, and by November of 1947 the

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[32] "Z-Division Progress Report, 20 September 1947-20 October 1947," p. 10, in SNL Technical Library, Central Technical File, Archive Reel 1513, p. 429.

[33] Conversations with both the Kirtland Air Force Base Real Estate Office and Cultural Resources Officer indicate that P605 was destroyed, but there is no documentation available as to when the building was removed or what it was used for after its assembly responsibilities were complete.

[34] Telephone conversation with Phil Dailey, September 3, 1997.

[35] "Z-Division Progress Report, 20 October 1947-20 November 1947," p. 11, in SNL Technical Library, Central Technical File, Archive Reel 1513, p. 511.

military had only one enlisted man and one officer involved in assembly and two enlisted men and one officer in repair operations.[36]

4.1 Construction

The architectural firm of W. C. Kruger and Associates was responsible for the design of the first buildings in Area II. W. C. Kruger was a noted New Mexico architect whose credits included serving as the State Architect for New Mexico (1936-1937); creating the Los Alamos master plan of 1947;[37] the Governor's Mansion in Santa Fe in 1955; the University of New Mexico Medical School Basic Sciences Building in 1965; and St. Joseph's Hospital for the Sisters of Charity, Albuquerque in 1965.

Kruger's firm worked with the Z-Division assembly group to design the Area II buildings. Preliminary plans were prepared by Z-Division, with all the groups involved in assembly operations approving them before the AEC Santa Fe Office arranged a contract with the architectural engineering firm of W. C. Kruger and Associates to do the detailed design. Kruger was only responsible for the buildings; fencing and paving for the area were arranged directly by Z-Division. A late 1947 estimate of the projected cost of the five buildings Kruger was designing for Area II (Buildings 901, 903, 904, 907, and 908) was $593,000.[38]

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[36] "Z-Division Progress Report, 20 October 1947-20 November 1947," p. 52, in SNL Technical Library, Central Technical File, Archive Reel 1513, p. 552.

[37] According to the biographical summary on W. C. Kruger in the W. C. Kruger and Associates Collection in the John Gaw Meem Archive of Southwestern Architecture at the University of New Mexico General Library, the "Kruger firm was the only private practice architect-engineer company employed by the Manhattan District Project to develop the site of Los Alamos by designing residential, technical, educational, medical, and recreational buildings for this highly secret area."

[38] P. J. Larsen, Associate Director, Los Alamos Scientific Laboratory, to C. L. Tyler, Manager, SFDO, USAEC, 23 December 1947, Collection 322 Sandia, B-9, D-58, Los Alamos Archives.

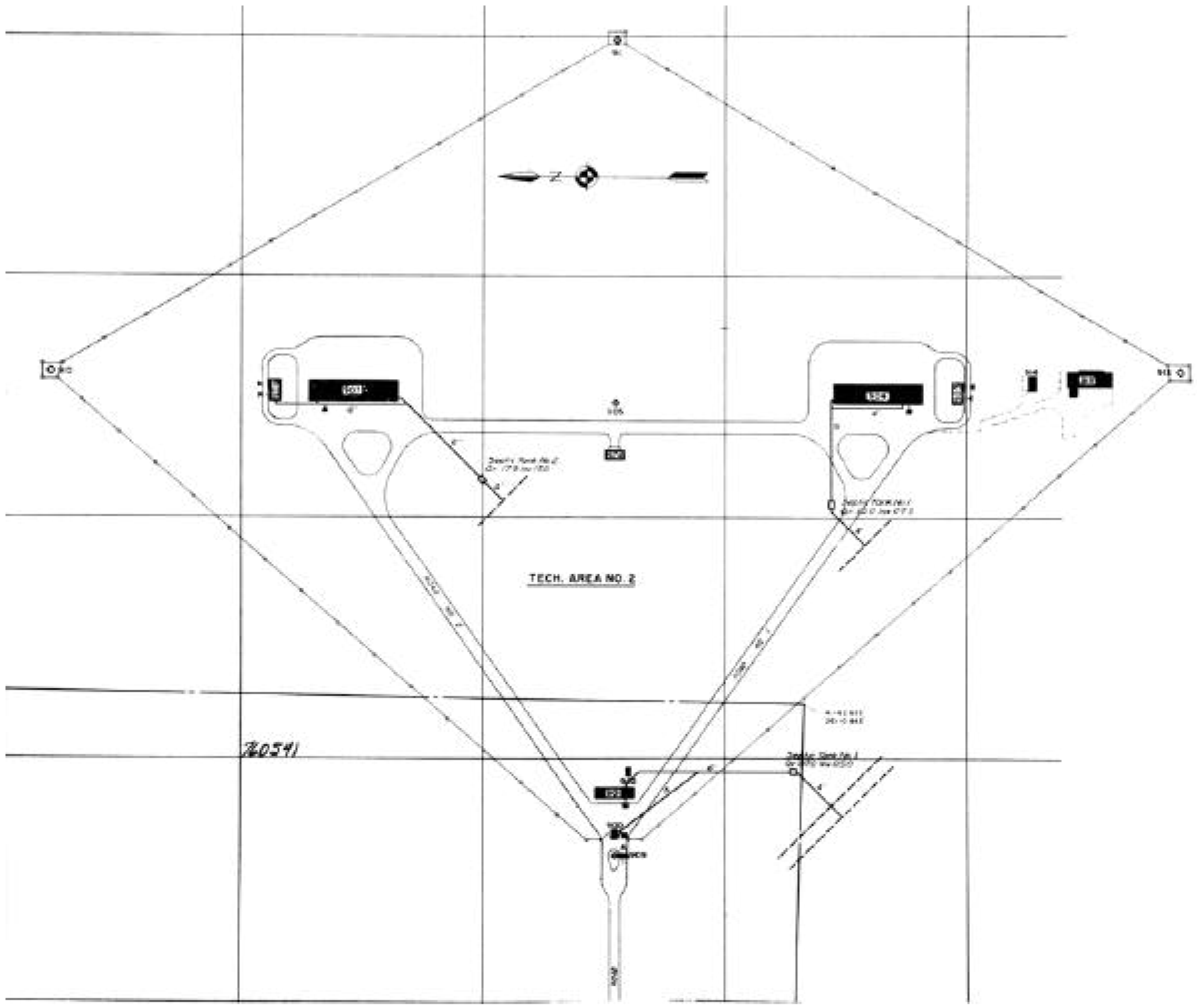

Figure 2. 1951 plot plan of Area II. Buildings 904 and 907 (the two large buildings located on the north-south axis of the area) are approximately 1,100 feet apart.[39]

The first HE assembly building was scheduled for completion July 1, 1948, with the second building ready by July 15.[40] With construction slippage, the buildings were not actually available for occupancy until September 7, 1948. Until the buildings opened, complaints were ongoing that "HE assembly operations are considerably curtailed by lack of facilities."[41]

[39] Drawing dated March 7, 1951, negative D20421, IRT 111735, SNL Archives.
[40] "Monthly Progress Report of Sandia Laboratory for the Period May 18, 1948 to June 18, 1948," p. 25, in SNL Technical Library, Central Technical File, Archive Reel 1513, p. 1065.
[41] "Monthly Progress Report of Sandia Laboratory for the Period June 18, 1948 to July 18, 1948," p. 16, in SNL Technical Library, Central Technical File, Archive Reel 1513, p. 1083.

Figure 3. Building 904 in November 1948. The flat roof on the front corridor and the clean lines of the building give it a slight flavor of the International style of architecture. Photograph looking southeast.[42]

4.2 Architectural Features

Buildings 904 and 907 were designed as mirror images of one another. The high bays where the completed sub-assemblies weapons were packaged for shipping were at the north end of Building 907 and the south end of Building 904, placing the two largest concentrations of high explosive in the area as far as possible from one another. Architectural historian David Kammer provides the following description of the buildings.

> Evidence of the great precautions taken in working with high explosives appears in the structures surrounding both buildings. Located twenty-five feet from both the north and south ends of each building are blast walls approximately seventeen feet high. Each wall consists of a twelve-inch thick poured concrete structure with tapered wings paralleling the buildings' end walls. A berm consisting of soil,

[42] Negative 19800, SNL Archives.

gravel and rubble extends away from each concrete blast wall. Behind the northern blast wall and berm of Building 904 and the southern blast wall and berm of Building 907 are small rectangular stucco-coated utility buildings (Buildings 903 and 908). Each building supplies heating, ventilation and air conditioning (HVAC) through a plenum enclosed with corrugated sheet metal that crosses over the top of the blast wall and extends the length of each building's roof. Six metal lightening rods implanted in concrete foundations are positioned periodically on the concrete aprons around each of the buildings. …

Both buildings are one-story, appearing as rectangular but with a small space protruding from each high bay to the east … Roofs are flat but stepped and consist of composition asphalt and stone sloped slightly to the center for drainage purposes. … Because of the requirement of a high bay equipped with an eight-ton overhead monorail crane to move the heavy assembled weapons as they were packaged and prepared for shipment, the roof at the north end of Building 907 and the roof at the south end of Building 904 both rise above the more extensive main portion of each building's roof. The main portions are themselves slightly stepped, reflecting the modest rise occurring at each of the interior blast walls. More substantial stepping indicates the roof portion over the narrow interior passageway lining the west side of each building. The main and high bay portions are marked by a slightly flared concrete cornice with copper flashing while a slight overhang extends along the portion of the wall offering pedestrian entry to the building.[43]

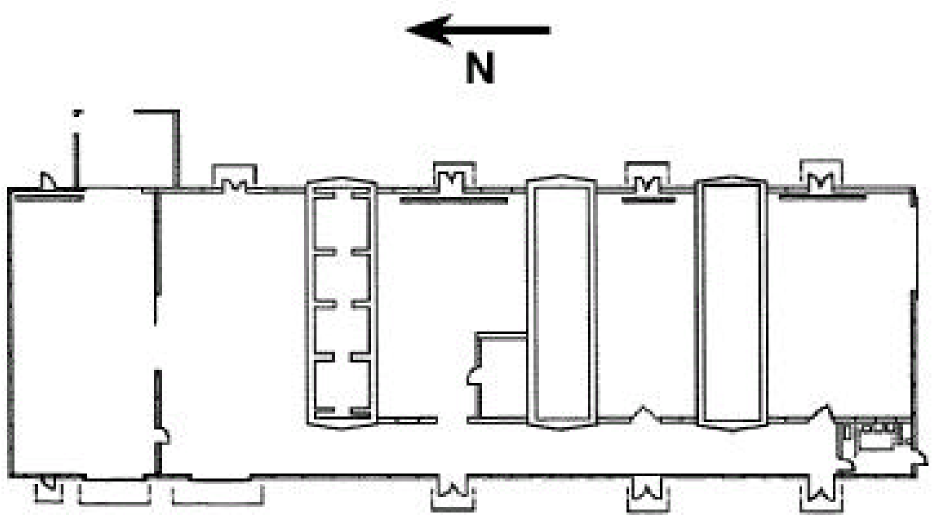

Figure 4. Floor plan of Building 907 based on the original drawings of the building.

[43] David Kammer, "An Architectural Description and Discussion of the Historical Significance of Buildings 904 and 907, Tech Area II, Sandia National Laboratories/New Mexico," prepared for Sandia National Laboratories/New Mexico, Organization 7258, by David Kammer under subcontract to Advanced Sciences, Inc., Contract 434-2300 (Albuquerque: Sandia National Laboratories, 1994), pp. 5 and 13.

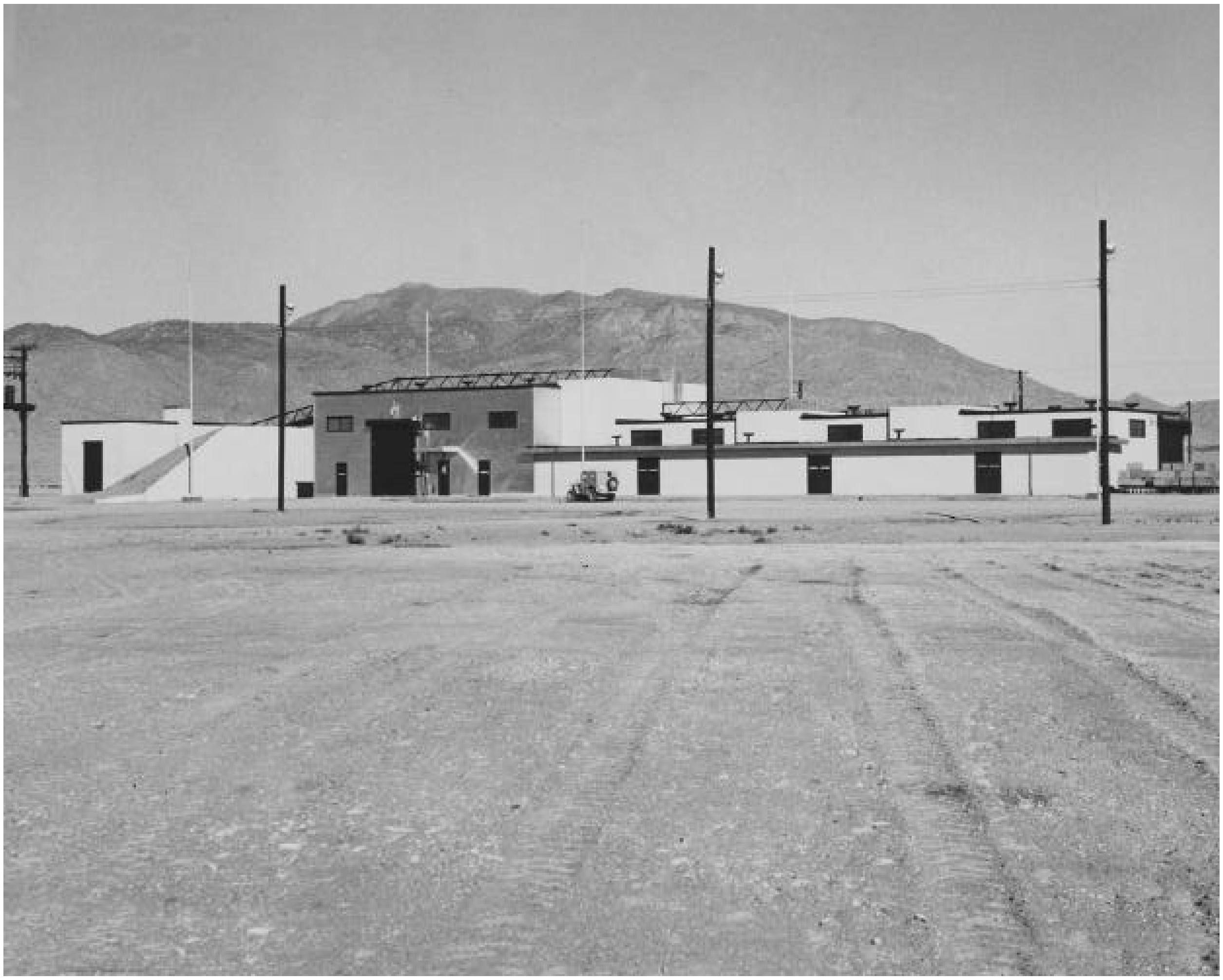

Figure 5. Building 907 in November 1948. Photograph looking northeast.[44]

The safety features designed into the buildings emphasize the danger of working with high explosives. In addition to the external blast walls designed to prevent the propagation of a detonation from one building to the other, there are three internal blast walls in each building. Given the thousands of pounds of explosives being handled in the building,

> three blast walls measuring twelve feet in width and marked by reinforced battered concrete walls two feet thick filled with rubble were used to separate each of the four assembly bays. These blast walls remain. In one instance, in Building 904, one blast wall has been opened, the rubble removed, and the space is used for storage. The fifth bay, or high bay, located at one end of each building was used for packaging and shipping of

[44] Negative 19801, SNL Archives.

the assembled weapon. The shipping shed extending eastward from each high bay marks the single departure from each building's rectangular plan.[45]

While stopping the spread of a detonation was of great concern, preventing one in the first place was obviously the highest priority. The high bay floor was a 6-inch concrete slab, covered in the assembly half of the bay by a conducting-type mastic floor covering.[46] Explosion-proof fixtures were installed and utility lines were painted down to prevent dust from the explosives from collecting in nooks and crannies. "Explosion-proof" does not imply that the fixtures are impervious to an explosion, but refers to the design features that prevent dust from explosives from getting into the wiring and causing a detonation.

Figure 6. 1997 photo of original light fixture in Building 907 high bay.[47]

The buildings appear to be unique in design for the time period.[48] The other American sites built to handle large amounts of high explosives in the same period took different approaches. The facilities constructed in the same period doing similar work were the Salt Wells

[45] David Kammer, "An Architectural Description and Discussion of the Historical Significance of Buildings 904 and 907, Tech Area II, Sandia National Laboratories/New Mexico," prepared for Sandia National Laboratories/New Mexico, Organization 7258, by David Kammer under subcontract to Advanced Sciences, Inc., Contract 434-2300 (Albuquerque: Sandia National Laboratories, 1994), p. 14.
[46] Drawing No. 30-05-01, sheet 7 of 17, "Assembly Bldg. No. 1 [Bldg. 904], Architectural Sections," As built, February 10, 1948, in SNL Facilities drawing files.
[47] Negative 19926, SNL Archives; photograph by Walt Dickenman, SNL photographer.
[48] Although David Kammer's report, "An Architectural Description and Discussion of the Historical Significance of Buildings 904 and 907, Tech Area II, Sandia National Laboratories/New Mexico," describes the buildings and assesses their historical significance, it does not include a comparison to other buildings of the period constructed for similar purposes. As a result, I have included a brief assessment of the issue here.

Pilot Plant at the Naval Ordnance Test Station (NOTS), Inyokern, California, constructed in 1945; the Burlington, Iowa high explosive pressing and assembly facilities begun in 1947; and the Pantex Plant buildings for high-explosive lens production and assembly begun in 1951.

NOTS Inyokern was created to serve as a testing and evaluation facility for the World War II rocket program under the supervision of the California Institute of Technology. It was built as a permanent base and has undergone a variety of changes over the years in support of Naval research. The Salt Wells Pilot Plant at NOTS was begun in 1945 in support of the Manhattan Project. High-explosive lens design for the Fat Man implosion weapon was done at Los Alamos during the war.[49] In 1945, development of production methods for high-explosive lenses for the Fat Man-type implosion weapon was assigned to NOTS Inyokern. A new high explosives processing facility, called the Salt Wells Pilot Plant was built and turned out its first casting of high explosive on July 25, 1945, just before the use of atomic weapons against Japan.[50] There is no evidence that any NOTS high-explosive lenses were used in the implosion weapon dropped on Nagasaki, but the facility remained in the business of developing and producing lenses for nuclear weapons until 1954.

The production buildings at NOTS look much different than the assembly buildings in Area II.

> Each includes a steel frame work building, originally sided in asbestos, surrounded by concrete and earthen revetments, with mechanical and storage rooms. The production buildings are accessible only through tunnels in the revetments, with concrete barricades outside each tunnel portal. Each production building was joined by ancillary structures—transfer docks, rest houses, and so forth. These are joined by covered walkways, through which special carts could be used to tow explosives from one area to the next.[51]

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[49] For information on the high-explosive lens problem and its solutions at Los Alamos during the war, see Lillian Hoddeson, Paul W. Henriksen, Roger A. Meade, and Catherine Westfall, *Critical Assembly: A Technical History of Los Alamos during the Oppenheimer Years, 1943-1945* (Cambridge: Cambridge University Press, 1993), which focuses on the technical details of the development of atomic weapons at Los Alamos during World War II; see also George B. Kistiakowsky, “Reminiscences of Wartime Los Alamos,” in Lawrence Badash, Joseph Hirschfelder, and Herbert Broida, eds., *Reminiscences of Los Alamos, 1943-1945* (Dordrecht, Holland: Reidel Publishing Co., 1980), pp. 49-65.

[50] For a general history of NOTS Inyokern, see Albert B. Christman, *Sailors, Scientists, and Rockets,* vol. 1 of *History of the Naval Weapons Center, China Lake* (Washington, DC: Naval History Division, 1971); and J. D. Gerrard-Gough and Albert B. Christman, *The Grand Experiment at Inyokern,* vol. 2 of *History of the Naval Weapons Center, China Lake* (Washington, DC: Naval History Division, 1978). The facilities at Inyokern have been evaluated for their historical significance, and the resulting four-volume report is quite informative. See “Inventory and Evaluation of National Register Eligibility for Buildings and Structures; Naval Air Weapons Station (NAWS), China Lake, California,” prepared by JRP Historical Consulting Services for Engineering Field Activity, West, Naval Facilities Engineering Command and Naval Air Weapons Station, February 1997.

[51] JRP Historical Consulting Services for Engineering Field Activity, West, Naval Facilities Engineering Command, and Naval Air Weapons Station, “Historic Context for Evaluating the National Register Eligibility of World War II-era and Cold War-era Buildings and Structures: Naval Air Weapons Stations (NAWS), China Lake, California,” November 1996, p. 42.

The NOTS Inyokern buildings were designed to hold the large machinery required to melt, cast, and machine the lenses. As a result, they are large and essentially buried by their concrete and earth blast revetments.[52]

The Pantex Ordnance Plant near Amarillo, Texas was, like NOTS Inyokern, a World War II creation. It was built in 1942 to produce conventional bombs and artillery shells. The plant was closed after the war and in 1949 Texas Tech bought the land for one dollar, subject to a recapture clause. The land was reclaimed in 1951, however, when the AEC chose the Pantex site to be a nuclear weapon assembly facility. Many of the World War II buildings were modified and put into use and new buildings constructed for HE machining and weapon assembly operations.[53]

Although as industrial in appearance as the Area II buildings, the original Pantex building differed from Buildings 904 and 907 in the construction of its internal blast walls. Pantex Building 12-26 was the first building used for nuclear weapon at the site. It was built during World War II, but never used. It consisted of 3 assembly bays with 1-foot thick common walls to prevent propagation of a detonation.[54] In contrast, Buildings 904 and 907 in Area II each contain three internal blast walls separating the four work areas in each building (See Figure 4). These internal blast walls extend from the east wall of the building to the inside corridor that extends from north to south along the west wall of each building. Each blast wall is essentially a rectangular box filled with sand. The east and west ends taper outward. The north and south sides of each wall consist of a concrete wall approximately two feet thick. The overall blast wall is approximately 12 ft. wide. Figure 7 shows the interior of the center blast wall in Building 904. In 1969, Pantex incorporated the wide blast wall filled with sand or rubble into the design of Building 12-64, its new assembly building.[55] Assembly cells buried in rubble, known as gravel gerties, were added at the Pantex site in 1956 to accommodate the assembly of the nuclear physics packages into sealed-pit weapons.

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[52] Drawings of the production buildings and their layout are included in JRP Historical Consulting Services for Engineering Field Activity, West, Naval Facilities Engineering Command, and Naval Air Weapons Station, “Inventory and Evaluation of National Register Eligibility for Buildings and Structures, Naval Air Weapons Station (NAWS), China Lake, California,” vol. 2, “Historic Resource Forms,” February, 1997.
[53] B. H. Carr, *Pantex: History, 1942 to 1992* (Amarillo: Pantex, 1992), p. 6.
[54] Telephone conversations with Kris Mitchell, Historian, Battelle Pantex Environmental Protection Office, August 20, 1997 and August 27, 1997.
[55] Telephone conversation with Kris Mitchell, August 20, 1997; and tour of Pantex Plant, January 7, 1998.

Figure 7. Interior of the center blast wall in Building 904. In 1969, the blast wall was opened, emptied, and turned into two small rooms. This room, 5A, was then used as a centrifuge room, but is currently used for storage. Note the thickness of the wall visible in the doorway.[56]

The original buildings in Area II are similar to other buildings designed to handle high explosives of the period in the emphasis on safety and the utilitarian nature of their designs. All of these sites placed their high explosive handling areas away from other facilities and separated the HE buildings from one another with buffer zones and blast walls based on standard quantity-distance calculations in which the quantity of explosives in use determine the distance between buildings. Buildings 904 and 907 lie on a north-south axis in the center of Area II, approximately 1,100 feet apart. Each building has concrete retaining walls with dirt blast berms 25 feet from its north and south ends. While the roof and east and west walls are frangible, allowing a blast to blow out in those directions, the retaining walls and blast berms represent a specific effort to prevent blast propagation from one building to the other.

In addition to the high explosive assembly buildings, Kruger designed Building 901 as a break and change room. Less interesting from a design standpoint, 901 is nevertheless important

[56] Negative 19872, SNL Archives; photograph by Walt Dickenman, SNL photographer.

because of the role it played in the workday routine of the area. It is a one-story industrial building that contained a changing room, shower room, and laundry, as well as a small office to handle administrative matters. Its appearance is striking because its front (west) face is a head wall, or concrete retaining wall that slopes to the ground at its north and south ends. The entire back and sides of the building are covered with a dirt blast berm.

4.3 Weapon Assembly

High-explosive lenses shipped in from Inyokern were inspected for damage and uniformity, sanded to achieve a smooth surface, and covered with paper. The lenses were assembled, along with the rest of the non-nuclear components, into a weapon sub-assembly. They were then packaged for shipping and sent for storage, first by truck to the igloos on Kirtland and later by rail to the various storage facilities scattered around the country. In addition to weapons for the stockpile, assemblies were made for training military weapon handlers and for both nuclear and non-nuclear testing.

The Road production group prepared components for assembly in Tech Area I. Several different buildings in Area I were used before Building 892 was completed in the summer of 1950. Parts produced by manufacturers around the country were shipped to Sandia, and assembled into complete components in Building 892. They were then sent to Area II to be joined with the high-explosive lenses into a complete weapon sub-assembly. High-explosive lenses were stored in the igloo area south of the Kirtland runways (now Sandia's 6000 area) until they were needed.

The high-explosive lenses and other components arrived by truck on the concrete aprons outside of Room 8 at the south end of Building 907 or Room 8 at the north end of Building 904. Items were unpacked and inspected. Lenses were placed on rubber topped tables and wheeled into Room 6 for repair. Small amounts of high explosive were melted with steam and used to repair chipped and cracked lenses, although any major damage rendered the lens unusable. The lenses were moved again to Room 5 to be covered with paper and stored until enough were ready for final assembly. Final assembly took place in Room 4, the first half of the high bay. An 8-ton monorail runs from east to west across the high bay (Rooms 4 and 3) to lift and move the heavy assemblies. Finally, the completed sub-assembly was moved to Room 3 where it was packaged for shipping.[57]

Workers had to sign in and out of the area in Building 901 and were taken by bus from building 901 to 904 or 907. Workers wore coveralls, gloves, and conductive shoes, and were not allowed to carry matches or lighters into the area. The amount of high explosive and number of workers allowed in each bay of the assembly buildings was limited. When production was at its peak, men worked in shifts from 7:00 a.m. to midnight.[58]

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[57] Sandia designed and assembled the packing crates, and was responsible for designing all handling gear for the weapons.
[58] "Phase 1 RCRA Field Investigation Work Plan," Draft (Albuquerque: Sandia National Laboratories, Environmental Restoration Program, 1990), pp. 2-4.

With the move into the assembly buildings in Area II, nuclear weapon sub-assembly had finally achieved something approaching assembly-line production. In 1948 the Mk IV bomb began to enter the stockpile, with its final assembly done in Tech Area II. The outbreak of the Korean War in 1950 had Area II working around the clock assembling the non-nuclear portions of new weapons to ensure an emergency capability stockpile of nuclear weapons.[59]

4.4 Security, Research, and Quality Assurance

Tech Area II was originally built to house early weapon sub-assembly activities. In addition to Buildings 901, 904, and 907, which formed the core of the assembly environment, other buildings were constructed to support the area and its work. Buildings 903 and 908 provide heating, ventilation, and air conditioning to Buildings 904 and 907, respectively. Designed by the Kruger firm as part of the original plans for Area II, they are small, stucco-covered, two-roomed utility buildings of no exceptional design except for their connection to the buildings they support by a corrugated metal plenum extending over a blast wall. Their separation from the buildings they support was a direct result of the fact that large amounts of high explosive were being handled in Buildings 904 and 907. Their purpose has not changed in the 50 years of their existence, although the utilities in Building 908 are now shut off, as Building 907 is no longer occupied.

Building 902 was also built in 1948 as a Standby Power Generator Building. It is a very small, one-room box of a building that sits directly behind (east of) Building 901. Its flat roof extends well beyond the edge of the building and it mirrors Building 900, the guardhouse, in that respect. It is a strictly utilitarian structure.

In 1950, Building 906 was added to the area. Originally a small storage building used for storing chemicals, beginning in 1960 it was used as a hazardous operation laboratory for the safety engineering group, work apparently placed there because of the remoteness of the area. In 1968, that work was replaced with a mass spectrometer used by the component testing department in their leak detection and vacuum standards section. Of no particular architectural interest, it is a small utilitarian structure that was put to a variety of different uses over the years.

Especially notable in the area, as in all of Sandia's technical areas, were the measures taken for security. Sandia/New Mexico's location on a military base removed its technical areas from immediate access and, in addition, each technical area was fenced with gates requiring special access. National security concerns dictated the emphasis on security. Although scientific research had rarely been conducted behind security fences for other than intellectual property reasons before World War II, government-sponsored research during and after the war generated strict security precautions. Work at Oak Ridge, Hanford, Los Alamos, and elsewhere was originally and always done within the confines of a secured area; Sandia was no different.

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[59] John Cochran, "Notes from the Interviews of Long-Time TA-2 Workers," in Tech Area II Collection, SNL Archives.

Area II was surrounded by a perimeter fence and had guard towers outside the fence at its four corners. The towers were similar to other military guard towers from the World War II and immediate postwar periods. Figure 8 provides a view of Building 909, the guard tower still standing at the west entrance to Area II. The towers provided views down the area's perimeter fence, as well as of the area and its surroundings as a whole. Entrance to the area was from the west, where one of the four guard towers still stands, although it is no longer part of the area's security system. The guard towers were in use until the late 1960s.

F
igure 8. Building 909, guard tower at the west entrance to Area II. Photograph looking east.[60]

Early plans of the area show a fifth guard tower in the center of the area, but no workers remember it being there and it is unlikely that it was ever actually constructed.[61] It would have stood where Building 920, built in 1954, is currently located; none of the available correspondence from the 1948-1954 period discusses the need to demolish a tower in order to build Building 920.

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[60] Negative 19852, SNL Archives; photograph by Walt Dickenman, SNL photographer.
[61] John Cochran, December 1992 interview with Area II retirees for the Environmental Restoration group, copy of transcript in Collection 238, Harold Rarrick Collection, folder 9, SNL Archives; also, telephone conversation with Phil Dailey, September 3, 1997.

In addition to the guard towers providing overall security for the area, a guard house was located at the west entrance to Area II. The guard house, Building 900, is a small, one-roomed building serving as an office for the guards who monitored pedestrian and vehicle traffic into the area. A Mardix Booth (Building MB-07) was added in 1986 to remotely monitor pedestrian access to the area.

Once the HE assembly buildings were occupied and in operation in Area II, other construction activities proceeded in support of Sandia's responsibilities. Nuclear weapon design has never been a static business. Research was ongoing to improve the materials, components, and capabilities of weapons. The high explosives used in the weapons to compress the nuclear material is the responsibility of the nuclear physics laboratories—Los Alamos (now Los Alamos National Laboratory (LANL)) and, later, Lawrence Livermore National Laboratory (LLNL). But explosives are also used in other components for which Sandia is responsible. This created a growing research and testing effort in the explosives area at Sandia.

Eventually, a variety of components incorporated an explosive portion into their design. These components included batteries, switches, firing sets, detonators, fuzing, and neutron generators. Such components require a great deal of research and testing because they must have a long shelf life, be rugged enough to survive environmental extremes, and be precisely timed. In the following discussion, explosive design and testing will be referred to frequently.

Individual groups usually ran several tests on a particular design and most of the components were of the one-shot variety, which meant they could only be tested once. Each device had to be assembled before a test or, in the case of quality assurance, access was provided to several lots from the manufacturer. Very small devices could be fired in small "boom boxes" inside of a building, while larger charges were fired on the pads frequently located behind the buildings. Research on this matter has turned up no moments of discovery that can be looked upon as historically distinct or significant. Rather, the work was ongoing and, as one former Area II engineer described it, there was "a lot of really good engineering out there, but no headline
[62]

In 1951, Building 913 was built at the south end of Area II as an explosives development facility. W. C. Kruger and Associates designed the building and it displays the same basic interior blast wall design as 904 and 907. The building is made of steel with anodized metal exterior walls. The building is divided into three rooms by two interior blast walls, each 8' x 34'. The blast walls are essentially concrete boxes made of 1'6" thick concrete walls filled with pea gravel. They extend above the roof of the building's rooms.

Building 913 was used as an explosives testing facility. Early information on 913 is scarce.[63] There is no record of any significant breakthroughs in this research, or in the experimental testing set-ups. However, the building seems to have been used in this period to test

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[62] Telephone conversation with Paul Cooper, January 1998.

[63] The collection of Sandia phone books in the SNL Archives offers a good overview of who was where at the Labs over the years. Unfortunately, in the early years of the Area's history, individuals and programs frequently are listed as being in Area II, not as occupying specific buildings in the area.

explosive materials used in Sandia-designed components. Sandia phone books from the 1950s indicate no individuals assigned to the building. The work in the building was most likely materials research, possibly aging or pressure tests, because the phone books do indicate that by 1955 the Special Projects Division of the Materials and Standards Engineering was using 913 for its Area II activities. By 1960, only the Electrical, Refrigeration, & Air-conditioning Section of the Plant Maintenance Department mentions 913, implying that they were supporting electrical and refrigeration needs in the building. By 1973, the north end of the building definitely was used for pressure safety work—testing pumps, valves, and piping. A camera room was added in 1975.

Building 914 was also built in 1951 as the equipment building for Building 913. It is a small, one-roomed building that holds equipment. There is nothing defining about its architecture, nor was any noteworthy work conducted there.

In addition to its production and design responsibilities, Sandia has also always been responsible for surveillance of the nation's stockpiled weapons. As summarized in a 1952 "Memorandum of Record: Scope of Work" between Sandia and AEC, this responsibility "involves functional surveillance to insure maintaining the weapons in a state of readiness and quality surveillance to perform quality assurance tests on the weapons, including life studies, etc."[64] Sandia kept engineers at the weapon storage sites scattered around the country to maintain readiness. From 1949, when the first storage sites opened, until 1960, Sandia "stationed staff at the storage sites to monitor, maintain, and assemble the weapons."[65] However, in this period, much of the quality assurance evaluation and study of the weapons and their components was done at Sandia.

To meet this responsibility, Sandia built Building 915 in 1951. Located at the far north corner of Area II, Building 915 is a large Quonset-hut style building. It housed the quality assurance operation, known as the Final Assembly Inspection Section, beginning in 1952. Selected sample weapons were disassembled, inspected, and reassembled. Sandia had the quality assurance inspection responsibility for all weapons in the stockpile, so representative weapons assembled at Burlington and Pantex were also brought to Building 915 for inspection once those facilities were producing weapons. Building 915 was built with a blast barricade on its south side to separate it further from Building 907's activities, and a north barricade was added in 1952.

4.5 The Integrated Contractor Complex

The growing demand for weapons, fed by increasing tension between the United States and the Soviet Union, meant that the AEC was continually trying to expand its facilities and increase weapon production in the 1948-1952 period. Several new production facilities opened in this period, but those of particular relevance to Area II were involved in high explosive production and assembly.

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[64] "Memorandum of Record: Scope of Work," between Sandia Corporation and the Atomic Energy Commission, dated 1952, Collection 222, OpenNet Collection, SNL Archives.
[65] Leland Johnson, *Sandia National Laboratories: A History of Exceptional Service in the National Interest* (Albuquerque, NM: Sandia National Laboratories, 1997), p. 42.

In a progress report submitted just over two months after the HE assembly buildings opened in Area II in the fall of 1948, Larsen discussed the new production facility at Kansas City and the conversion of the Iowa Army Ammunition Plant near Burlington from ordnance production to fabricate high-explosive lenses and perform final weapon assembly. He summarized these activities by stating that the "objective is to separate Sandia Laboratory from all functions that are not directly concerned with research and development."[66] The Burlington plant began producing HE components in 1948, and in 1949 or 1950 it completed its first weapon assembly.[67]

Component production did begin to move away from Sandia once the Kansas City plant, known as Project Royal, was in operation. The 1950 *Annual Report* for Sandia Corporation indicated that "Except for model shop activity, few manufacturing operations are carried on in the Laboratory. Assembly operations are fed from sources throughout the country."[68] Final assembly activities proved harder to unload. The expectation for a growing stockpile required both Sandia and Burlington to assemble weapons, dividing projects between them.

In March 1949, Sandia held a conference "with representatives from Project Sugar to formulate facilities and equipment required for operations at that project." Sugar's operations were to include "assembly operations similar to those at Sandia Laboratory."[69] Employees from the Sugar site were sent to Area II for training in weapon assembly.

A Production Coordination Staff was created at Sandia to coordinate all production activities and a production schedule was created.[70] This oversight role was essential to the notion of the integrated contractor complex. Component production was done at a variety of sites in the country and parts were shipped to assembly sites. Sandia was responsible for non-nuclear production, although it was itself no longer producing many components, and oversaw the production activities within the complex.

In 1951, the AEC began to convert the Pantex plant to explosive production and weapon assembly to supplement the Burlington assembly facilities. Like Burlington, the Pantex Plant was a World War II ordnance production plant and was quickly converted to high explosive production and assembly. In 1975, the Burlington activities were consolidated at Pantex.

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[66] "Monthly Progress Report of Sandia Laboratory," SLMS-48, p. 4, in SNL Technical Library, Central Technical File, Archive Reel 1513, p. 1201.

[67] George West indicates that Burlington's first weapon sub-assembly was a Mark IV bomb, completed in 1949, while Ann Lemert suggests that Burlington did not begin assembling weapons until 1950. See George T. West, *United States Nuclear Warhead Assembly Facilities (1945-1990)* (Amarillo, TX: Mason & Hanger - Silas Mason, Inc., March 1991), p. 2; and Ann Arnold Lemert, *First You Take a Pick & Shove: The Story of The Mason Companies* (Lexington, KY: The John Bradford Press, 1979), p. 167.

[68] Sandia Corporation, *Annual Report of the Board of Directors to the Stockholders for the Year Ending December 31, 1950* (Albuquerque: Sandia Corporation, 1951), p. 8, declassified copy in Collection 222, OpenNet Collection, SNL Archives.

[69] "Monthly Progress Report of Sandia Laboratory, February 18, 1949 to March 18, 1949," SL-79, p. 5, in SNL Technical Library, Central Technical File, Archive Reel 1513, p. 1328.

[70] "Monthly Progress Report of Sandia Laboratory, March 18, 1949 to April 18, 1949," SL-83, p. 4, in SNL Technical Library, Central Technical File, Archive Reel 1513, p. 1382.

5.0 AREA II, 1952-1959

With the successful expansion of the AEC's production complex in the early 1950s, Sandia was no longer the sole, or even the primary, assembly site for nuclear weapon sub-assemblies. Sandia and Burlington divided the assembly tasks, with Sandia still taking the heavier load in actual weapon assembly.[71] Pantex began some assembly activities in 1952 and increased its share of the assembly responsibilities in subsequent years. Sandia did assemble the Mk 17 bomb, which entered the stockpile in 1954, in Area II. Assembly also was ongoing for test devices and prototypes in support of Sandia's design responsibilities.

The 1955 Sandia "Emergency Plan," outlining steps to take if the President declared a national emergency, required that, as "soon as AEC so directs, Sandia Corporation will with the utmost expediency assemble available materials at Sandia Corporation with such additional matching materials as must be brought in from suppliers." Assembly personnel were to be identified ahead of time so they could be called upon immediately should an emergency be declared.[72]

In 1957, Sandia's assembly role was reassessed. New sealed-pit weapon designs made it difficult, if not impossible, for Sandia to conduct final assembly. Sandia was given the delivery responsibility for all training units (with HE), inert training units (no HE), and inert samples of weapons in the early stages of design. Inert weapons contained cement instead of high explosive and the assembly of a dummy gas boost unit. Burlington and Pantex were to have the delivery responsibility for all War Reserve units. Some final weapon assembly of non-War Reserve units continued in Area II until about 1959, when the assembly buildings began to be remodeled. Sandia was out of the business of assembling weapons for the stockpile.[73]

5.1 Explosive Research

While assembly was moving out of Area II, there was a growing interest in improved components and, of particular importance to Area II, in explosive components. In 1957, Sandia's Components Development Committee recognized the "increasing amount of work being done with explosive and pyrotechnic devices in the Corporation [Sandia]."[74] They asked all divisions conducting such work to provide the committee with information on their future facilities

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[71] Sandia Weapon Development Board, "Minutes of the 47th Meeting, 20 December 1950," SWDB-50-47, p. 15, SNL Archives.
[72] H. G. Mehlhouse to all Superintendents, April 12, 1955, memo re: "Emergency Plan," pp. 2-3, Collection 222, OpenNet Collection, SNL Archives.
[73] R. P. Lutz to Frank C. DiLuzio, September 1956, subject: "Final Weapon Assembly at ALO Prime Contractor Plants in 1957 and Beyond," copy from DOE/NV Coordination and Information Center, Las Vegas, Accession Number NV0135057.
[74] F. A. Goss memo to Distribution, February 27, 1957, in SNL Technical Library, Central Technical File, Alpha Reel 25, p. 937.

requirements to support such research. They were particularly concerned that facilities being used for detonating explosives and fabricating and loading the materials be appropriate and safe.

A 1958 conference on high-explosive activities at Sandia explored the existing research and design work on explosives and outlined some areas for future research. J. W. McRae, Sandia's president, summarized the state of Sandia's interest in his opening remarks.

> It was only 3 or 4 years ago that we began to see the possibilities in explosive-actuated devices, but before that we had programs in which we attempted to learn through the use of high explosives certain fundamental things about explosions which we could apply to the interpretation of, and the provision of safety criteria for, tests of atomic explosions.[75]

Thus, while research was already underway to understand the nature of explosives and explosive detonation, the application of explosives in components was really just beginning.

Further, basic research was deemed necessary to ensure a fundamental understanding of energetic materials, while the practical application of explosives was also pursued.

> There is still an amazing amount of "black magic" and/or "cut and try" in the explosive industry, i.e., the precise ballistics effects achieved by artillery ammunition is brought about by blending techniques in manufacture rather than by control of material and processes. There is an even greater need for more to be learned in the field of initiating or primary explosives.[76]

Explosive timers were singled out for attention since electronic timers were still being used in the weapons to delay the release of neutrons from the neutron generator until the appropriate moment. It was felt that explosive timers might offer a more precise timing capability. Several sources indicate that, in general, it was expected that components using explosives would become more important to the fuzing and firing system as time went on, and that Sandia needed to support research in explosives applications.

5.2 1952-1959 Construction

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[75] J. W. McRae, Opening Remarks in "Presentations on High-Explosives Activities at Sandia Corporation," presented to the Advisory Panel on Ordnance (Office of the Assistant Secretary of Defense, Research and Engineering), p. 11, in SNL Technical Library, Central Technical File, Alpha Reel 25, p. 975.

[76] Sandia Corporation, "Research and Testing Facility Requirement for Fiscal Years 1959 and 1960," September 12, 1958, p. 7, in SNL Technical Library, Central Technical File, Alpha Reel 3, p. 1140.

Construction in the area from 1952 to 1959 indicates the increasing emphasis on explosive component research and testing.[77] Buildings were not built with such large internal blast walls, test pads were located outside of several buildings for detonating explosives in a test environment, and small firing chambers were added to interior rooms. Both new construction and remodeling indicate changes in the type of work being done in Area II. The emphasis in construction was no longer on preventing the detonation of large amounts of high explosive and containing such a detonation should one occur. Instead, the test pads and firing chambers allow for the safe, controlled detonation of small amounts of explosive in test items.

Further, the majority of the buildings remained on the north-south line in the center of the area, but they began to fill in the space around 904 and 907, reflecting the construction of inert rather than live units in those buildings, as well as the smaller amounts of explosives behind handled in the research and development programs.

Building 917, a small explosives assembly facility, was built just north of 913. Like 913, records have not been found to document early 917 activities, but it is described as an explosives assembly facility, and may have been used to assemble charges to test detonations. It appears in the phone books repeatedly as a test site for electro-explosive devices, but it is a very small building and does not contain a firing pad, so it is more likely that it was used to pack explosives and to assemble equipment. There is, however, a high voltage outlet in the building, so it is possible there was a small firing chamber in the building at one time. By the mid-1980s, it was being used to develop support equipment for explosive experiments.[78]

Building 922, an explosive devices development laboratory, was added to the area in 1957. A direct result of the effort to pursue explosive components, Building 922 was built as a research and test area, with a firing pad in the back of the building and portholes to observe and record tests. From at least 1980 the building was devoted exclusively to ongoing research on energetic materials. A gas gun was added to the facility in 1980 or 1981, and research was ongoing on explosive detonation and shock-induced chemistry of explosives. In addition to the gas gun, the building contained a laser spectroscopy lab with diagnostic equipment. This work was not directly related to components; rather, it was devoted to understanding the physics and chemistry of the materials.[79] Building 922 had a fundamentally different role from other buildings in the area. It was devoted to research.

Storage facilities were added to Area II in 1954, with the construction of buildings 920 and 921. These corrugated metal buildings are plainly utilitarian in design and purpose. Building

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[77] The chronology of construction in Area II was assembled from several sources, including Sam L. Johnson, "History of Facilities at Sandia National Laboratories in Albuquerque," January 1985, in Collection 46, Plant Engineering Collection, Box 1, SNL Archives; Architectural drawings of Area II buildings, copies held in the SNL Facilities Technical Library; John Cochran, "Notes from the Interviews of Long-Time TA-2 Workers," copy in the Tech Area II Collection, SNL Archives; Sandia National Laboratories, *Site Development Plan* (Albuquerque: Sandia National Laboratories, 1984); Sandia National Laboratories, *Site Development Plan* (Albuquerque: Sandia National Laboratories, 1989); and "Phase 1 RCRA Field Investigation Work Plan," Draft (Albuquerque: Sandia National Laboratories, Environmental Restoration Program, 1990).
[78] Telephone conversation with Roy LeBlanc, January 1998; visit to Building 917, January 1998.
[79] Telephone conversations with Paul Cooper and Anita Renlund, January 1998.

920 has 10 garage-type doors to allow access to distinct storage bays divided by high curbs. Building 921 has large roll-up doors at its north and south ends to allow a forklift to drive in from either side. Building 932 was added in 1955 for the storage of small amounts of explosives. It is a concrete rack of small metal cupboards on a concrete slab. While not of any particular interest in its own right, 932 does offer a clear indication of the type of work undertaken in Area II.

6.0 AREA II, 1960 TO THE PRESENT

By 1962, a memorandum prepared for the House of Representatives' Sub-Committee of the Committee on Appropriations was able to state categorically that "although both war reserve and training weapons were assembled at Sandia during the first years of operation, this activity is now conducted by other prime contractors of the AEC."[80] By 1959, final high explosive weapon assembly had completely moved out of Area II and been replaced by small explosive component research and testing. So dominant did the research and testing on explosive devices become in Area II that a 1966 summary of buildings and facilities at Sandia described the area as a whole as an Explosives Devices Lab.[81]

6.1 Building Modifications and New Construction

In 1959 new as-built drawings were prepared for Buildings 904 and 907 to indicate the alterations underway. Both buildings underwent a variety of modifications in the ensuing decades, but the work centered on explosives testing. Camera ports were installed in 1959 to provide data on test detonations. In 1962, observation portholes were added to 907's east wall and an observation control room was added just to the east of the original Room 4, from which tests on firing pads all along the back of the building could be observed and recorded. As shown in Figure 9, the observation room included a number of portholes. These provided a line-of-sight to all of the test pads located along the back of the building, as well as a view to the east of the building. By 1963, the advanced development division had installed a streak-camera in Building 907 to record its tests. Building 907 became an all-purpose small explosive test area, handling a variety of tests in a range of facilities for programs throughout SNL. For example, by the 1980s, 907 test capabilities included statistical testing of components in a range of environmental settings, a flash x-ray high-speed camera facility, and a laser-based interferometry system.

[80] "Memorandum on the Origin and Certain Other Aspects of Sandia Corporation Prepared for the House of Representatives' Sub-Committee of the Committee on Appropriations," June 29, 1962, p. 2, copy in Collection 69, Early Histories from Legal, SNL Archives.
[81] H. H. Pastorius, "Buildings and Facilities Data," September 1966, p. 3, in Collection 46, Plant Engineering Collection, Box 1, SNL Archives.

Figure 9. Room 4E in Building 907. Installed as an observation control room in the building in 1962, the room has portholes along its east (left) and south walls. The portholes in the south wall provide a line-of-sight through the various firing pads along the back of the building. 1997 photograph, looking southeast.[82]

[82] Negative 19903, SNL Archives; photograph by Walt Dickenman, SNL photographer.

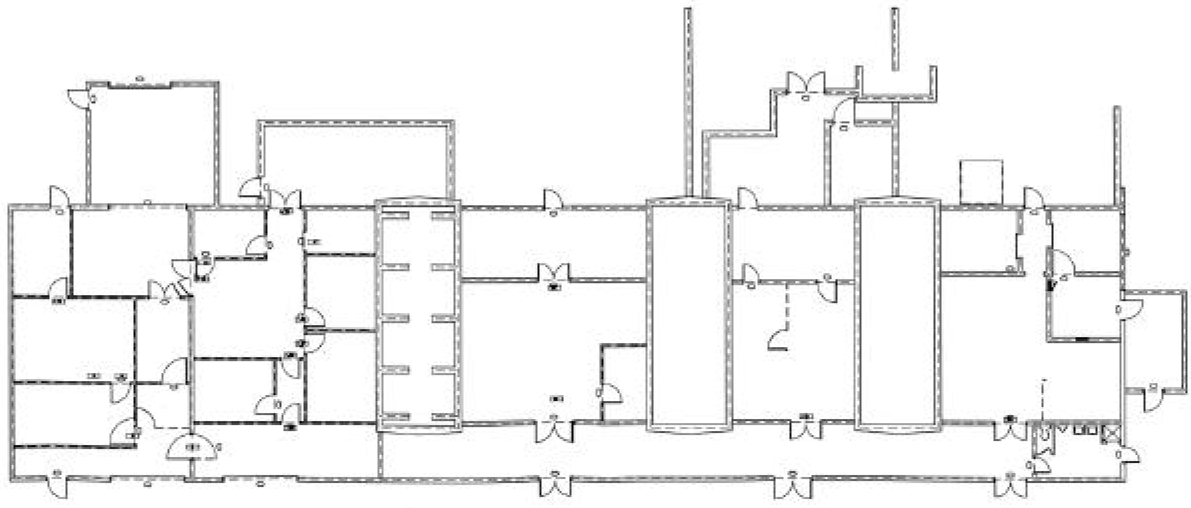

Figure 10. 1997 floor plan of Building 907. Modifications are apparent when this figure is compared to Figure 4.

Building 904 also underwent periodic modifications to align it with various research projects and testing. By 1962, the environmental testing program housed one electrodynamic system and one mechanical system for vibration testing of explosive components in Building 904, although the rest of the environmental testing program's facilities were in Tech Area III and Coyote Canyon. In 1968, a small addition was built at the south end of the building to house a small darkroom, a control console, and x-ray equipment. Until the addition was completed, there were no darkroom facilities in Area II and all x-rays had to be taken to Area I to be developed. In the 1970s ovens were added at the south end of the building to do long-term aging of components. Once the materials were aged, they were taken to the chemistry lab for analysis. This is a crucial part of the research done to ensure the components will have a long shelf-life, and perform in a range of environments.

Building 904 was also host to part of the access delay technology department beginning in the early 1980s. That area was not related to explosive research, but required a large laboratory area for testing physical security barriers and devices. Part of that group still occupies Building 904. Their work is quite interesting and forms a completely separate thread in the pattern of Area II's history. The organization was created out of the response to the growing terrorist threats of the 1970s and is concerned with access denial technologies of all sorts (barriers, goop gun, etc.). While Building 904 has undoubtedly witnessed a great deal of their research and development efforts, it neither witnessed the beginning of the program, nor does it reflect their activities. It is clear that this program uses 904 because it has room; when they leave there will be no trace of their work in the building itself.

Building 901 similarly abandoned its earlier role in weapon assembly and was put to other uses. In 1964, its showers were removed and the building remodeled for the advanced development division, which set up offices and a device assembly area in the building. Still later, a small shop was established at the north end of the building, while the rest of the building remained offices.

To accommodate the increase in explosive testing and to provide safe storage for explosive materials, several small igloos made of reinforced concrete and covered with earthen blast berms were built in the area by 1963. These are of standard military munitions storage depot design. First developed by the military in 1926, storage igloos like these appear around the country and are visible in New Mexico at Fort Wingate, which has 850 such igloos.[83] Figure 11 is a photograph of the small igloos located along the northwest side of Area II.

The igloos in Area II were used for storing small amounts of explosives being used in research and testing. All of Sandia's incoming explosives are received in the 6000 igloo area south of the Kirtland east-west runways. They are then transported as needed to the sites where they will be used. Area II's supplies were brought by truck to the area and unloaded in the Building 907 receiving area, from which they were distributed to the igloos or the labs.

The larger igloos in the area, Buildings 942 and 943, were built in 1967 and 1968, respectively. They are identical to the smaller igloos except for their size, and are designed to hold more explosive, and so are suitable for larger items. In addition, in 1976 Building 942 had a small concrete block room added in front of its entrance. The room was designed to hold special materials that required some sort of special handling. For example, some explosives are stored in refrigerators. The igloos themselves have no electricity sources, except for the lights, and the additional room on 942 was built with outlets to accommodate refrigerators and freezers.

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[83] Joseph S. Murphey, *Building the Arsenal of Democracy: A Survey of the World War II Military-Industrial Army Ordnance Complex* (Washington, DC: U.S. Army Corps of Engineers, August 1993), pp. 8-9.

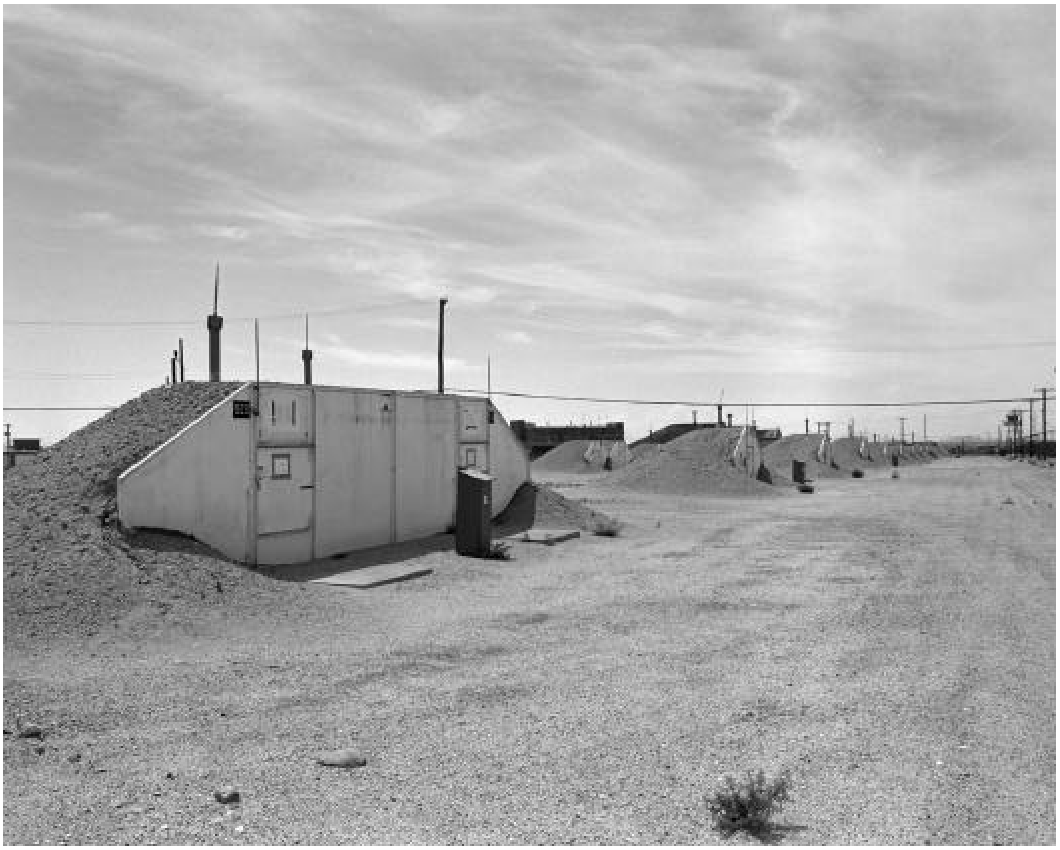

Figure 11. Igloos for storing explosives used in Area II research and testing. This row of igloos faces the northwestern edge of Area II. The dirt blast berms face the rest of the area to prevent propagation should a detonation occur.[84]

A component test facility was added to the area in 1964 as Building 935. The building was always and exclusively used for the development and testing of neutron generators. The design work for neutron generators was done in Area I, then prototypes were built in the Sandia shops or at the Pinellas production facility, and tested in Building 935. Functional testing of the devices was conducted in the building in environmental test fixtures to test for normal mechanical and thermal environments.[85] The devices were tested in test chambers within the building, and the building itself was not designed to contain a detonation.

Building 940 was built the following year as an explosive chemical laboratory, designed to handle a variety of experiments with hazardous materials. One of the safety features of the building was a remote control facility used for the precision machining of explosive components and materials, as shown in Figure 12. The building is laid out with large work and control rooms in the front and seven vaulted test rooms, with frangible walls to blow out (away from the area) in case of an accident along the back (southwest) wall. A concrete blast wall was added outside of the back wall of the building in 1987 as growth in Sandia's Tech Area IV began to encroach on

[84] Negative 19821, SNL Archives; photograph by Walt Dickenman, SNL photographer.
[85] Telephone conversations with Frank Bacon and Lucien Rice, January 1998.

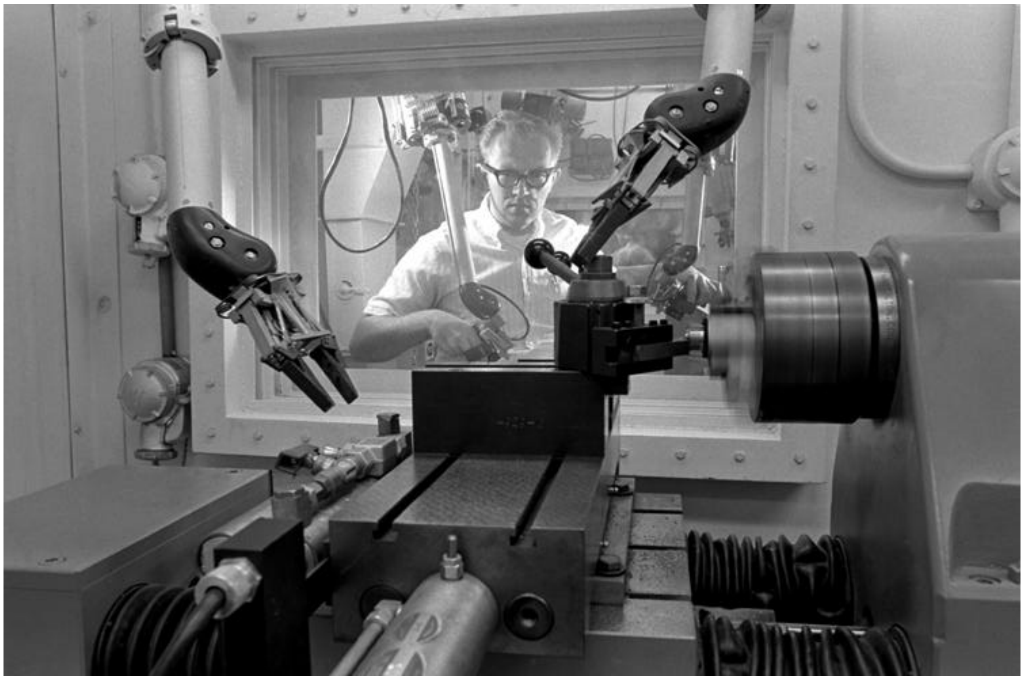

Figure 12. Remote control facility in Building 940. This 1969 *Lab News* photograph shows Tom Massis demonstrating the use of master-slave manipulators.

In addition to basic chemical research on explosives that resulted in the synthesis of new explosives, the building was used for explosive surveillance activities, particularly aging and compatibility tests. The building held big ovens for aging components. For example, in 1983, Tom Massis and George Bradley reported on an aging and compatibility study they had undertaken on the MC1442 thermal battery igniter. They were specifically interested in the effects of a hydrogen atmosphere on the energetic materials. Although the MC1442 had been in production since 1961, it had never undergone aging and compatibility tests for the igniter separate from the thermal batteries.[86] As a result, after 20 years of service, it was felt that more needed to be known about this particular component. This is one minor example of the ongoing research conducted in Building 940.

In the early 1980s a lab in Building 940 was devoted to Bob Bickes' research and development work on the semiconductor bridge, which was a Sandia invention. The development of the semiconductor bridge can be considered a singular breakthrough of some importance in explosive component design. It could ignite explosions 1,000 times faster than any previous igniter. In general, however, the work in the area represented ongoing research and development activities in which historical turning points or major events are nonexistent.

Building 915 was converted into an explosive component development facility in 1960. The quality group had moved out of 915 because it was too small and could not be enlarged

[86] Thomas M. Massis and George H. Bradley, Jr., *MC1442 Aging and Compatibility Studies*, SAND83-1288 (Albuquerque, NM: Sandia National Laboratories, 1983).

because of its design. Once Building 915 was converted, explosive devices were assembled there, and there were several explosive-handling fixtures, including a static-free room for handling some sensitive explosives, a small oven for baking explosives that were safest when stored wet and had to be dried before they could be used, and a firing pad outside the building for test detonations.

In 1967, Building 919 was built as an explosive devices building for the quality engineering department. The quality group was apparently conducting most of its research in Area III.[87] They had been using a firing chamber in Building 906 to conduct some of their tests. Building 919 contained a small chemistry lab and a great deal of testing was done in the building over the years on thermal batteries, neutron generators (which were also tested in the center of Area II), and various new explosives.

7.0 CONCLUSION

The new Explosive Components Facility (ECF) was opened in 1995 and all explosives work moved out of Area II. The original Area II buildings, considered permanent at the time of their construction in 1948, were described as substandard in the SNL Site Development Plans of 1984 and 1989.[88] Their period of usefulness to Sandia is over.

Area II still feels isolated, although that is probably because it is relatively uninhabited. Only Building 904 is occupied at this point. The Environmental Restoration projects also have staff in the area, so it is not completely vacant, but it does feel very far from the rest of Sandia. Certainly Area II is not as physically isolated as it was in 1948. Tech Area IV is located just to the southwest of Area II and there are several occupied buildings to the northwest of the original area. These are considered part of the current Area II, but are not on the same parcel of land as the original site.

Within the security of its perimeter fences, Area II housed two major activities in support of Sandia's mission from 1948 to 1995. For the 1948-1952 period, Tech Area II was the primary assembly site for America's nuclear weapons. Weapon assembly continued in Area II from 1952 to 1957, but the major responsibility for this work shifted to other sites in the Atomic Energy Commission's integrated contractor complex. Instead, building modifications and additional construction were undertaken to accommodate the research and testing of high-explosive components for nuclear weapons, which became the Area II's primary purpose after 1960. Both weapon assembly and explosive components contributed to the growth and the character of America's nuclear stockpile. Appendix I is an assessment of the eligibility of each of the buildings in Area II to the National Register of Historic Places, as well as the eligibility of the area as a Historic District.

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[87] "Proposed Construction for FY65," in SNL Technical Library, Central Technical File, Alpha Reel 4, p. 55.
[88] Sandia National Laboratories, *Site Development Plan* (Albuquerque: Sandia National Laboratories, 1984), pp. 30-31; and Sandia National Laboratories, *Site Development Plan* (Albuquerque: Sandia National Laboratories, 1989), pp. 115-116.

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APPENDIX I
NATIONAL REGISTER ELIGIBILITY

The National Register offers four criteria by which a property can be evaluated within its historic context.[89] They are:

> Criterion A: An event, a series of events or activities, or patterns of an area's development;
> Criterion B: Association with the life of an important person;
> Criterion C: A building form, architectural style, engineering technique, or artistic values, based on a stage of physical development, or the use of a material or method of construction that shaped the historic identity of an area;
> Criterion D: A research topic.

With regard to the Area II buildings, Criterion B appears not to apply. There are no single individuals recognized as historically important who are associated with the area. Also, the buildings are empty of equipment now and, although several of them were obviously used for high explosive work, they do not reveal anything important about the process of that work that does not require identification by other means. Therefore, Criterion D appears not to apply.

The buildings in Area II are all industrial in design and purpose. Although the flat roofs and clean lines of the buildings built in 1948[90] indicate the influence of the International Style, they are not truly representative of that style and are better seen as utilitarian designs reflecting their industrial purposes. However, Criterion C may apply to Buildings 904 and 907. As described in the history of Area II, they are apparently unique for the time in their interior blast wall design and represent a stage in the evolution of the design of high explosive handling facilities. Building 913, designed by the same architectural firm, is a smaller building reflecting similar design features, particularly the interior blast wall design. Its design appears to be derivative, the application of the design of Buildings 904 and 907 to a building intended to handle smaller amounts of explosives. The rest of the buildings in the area do not appear to meet Criterion C because they are similar to other industrial research buildings of the period of their construction.

It is Criterion A that, when applied to Area II, reveals the historic context of the buildings and the lens through which their National Register eligibility should be viewed. Area II is eligible as a historic district when Criterion A is applied. Area II cannot be said to have had a large impact on local or State developments. Although Sandia itself has played a significant role in the growth of Albuquerque, and the location of two national security laboratories (SNL and Los Alamos National Laboratory) in New Mexico has had a tremendous impact on the State's economic and political development, Area II itself has never been large enough to make such a mark. Instead, the work in Area II can be seen as revealing of the history of Sandia itself. Weapon production was a key part of Sandia's early activities, and final assembly of weapon sub-assemblies was done in Area II; the final move out of production in the 1950s transformed Area II; and finally, Area II

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[89] *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation* (1991), p. 7.
[90] Buildings 900, 901, 902, 903, 904, 907, and 908 were all built in 1948 and all display these qualities.

is indicative of the enormous amount of research and testing that are involved in the ongoing development of explosive components for nuclear weapons.

Further, the history of Area II must be viewed in the larger context of the Cold War. Both early weapon assembly and the high explosive research and testing that followed it in the area were outgrowths of Cold War policies and contributed, to different degrees, to the pattern of the Cold War. However, not every structure in Area II played a significant role in Cold War history.

The security structures in Area II exist because of national security concerns adjacent to the development of nuclear weapons and national policies related to those weapons. However, Building 900, the guard building, and Building 909, the remaining guard tower did not contribute to the pattern of the Cold War on their own. Buildings 900 and 909 do not appear to be eligible for the National Register.

Buildings 901, 904, and 907 do appear to be eligible under Criterion A, because they "have made a significant contribution to the broad patterns of our history."[91] Buildings 904 and 907 were designed specifically for weapon assembly and reflect the nature of that work. With their blast walls and assembly cell design they indicate the danger of working with large amounts of high explosive and the steps taken in 1948 to mitigate that danger. The work done in these buildings played a crucial role in early Cold War history. The area served as the primary assembly site for America's nuclear weapons during the 1948-1952 period when the demand for weapons increased sharply.

Building 922 as a basic research area and Building 940 as an explosives surveillance area were both sites of important work in the understanding of energetic materials and the development of explosive components. However, while the pressure for more and varied weapons grew out of mid-1950s Cold War sensibilities, it is difficult to track particular policies to specific developments in explosive component design. While the range and capabilities of weapons in America's stockpile are undoubtedly due in large part to changing component design, the work in this area can most usefully be viewed as ongoing improvements to weapon design. Building 922 does not appear to be eligible for the National Register under Criterion A.

Building 940's witness of the invention of the semiconductor bridge is of possible interest. However, this work is so recent that it is difficult to evaluate its historic significance. While a real breakthrough in the precision of explosive component design, it is not clear that this invention will change our understanding of explosives. Nor does it appear to have had an impact on the Cold War or, so far, on succeeding international policy. Building 940 does not appear to be eligible under Criterion A.

Building 935, dedicated throughout its history to neutron generator testing, is of some interest. However, neutron generators were in the stockpile and operating reliably by the time 935 was built in 1964. Improvements in the neutron generators, while important in weapon design and particularly in maintaining the enduring stockpile as the neutron source needs to be

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[91] Marcella Sherfy and W. Ray Luce, "Guidelines for Evaluating and Nominating Properties that have Achieved Significance within the Last Fifty Years," *National Register Bulletin 22* (1987), p. 9.

replaced, do not appear to have had an impact on the course of the Cold War. Building 935 does not appear to be eligible for the National Register.

Similarly, the variety of testing done in Building 913, does not appear to qualify it for the National Register. Like all of the explosive work done in Area II, the work in 913 was a direct result of the Cold War context. But the pressure safety research, the materials research, and the device assembly were all ongoing research projects, contributing to improvements in weapon design but not transforming the operation or use of the weapons. Building 913 does not appear to be eligible for the National Register.

Buildings 915 and 919 are interesting because of their role in stockpile quality assurance, which is an ongoing Sandia responsibility. The high quality of components in nuclear weapons must be certified to guarantee the reliability and safety of the stockpile. Testing is an ongoing and central part of quality assurance and that was the role of these buildings. However, the quality assurance organization used a variety of test sites, including other buildings in Area II on occasion, to complete their mission. Further, the tests done did not influence the size or nature of the stockpile in any significant way and cannot be seen to have influenced the Cold War. Quality assurance ensured that the weapons were reliable had the United States chosen to use them, but it did not in any way determine how they were used, either politically or tactically. Buildings 915 and 919 do not appear to be eligible for the National Register.

Building 917, the small explosives assembly facility, housed a variety of activities over the years, most of which seem to have been placed there for convenience. There were no single significant actions in 917 that would have contributed to U.S. Cold War policies or actions. Rather, Building 917 seems to have always served as one step in the testing process. Initially used to assemble explosive devices that would be fired in tests elsewhere, it then became a staging site for experiments actually conducted at the Nevada Test Site. The major purposes of the activities it housed were enacted elsewhere. Building 917 does not appear to be eligible for the National Register.

The maintenance and utility buildings in the area—Buildings 903, 908, 914, and 916—are not eligible by any of the criteria. Their only significance lies in their connection to other buildings in the area. They played a supporting role in the operation of the buildings, but had no direct role in the Cold War and its patterns. They would only be of interest if the buildings they support were to be found eligible for the National Register. For example, if Building 907 were to be nominated for the National Register, then Building 908 should be included in the nomination because it is essentially a part of 907.

The storage buildings in the area also do not appear to be of historic significance. The concrete chemical storage cupboards (Building 932) and the igloos used to store explosives directly reflect the explosive component research and development activities conducted in Area II. However, the structures are not unique. The igloos can be found throughout the United States on military bases storing ordnance. While the Area II igloos are good examples of this style of storage building, they are not of particular significance.

The other storage buildings in the area—Buildings 902, 920, and 921—undoubtedly played a necessary role in the daily activities in Area II. However, they are not interesting architecturally, nor did they contribute directly to, nor reflect the development of, U.S. Cold War policy. They are storage buildings. They do not appear to be eligible for the National Register.

In addition to assessing the National Register eligibility of the individual buildings in Area II, it is possible to consider Area II as a Historic District. The area can be considered as a district because of its integrity and unity of design and function. Together, the major buildings in the area are a unified entity, interrelated in purpose and design. Districts are evaluated for National Register eligibility under the same set of criteria as individual structures.[92] Criteria B and D appear not to apply to Area II as a district, as it is not associated with the life of an important person and it does not reveal anything important about the work it housed that is not available in other forms of documentation. Similarly, Criterion C, architectural style, applies to Buildings 904 and 907, but not to the area as a whole. However, as noted earlier, Criterion A clearly applies to Area II as a district just as it does to individual buildings in the area. Area II is both illustrative of, as well as a contributor to, the history of American participation in the Cold War. It is likely that Area II is eligible for the National Register of Historic Places as a Historic District with the majority of the larger buildings in the area contributing to that status.

In summary, Buildings 901, 904, and 907 appear to be eligible for the National Register. Moreover, Buildings 900, 901, 903, 904, 907, 908, 909, 913, 915, 919, 922, 935, and 940, together with storage igloos 923-927, 929-939, 942, 943, and 945-948, combine to form a historic district that is probably eligible for the National Register. The following table provides a list of the buildings in the area and indicates whether each contributes to the area as a historic district. Photographs of these buildings, as well as representative drawings of them are stored in the Sandia National Laboratories Corporate Archives at the SNL/NM site.

[92] *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation* (1991), p. 5.

AREA II HISTORIC DISTRICT
INDIVIDUAL BUILDING ROLES

Building	Built	Name/Purpose	Contributing or Not
900	1948	Guard/Gate House	Contributing
901	1948	Systems Analysis Facility	Contributing
902	1948	Storage	Not Contributing
903	1948	HVAC for Building 904	Contributing
904	1948	Environmental Testing Lab	Contributing
906	1950	Safety Chemical Labs	Not Contributing
907	1948	Explosives Application Facility	Contributing
908	1948	HVAC for Building 907	Contributing
909	1948	Guard Tower	Contributing
913	1951	Component Assembly Facility	Contributing
914	1951	Equipment Building for 913	Not Contributing
915	1951	Explosives Development Lab	Contributing
916	1957	Equipment Building for 922	Not Contributing
917	1953	Explosives Assembly Facility	Not Contributing
919	1967	Explosive Devices Building	Contributing
920	1954	Storage	Not Contributing
921	1954	Storage	Not Contributing
922	1957	Explosive Devices Development	Contributing
923-927	61-65	Storage Igloos	Contributing
929-939	61-65	Storage Igloos	Contributing
932	1955	Explosives storage	Not Contributing
935	1964	Component Test Facility	Contributing
940	1965	Explosive Testing Lab	Contributing
940C	1983	Storage	Not Contributing
942	1967	Chemical Storage Igloo	Contributing
943	1968	Explosive Storage Igloo	Contributing
945-948	1968	Storage Igloos	Contributing
MB-07	1986	Mardix Booth	Not Contributing

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