SAND REPORT

SAND2003-0112
Unlimited Release
Printed January 2003

Cold War Context Statement Sandia National Laboratories California Site

Rebecca A. Ullrich

Prepared by
Sandia National Laboratories
Albuquerque, New Mexico 87185 and Livermore, California 94550

Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under Contract DE-AC04-94-AL85000.

Issued by Sandia National Laboratories, operated for the United States Department of Energy by Sandia Corporation.

Available to DOE and DOE contractors from
U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831

Telephone: (865)576-8401
Facsimile: (865)576-5728
E-Mail: reports@adonis.osti.gov
Online ordering: http://www.doe.gov/bridge

Available to the public from
U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Rd
Springfield, VA 22161

Telephone: (800)553-6847
Facsimile: (703)605-6900
E-Mail: orders@ntis.fedworld.gov
Online order: http://www.ntis.gov/help/ordermethods.asp?loc=7-4-0#online

SAND2003-0112
Unlimited Release
Printed January 2003

Cold War Context Statement

Sandia National Laboratories
California Site

Rebecca A. Ullrich
Corporate Historian
Recorded Information Management Department
Sandia National Laboratories
P.O. Box 5800
Albuquerque, NM 87185-0612

Abstract

This document was prepared to support the Department of Energy's compliance with Sections 106 and 110 of the National Historic Preservation Act. It provides an overview of the historic context in which Sandia National Laboratories/California was created and developed. Establishing such a context allows for a reasonable and reasoned historical assessment of Sandia National Laboratories/California properties. The Cold War arms race provides the primary historical context for the SNL/CA built environment.

Acknowledgment

I have several people to thank for going beyond their regular routine to support the research for this project. Al Du Charme provided extensive information about the SNL/CA site, building designs, and overall philosophy of architecture. Robert Holland gave me a detailed and interesting tour of the SNL/CA facilities. Gabe Gutierrez provided access to and explanations of the SNL/CA drawing collection. I am happy to acknowledge their assistance. I am also grateful to Barbara Larsen for initiating and supporting this project.

Contents

Figures

1.0 Introduction

Sandia National Laboratories is a government-owned, contractor-operated national laboratory. Sandia Corporation, a Lockheed Martin Company, operates Sandia National Laboratories (SNL) for the U.S. Department of Energy's (DOE) National Nuclear Security Agency (NNSA). SNL conducts research and development activities in areas related to national security. Historically, this work has centered on the laboratory's original and main mission—to design the non-nuclear components for U.S. nuclear weapons. Over the years, SNL has expanded its work to include energy research and development projects, as well as assignments in non-nuclear national security areas.

SNL maintains two primary facilities, one in Albuquerque, New Mexico, and the other in Livermore, California. In addition, SNL operates the Kauai Test Facility in Hawaii and the Tonopah Test Range in Nevada. The majority of employees work at the Sandia National Laboratories/New Mexico (SNL/NM) site in Albuquerque. However, a significant contingent is employed at the Sandia National Laboratories/California (SNL/CA) site. This document applies to SNL/CA.

SNL/CA was established in 1956 and currently employs approximately 850 people. The site consists of approximately 70 facilities containing about 760,000 gross square feet (gsf) on 410 acres located approximately three miles east of downtown Livermore, California, and forty miles east of San Francisco. Most of the structures are permanent or semi-permanent in design. DOE owns the property and the facilities.[1] Figure 1 is a map of the SNL/CA site. Figure 2 is a map indicating the boundaries of the SNL/CA property.

SNL/CA was established in response to the creation of Lawrence Livermore National Laboratory (LLNL).[2] LLNL was created in 1952 as a second nuclear weapons design laboratory to supplement and compete with Los Alamos National Laboratory (LANL).[3] As SNL/NM provided ordnance engineering design support to LANL, so SNL/CA was created to provide direct support for LLNL designs. SNL/CA's creation and evolution are detailed below.

---

[1] Sandia National Laboratories, *Sites Comprehensive Plan, FY 2001 to FY 2010,* SAND2001-0034P (Albuquerque: Sandia National Laboratories, 2001).

[2] The facility known as Lawrence Livermore National Laboratory (LLNL) was originally part of the University of California Radiation Laboratory. Although it has undergone a number of name changes, it will be referred to as LLNL throughout this document.

[3] Los Alamos was originally called Los Alamos Scientific Laboratory. Los Alamos, Lawrence Livermore, and Sandia were named national laboratories in 1979. For consistency, all three are referred to by their current names throughout this document. The University of California is the managing contractor for LANL and LLNL.

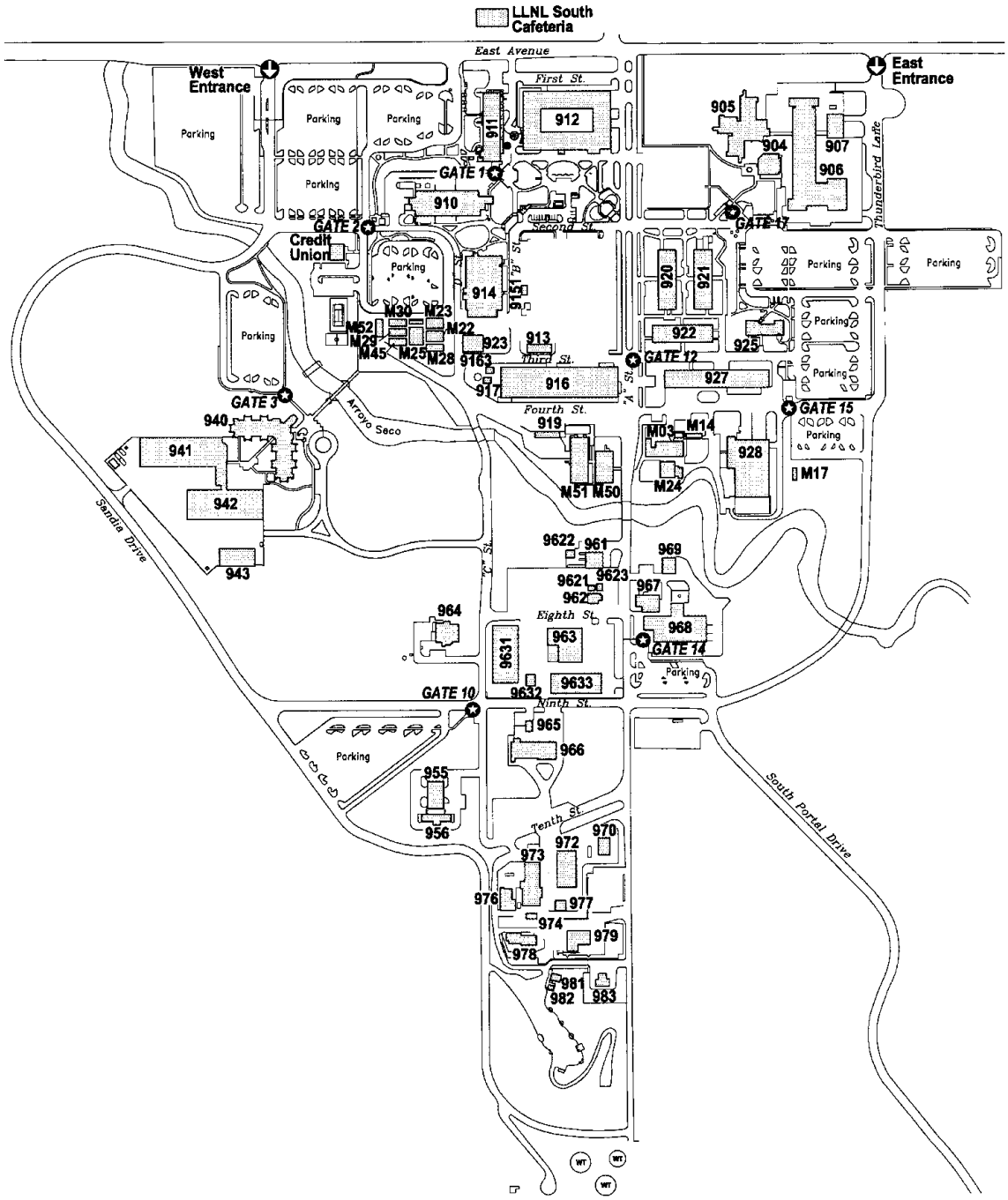

Figure 1. Map of SNL/CA facilities.

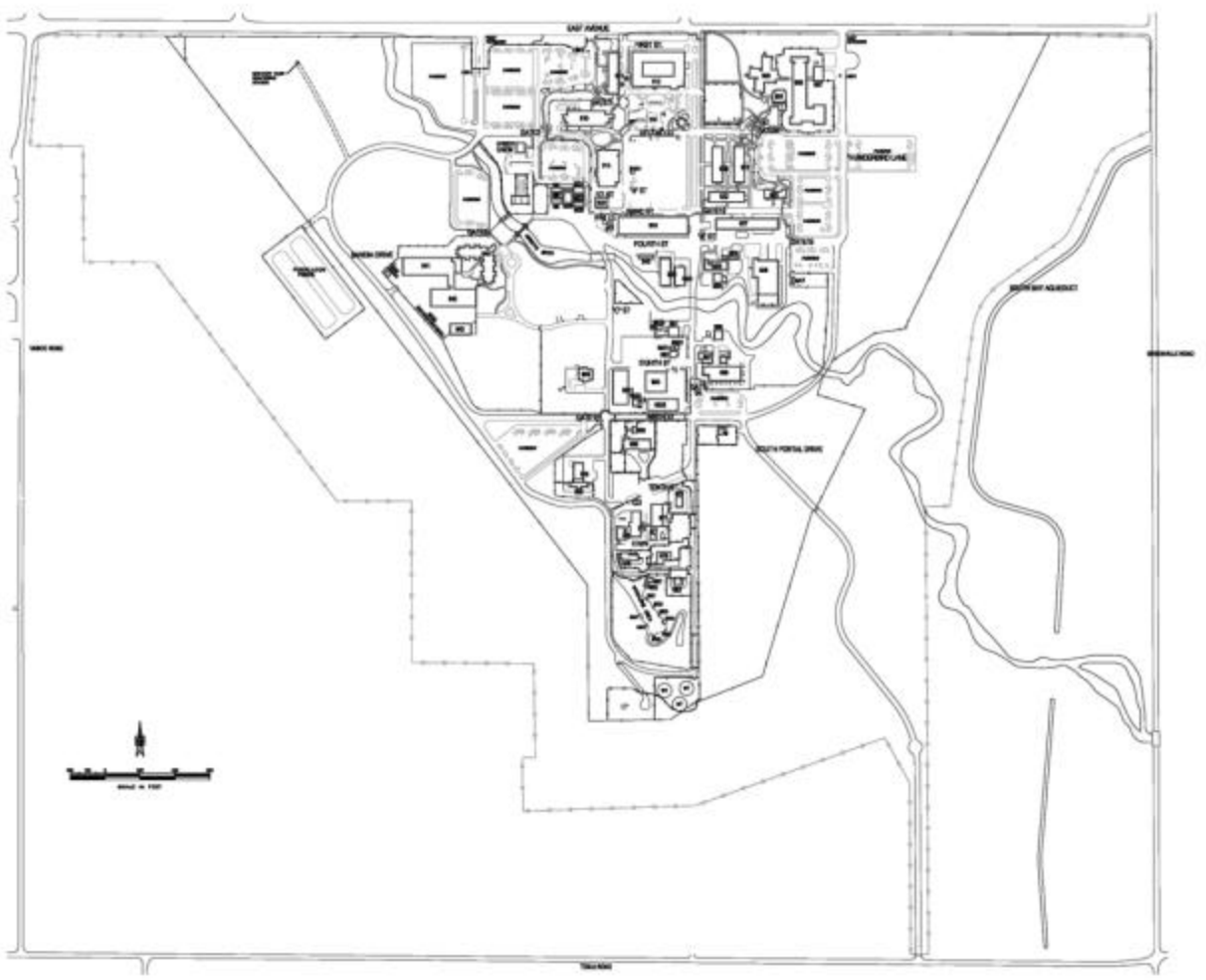

Figure 2. Boundaries of SNL/CA property.

1.1 Purpose

This document delineates the historic context within which SNL/CA properties will be evaluated for eligibility to the National Register of Historic Places. It was prepared to support DOE compliance with the National Historic Preservation Act (NHPA). It was designed to assist DOE in evaluating the National Register eligibility of SNL/CA properties. DOE will determine, in consultation with the California State Historic Preservation Office, whether individual buildings or sets of buildings are eligible for the National Register.

Specifically, this context statement addresses the relationship of SNL/CA properties to the national pattern of historical events known as the Cold War. DOE will determine whether individual properties or groups of properties are eligible for the National Register based on the extent to which they significantly represent or contribute to the themes related to SNL/CA's role in the Cold War.

Eligibility to the National Register also depends upon the integrity of the properties. Structures that may have played a significant role in Cold War history and could be judged eligible for the National Register because of the work they housed at an earlier point in time may be determined to be ineligible because of more recent modifications. Alternatively, building alterations may not harm the basic integrity of a historic structure, and may even add to its historic significance if such changes were done to enable the conduct of recognizably significant activities.

A historic context statement is not meant to provide the entire history of a site or set of properties. Although there is no published history devoted to the SNL/CA site alone, there are published histories of SNL's past, as well as a one-volume overview of the laboratory's history directed at a general audience.[4] This document is meant neither to replace nor compete with those histories. It necessarily considers some aspects of SNL/CA's history, but is not comprehensive. Rather, it focuses on SNL/CA's place within the broader development of U.S. and local history and describes the overall development of the site's physical properties.

1.2 Organization

This report is divided into seven sections. Section 1 is this introduction, which includes a brief discussion of the NHPA and Section 106 and 110 compliance, as well as the rationale for focusing on the Cold War as the primary historic context for SNL/CA's structures. Section 2 follows the introduction with an overview of the Cold War, emphasizing the nuclear arms race as the aspect of the Cold War most relevant in understanding SNL/CA's history. Section 3 provides a summary of the site's origins and its place within the U.S. nuclear weapons complex. This leads into Section 4, which places SNL/CA's history within the Cold War context by examining each of the specific Cold War themes that emerge. An overview of SNL/CA's physical plant is provided in Section 5, which describes the evolution of construction at SNL/CA as well as the different building types found at the site. A brief conclusion and a bibliography form the final two sections.

1.3 NHPA Compliance

The National Historic Preservation Act (NHPA) of 1966 (as amended) supports the preservation and use of the nation's historic built environment. It does so by encouraging historic preservation programs and activities, as well as authorizing the Secretary of the Interior to maintain the National Register of Historic Places and to create regulations for State Historic Preservation Programs. Sections of the NHPA specifically address the responsibility of Federal agencies in owning or interacting with National Register-eligible properties.

SNL is a government-owned, contractor-operated laboratory. It is managed and operated by Sandia Corporation, a Lockheed Martin Company, for DOE. As DOE owns all SNL/CA property, it is subject to the NHPA.

---

[4] See bibliography for histories of SNL. The one-volume general history referred to is Leland Johnson, *Sandia National Laboratories: A History of Exceptional Service in the National Interest* (Albuquerque: Sandia National Laboratories, 1997).

Section 106 of the NHPA directs any Federal agency undertaking or licensing any activity, to "take into account the effect of the undertaking on any district, site, building, structure or object that is included in or eligible for inclusion in the National Register." In order to assess the impact of any undertaking, an agency must know whether any affected district, site, building, structure, or object is eligible for the National Register.

Section 110 of the NHPA requires a federal agency to assume responsibility for historic properties it owns or controls. Historic properties must be identified, evaluated, documented, and nominated to the National Register, if appropriate. Thus, Section 110 obliges an agency to identify its historic properties and manage those properties in compliance with Section 106—that is, if something the agency is going to do or authorize to be done will have a potential impact on a property that is on, or eligible for, the National Register, the agency must engage in consultation with the relevant State Historic Preservation Office on the impact and ensure that the impact is mitigated.

1.4 Criteria for National Register Eligibility

The Secretary of the Interior specifies four criteria by which a property (whether a single structure or a district) can be evaluated within its historic context for eligibility to the National Register.[5]

Criterion A: Associated with an event or pattern of events that has made a significant contribution to history

This context statement specifically addresses Criterion A in that it summarizes the patterns of events with which SNL/CA is most closely tied. As noted above, the primary pattern of events that form SNL/CA's historic context is the Cold War. The survey of the individual buildings at the SNL/CA site will be done with an understanding of the Cold War context and the assessment of whether a given structure or district may be significant will include a consideration of the structure's role in the Cold War.

Criterion B: Associated with an individual of historic importance

It does not appear that any individual of recognized historic importance has been directly associated with the properties at SNL/CA. Should further research during the building survey indicate otherwise, Criterion B will be considered. However, there is no expectation that Criterion B will be relevant at this time.

Criterion C: Architectural significance

As will be discussed below in Section 5, which deals with SNL/CA's facilities, the site's buildings fall into the general category of Industrial Vernacular in style. It currently appears that very few are likely to be noteworthy for their architecture. However, because the structures directly reflect the work for which they were built and may therefore demonstrate some unique architectural qualities, the survey of the buildings will address more closely the architecture of individual buildings and areas.

---

[5] U.S. Department of the Interior, National Park Service, Interagency Resources Division, *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation* (Washington, DC: USGPO, 1991).

Criterion D: Yields or may yield information important in history or prehistory
Most often applied to archaeological sites, Criterion D considers whether a property tells us something about human history that we do not know from other sources. Earlier cultural resources surveys indicate that there are no known archaeological sites of interest at SNL/CA, neither are there indications of a possible site.[6] Should indications of an archaeological site, or archaeological artifacts be discovered at some future date, they will be evaluated and addressed in an appropriate manner.

It is possible that one or more of SNL/CA's buildings might tell us something about human history that is unavailable elsewhere. For example, a building's existing layout and equipment may provide insight into patterns of work activities. This will be assessed in the survey of the buildings. However, the properties are very young and quite well documented as well as being frequently upgraded, making it unlikely that they will provide information not better obtained from other forms of documentation.

Criterion Consideration G
In addition to the four criteria, the National Register, under Criterion Consideration G of the National Park Service guidance, generally only accepts nominations for properties over fifty years of age. Buildings younger than fifty years are only accepted to the National Register if they are of exceptional significance.[7] However, the Cold War is recognized as an identifiable period of exceptional significance in U.S. history and properties can be nominated to the National Register for their ties to it. This is the primary context into which SNL/CA's properties fit and there is no need to distinguish between properties older and younger than fifty years at the site that have housed Cold War activities. With the exception of very young buildings, which will have to be evaluated again as they approach fifty years of age, SNL/CA properties were involved in Cold War-related activities and will be evaluated accordingly.

1.5 The Cold War Context
The Cold War is the dominant context for understanding nearly all of SNL's history, including the origins and development of the facilities at SNL/CA. With the exception of one minor storage structure left from the World War II naval presence in Livermore, all of SNL/CA's current facilities date from the Cold War and after. Its existence is a product of the Cold War. The period of the Cold War (from the end of World War II

---

[6] Colin I. Busby and Donna M. Garaventa, *A Cultural Resources Overview and Historic Preservation Regulatory Analysis of Sandia National Laboratories Livermore Facility, Alameda County, California,* Document Number 84-9691 (San Leandro, CA: Basin Research Associates, Inc., 1990; Colin I. Busby, Donna M. Garaventa, and Robert M. Harmon, *A Cultural Resources Assessment of Sandia National Laboratories Livermore Facility, Alameda County, California,* Document Number 84-9691 (San Leandro, CA: Basin Research Associates, Inc., 1990); and U.S. Department of Energy and University of California, *Final Environmental Impact Statement and Environmental Impact Report for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore,* DOE/EIS-0157 (Livermore, CA: U.S. Department of Energy and University of California, 1992).
[7] *National Register Bulletin 15.*

until the fall of the Berlin Wall—1945-1989) includes the majority of the construction at SNL/CA and also defined the site's mission.

The National Register discourages listing properties that are less than fifty years old, to "avoid judgments based on current or recent popular trends."[8] However, a property built within the last fifty years may be eligible for listing if it is of exceptional importance. Most of SNL/CA's properties are less than fifty years old. However, most of the buildings were associated with Cold War activities for most of their lives and are best evaluated together within that context. The exceptional significance of the Cold War in U.S. and world history has been recognized. It is clearly a pattern of events that has had a tremendous impact on the world and is of historical importance; properties can be judged historically significant and eligible for the National Register within its context.[9]

Not all aspects of the Cold War are relevant to SNL/CA's history. As SNL/CA's mission focused on the design, environmental testing, and support for the testing of nuclear weapons, it is the arms race that provides most of the site's historic context. Thus, U.S. nuclear weapons policy, international arms control treaties, and decisions based on weapon capabilities are the focus of the Cold War context discussion below in Section 2, rather than other aspects of the Cold War. For example, SNL/CA was not involved in the space race and it is not discussed here although it was clearly a part of the Cold War.

Similarly, not all aspects of SNL/CA's association with the Cold War will necessarily be determined to be historically significant. SNL/CA's primary mission in the Cold War context was related to the design, development, and testing of nuclear weapons and it is that association, if any, that will determine a structure's historic significance. It is not enough to be part of the Cold War or built in support of the Cold War—a structure or district must show a clear and significant affiliation with SNL/CA's role in or contribution to the Cold War to be considered significant in this context. The SNL/CA site exists because of the Cold War, but not everything at the site contributed significantly to the Cold War. The survey of the structures at the site will evaluate the historic significance of individual and groups of buildings. It is possible that no existing structures will be found historically significant.

Only aspects of SNL/CA's history that can be understood within the Cold War context are addressed in this document. While SNL/CA has moved into areas beyond its immediate Cold War heritage, those moves have been relatively recent and are not likely to be of historic interest at this time. Certainly, SNL/CA's non-Cold War work is still too young for an evaluation—it has no historic context in the sense used in evaluating properties for National Register eligibility.

---

[8] Marcella Sherfy and W. Ray Luce, *National Register Bulletin 22: Guidelines for Evaluating and Nominating Properties that Have Achieved Significance Within the Last Fifty Years* (Washington, DC: U.S. Department of the Interior, National Park Service, National Register of Historic Places, 1979; internet edition, 1998), 2.
[9] Ibid., 7.

1.6 Local Context

In addition to evaluating SNL/CA's historical role in the national and international Cold War context, historic context must also consider local and California history.

SNL/CA was part of the post-World War II expansion in defense-related activities in the State of California. The aircraft industry, education, and defense manufacturing all expanded on defense dollars in the face of the Cold War, as well as the hot wars in Korea and Vietnam. California was the leader among states in receiving federal military and space contracts in the decades immediately after World War II. SNL/CA appears to be a relatively small ripple in the pond of post-war California expansion and development. The presence of the lab neither drove decisions about California expansion nor influenced the manner in which the state managed its defense industry involvement. SNL/CA was created because LLNL was already in Livermore. The larger institution, situated in Livermore because it was close to the University of California and E. O. Lawrence's Radiation Laboratory, of which it was initially an extension, more clearly reflects the expansion of existing California capabilities and the decision to capitalize upon them. Overall, within the magnitude of the expansion that occurred, SNL/CA appears to be part of the trend rather than a leader or significant indicator of it.

Within the local Livermore community, however, SNL/CA had a more obvious impact. From the beginning, lab management made a deliberate effort to participate in the local community—to be a good neighbor and contribute to activities, as an institution as well as in terms of the individuals among its employees who chose to become involved in the local community. In 1958, for example, Jack Howard, director at SNL/CA, led the effort to get a special bond passed to fund new facilities within Livermore in response to housing and sewage facilities problems created by the rapid growth in the area. Individual employees have been consistently involved with local politics over the years.

LLNL and SNL/CA moved into a very small community in the 1950s. The Livermore-Amador Valley around Livermore was largely agricultural, supporting ranching, farming, and, beginning in the 1880s, viticulture. In the 1950s some of the agricultural land began to give way to housing developments in response to both local growth and the expansion of some Bay Area interests to the east. In 1950, the town of Livermore had a population of 4,364. By 1960, with the two laboratories just three miles from downtown and employees living in the immediate area, the population had nearly quadrupled to 16,058. In addition to increasing the local population, the labs contributed to the local economy. By 1960, for example, the SNL/CA payroll reached $4,000,000, much of it spent locally. That SNL/CA influenced Livermore in the early period is undeniable.

However, it is not clear in what way SNL/CA's influence on local development might be reflected in individual or sets of structures at the site itself. Certainly, SNL/CA itself did not reflect much of the local context in the early years. The funding and decision-making to place SNL/CA in the particular location came from the Federal government and the lab was and is largely oriented toward national, rather than State or local, policy. The properties constructed at SNL/CA in the site's first two decades do not reflect any particular local or California influence. The large industrial structures initially built at the

site, while drawn by California architects do not reflect a noticeably California aesthetic in their design. Rather, they looked like large industrial research buildings, not unlike those being built in the same time frame at SNL/NM and other sites both within and outside of the nuclear weapons complex. It is obvious the site was an engineering laboratory.

More recently, an active effort has been made to emphasize earth tones in SNL/CA design and to use drought-resistant plants in landscaping in keeping with the site's California location. This effort reflects a deliberate shift in facilities design at SNL/CA and is part of the effort to create a more consistent, attractive site in support of recruiting, retention, and partnering efforts. However, even in this recent trend, SNL/CA's structures do not reflect or enlighten an understanding of California or local history. The Cold War context supercedes the local in understanding SNL/CA's properties.

1.7 Themes

SNL/CA's central mission during the time period covered by the Cold War was the design and testing of the non-nuclear components of nuclear weapons designed by LLNL. That central mission produced three themes that directly supported, and can be considered historically significant within, the broader history of the Cold War. These themes are weapon design, support for nuclear weapon testing, and environmental testing.

The three themes are further articulated in section 4.0 below. The themes will be used during the building survey and assessment. They allow for a full understanding and ability to assess the potential significance of individual structures and sets of structures within the SNL/CA site.

2.0 The Cold War

The Cold War—the forty-five year long struggle between the United States and the Soviet Union—and the nuclear arms race that accompanied it serve as the primary backdrop for the activities at SNL/CA from its inception until the 1990s. It is against this backdrop that we can most clearly evaluate any work of historical significance within SNL/CA's activities during this period.

The Cold War was not a single monolithic event and can be viewed as evolving in several stages over time. From the point of view of nuclear weapons history and the arms race, it is easiest to divide the Cold War along the lines of policy responses. The following list of policies includes approximate dates—policies overlapped in periods of transition.

- Early efforts at international control (1945-1948);
- Truman's containment efforts and early stockpile growth (1949-1952);
- Eisenhower's New Look, with a dependence on Massive Retaliation (1953-1960);
- Kennedy's Flexible Response (1961-1964);
- Johnson's return to an emphasis on deterrence with Assured Destruction (1965-1969);
- Nixon's détente and the return to an emphasis on a war-fighting capability, with first strike as well as tactical weapons and increased conventional forces (1970-1980);
- Reagan's increases in war-fighting capability (1981-1988); and
- the end of the Cold War (1989).

Within the period of each policy, other developments regarding nuclear strategy and nuclear weapons technology occurred, such as Atoms for Peace and Project Plowshare. Nevertheless, the central strategic policies help periodize the Cold War era.

The main periods of the Cold War are summarized below. The discussion is based on the historical literature pertaining to the Cold War. References for each Cold War event and turning point mentioned are not provided, as relevant sources are included in the bibliography. More detail regarding Cold War events and policy development can be found in those sources.

2.1 The Immediate Postwar Period

During the 1940s, nuclear weapons moved to the forefront of U.S. policy decisions, but this was neither an immediate nor an inevitable move. As the nation demobilized after World War II ended on August 14, 1945, there was no clear U.S. policy on the development or use of nuclear weapons. The primary development work, performed at Los Alamos during this period, consisted of some new design work and attempts to stabilize production.

But from a purely military standpoint, the atomic bomb was still just another bomb—more efficient perhaps than conventional explosives carried by fleets of airplanes, but still fitting into the vision of strategic bombing that had evolved during the war. The air force, for example, saw no changes necessary in its force structure as a consequence of this new weapon.

Some American scientists believed as early as 1946 that the Soviets might develop their own bomb by 1949. However, there was considerable disagreement among American policy planners over how long a Soviet bomb project would take; for example, General Leslie Groves, commanding officer of the Manhattan Engineer District, testified before Congress that it would take the Soviets twenty years to duplicate the American success.

For a variety of reasons, the United States demobilized from the war relatively quickly. The military budget was capped at lower and lower levels, and the Truman administration briefly considered proposals to control nuclear weapons internationally. But when it became clear that the Soviet Union was intent on entering nuclear arms control agreements only from a position of equality with the United States, preserving the American monopoly, or at least overwhelming superiority, in nuclear weapons became a cornerstone of American military policy. And by then, tensions with the Soviet Union were rising on other fronts.

2.2 Increasing Post-War Tension

In March of 1946, former British Prime Minister Winston Churchill, speaking at Westminster College in Fulton, Missouri, first promoted the image of an "Iron Curtain" that was beginning to divide Europe, and ultimately the entire world, into pro-Soviet and pro-West spheres of influence. By that point, increasing tension between the Soviet Union and its World War II allies had seriously damaged East-West relations, and positions 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. As a consequence, an increasing portion of American foreign and military policy became centered on nuclear weapons.

2.3 Atomic Energy Commission

Congress, the military, and civilian scientists and engineers struggled with the issue of military vs. civilian control of atomic energy immediately after the war. The debate was heated and occasionally acrimonious, and resulted in the Atomic Energy Act of 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 continued throughout the Cold War period, and even persists today.

The Act created an Atomic Energy Commission (AEC) to oversee all elements of atomic energy technology in the United States. On January 1, 1947, all property and personnel of the Manhattan Engineer District were transferred to the Atomic Energy Commission. However, to make sure that military needs were met—atomic energy had only been used as a weapon to this point, after all—the AEC had a liaison committee of military officials, the Military Liaison Committee (MLC). This arrangement created what is referred to as "dual-agency responsibility" for the weapons and their uses: the AEC controlled atomic energy, and the AEC and the military were jointly responsible for nuclear weapons.

In addition, the Act established a General Advisory Committee (GAC) within the AEC, made up of prominent scientists and engineers. The GAC provided technical advice to the AEC and helped evaluate research and development programs and proposals.

2.4 Cooling Relationship between U.S. and USSR

Several crises in 1948 and 1949 served to accelerate the chilling of relations between the United States and the Soviet Union. The Soviet attempt physically to blockade the city of Berlin in 1948 was the first major Cold War crisis, and also had direct effects on American nuclear strategy. The tensions stemming from the crisis resulted in a revised production system that aimed to quadruple the U.S. nuclear stockpile. In addition, a review of U.S. military nuclear readiness during the Berlin crisis found a "discouraging" level of preparedness; strategic bombing and nuclear weapons proponent General Curtis LeMay was consequently put in charge of Strategic Air Command.

In response to the growing Soviet influence in eastern Europe, the United States formed the North Atlantic Treaty Organization (NATO) in early 1949. NATO was a collective security alliance between the U.S. and most of the nations of western Europe, and served as a guarantee of American military support, including the use of nuclear weapons, in the event of Soviet military expansion westward. In response, the Soviet Union and its eastern European allies formed the Warsaw Pact shortly thereafter.

Also in 1949, the Soviets detonated their first atomic bomb. Later that same year, Chinese Communists led by Mao Zedong succeeded in toppling the nationalist government in that country, establishing the Peoples' Republic of China. While American policy analysts had long predicted both of these events, their rapid succession left many in the American public (which had been inadequately prepared for these events by the Truman administration) clamoring for a dramatic response. Truman quickly directed the AEC to consider developing the thermonuclear, or hydrogen "super" bomb.

2.5 Korean War

The largest and most important crisis in the early Cold War era was the conflict in Korea. After several years of diplomatic conflict over whether or how North and South Korea, partitioned by the Allies at the end of World War II, should be re-unified, the pro-Communist North Koreans attempted to re-unite the country by force of arms in June 1950. While we now know that this action was taken by the North Korean government largely without authorization or coordination from Moscow or Beijing, at the time it appeared to be a clear example of Communist expansion in Asia.

The Truman administration quickly committed the United States to containing this apparent case of Soviet expansion. Eventually, a U.N. force, comprised overwhelmingly of American military personnel, would fight in Korea against both North Korean and Chinese forces.

In the spring of 1951, concerned with the tenuous military situation in Korea, President Truman authorized, for the first time in the AEC's history, the transfer of nuclear weapons to the Air Force for deployment to Asia.

Nuclear weapons were not used in Korea. There were several reasons for this. The most important was probably the conclusion that conventional military means could be employed as successfully. In addition, the Truman administration was determined not to draw the Soviets directly into the war, and concerned that an ineffective use of nuclear weapons would undercut their deterrence value. This last proved critical numerous times in discussions of potential uses for nuclear weapons. However, the Truman administration continued preparations to use nuclear weapons in the future, if necessary.

The war in Korea also accelerated the push for tactical nuclear weapons, which were tested at the Nevada Test Site in 1951. The nuclear stockpile grew, and by 1953, the U.S. arsenal contained over 1,100 weapons, up from approximately 50 just five years earlier.[10]

2.6 New Look

Over the course of his two terms as President, Dwight Eisenhower re-shaped American nuclear policy. As Supreme NATO Commander in Europe, Eisenhower had earlier paved the way for the forward deployment of American nuclear weapons in Europe. As President, he oversaw the growth of the nuclear stockpile to over 18,000 weapons by 1960. During his eight years in the White House, programs were undertaken to bring Intercontinental Ballistic Missiles (ICBMs) and Submarine Launched Ballistic Missiles (SLBMs) into the arsenal.

But most importantly, Eisenhower, concerned about the growing cost of a large, conventional military, became increasingly attracted to the nuclear option. The Eisenhower administration's "New Look" was a new military posture for the United States that was heavily dependent on the threat of massive retaliation with nuclear weapons in response to Soviet aggression. To add teeth to the language of deterrence by massive retaliation, Eisenhower diversified the stockpile to include more tactical nuclear weapons, and also adopted the policy that, in the event of war, the United States would consider nuclear weapons available for use as any other munition.

2.7 Peak of Cold War

The latter years of Eisenhower's presidency and the first years of Kennedy's saw further transformations in the American nuclear policy. By the end of the 1950s, the policy of massive retaliation was beginning to look overly rigid and clumsy, especially after it became clear that the United States was not willing to engage in full-scale nuclear war over relatively small international crises (like the periodic shelling of the islands of Quemoy and Matsu by the Peoples' Republic of China). The successful Soviet launch of Sputnik in 1957 led many Americans to believe that the United States' nuclear superiority was at risk; even if we had more bullets, the Soviets now appeared to have a bigger gun. The doctrine of massive retaliation was gradually yielding to the reality of mutual assured destruction (MAD), which essentially meant both sides had enough firepower to completely destroy one another should a nuclear war begin. This was the

[10] "Declassification of Selected Nuclear Weapon Stockpile Information," *Sandia Classification Bulletin*, no. 94-8, November 1, 1994, 9.

key thinking behind the idea of deterrence for most of the Cold War—that is, that both sides knew that initiating nuclear war would mean annihilation for both.

In the last years of his administration, Eisenhower hoped to end the Cold War and the arms buildup through negotiation with the Soviet Union. His final hopes for such an achievement died when the U.S. U-2 surveillance aircraft carrying Francis Gary Powers was shot down by the Soviets in 1960.

John Kennedy willingly assumed the Cold Warrior mantle when he became President in 1961. He had campaigned on the pledge to close the supposed "missile gap" with the Soviet Union, and was undeterred when he discovered after becoming President that the United States actually enjoyed a large missile superiority over the Soviets. And although he was personally shaken by the Cuban Missile Crisis in 1962, he continued to promote a larger nuclear stockpile.

2.8 Flexible Response

But Kennedy also reformed American nuclear policy. Unsatisfied with the rigidity of massive retaliation or the horror of mutual assured destruction, the Kennedy administration developed the doctrine of flexible response. Under flexible response, the President would have a wider range of nuclear and conventional military options in response to crises or during time of war—graduated military options, variable target sets, etc. Flexible response, rather than massive retaliation, became the foundation of American nuclear strategy until the late 1970s.

2.9 Safety Concerns

One important set of technical developments during the 1960s pertained to safety. A visit to Europe by members of Congress's Joint Committee on Atomic Energy in 1961 revealed a concern over unauthorized use. With an increasing number of weapons forward deployed to Europe, the Kennedy administration decided that it was necessary to install greater protective devices on nuclear weapons to prevent their use if they fell into enemy hands. In 1962, Kennedy ordered that all American weapons be equipped with Permissive Action Links (PALs) for this purpose. PALs began as relatively conventional locking mechanisms, and gradually evolved into more complicated encryption devices.

Political pressure for increased safety continued through the 1960s, especially in response to accidents regarding aircraft carrying nuclear weapons at Thule, Greenland, and Palomares, Spain.

2.10 Vietnam and SALT

As president, Lyndon Johnson was much more concerned with issues of domestic policy (civil rights, the Great Society, the War on Poverty, etc.) than with foreign policy. In addition to contributing to the drift into the quagmire of Vietnam, this focus also resulted in relatively minor shifts in nuclear strategy and policy. The increasing size of the Soviet arsenal resulted in (1) a gradual move back to the doctrine of assured destruction in the event of nuclear war, and (2) growing political pressure for arms control.

The war in Vietnam only reinforced these trends, and the 1960s began a series of nuclear arms control agreements between the United States and the Soviet Union. The first was the Limited Test Ban Treaty, concluded by Kennedy in 1963. In 1965, Johnson committed the United States to a Nuclear Non-Proliferation Treaty, which he signed in 1968 but was not ratified until 1970.

Richard Nixon's foreign policy triumphs with Moscow and Beijing resulted in a temporary thaw in Cold War relations known as *détente.* The most important consequences of détente for nuclear policy were the Anti-Ballistic Missile Treaty (1972) and the Strategic Arms Limitation Treaty (1972). By the early 1970s, treaties on these issues had become particularly important for both foreign and domestic policy. The technological development of feasible anti-ballistic missiles had by then begun to threaten the stability of nuclear deterrence, and the development of Multiple, Independently-targetable Re-entry Vehicles (or MIRVs, which permitted both sides to put many warheads on a single missile) threatened to cause an enormous acceleration of the arms race.

By the end of the 1960s, the enormous growth in the size of the American nuclear stockpile was clearly slowing. Even with the shift toward larger numbers of tactical weapons, the size of the arsenal, both in megatonnage and number of weapons, was on the decline by 1968.

2.11 The End of the Cold War

In his single term as president, Jimmy Carter stressed the importance of international human rights. As for nuclear matters, his administration focused on securing further arms control agreements with the Soviet Union. These negotiations led to the signing of SALT II, a treaty that was shelved after the Soviet invasion of Afghanistan and never ratified by the U.S. Senate.

Ronald Reagan's reinvigoration of Cold War tension entailed a striking departure from earlier Cold War presidents: open discussion of how the United States could plan to fight, survive, and even win a nuclear war with the Soviet Union. The hard-line language was accompanied by the largest peacetime military build-up in the nation's history. The $2 trillion defense program included a multitude of new weapons systems, as well as the Strategic Defense Initiative (SDI). Serving the dual purpose of further intimidating Soviet leaders and quelling domestic pressure for a nuclear freeze, SDI proposed to build an anti-ballistic missile shield that would protect the entire nation against nuclear missile attack.

While the results of SDI (dubbed "Star Wars" by its critics) fell far short of its promises, the same could be said of the Soviet Union, which experienced radical reform under Mikhail Gorbachev in the late 1980s and then collapsed completely after a failed coup in 1991. With the demise of the Soviet Union, the Cold War came to an end.

3.0 SNL/CA in the Nuclear Weapons Complex

To support its Cold War policies, the United States established a large complex of weapon design, testing, production, and assembly facilities. The largest push to create the complex came in the 1948-1952 time frame, when the Cold War was accelerating. Facility construction and expansion continued throughout the 1950s as the initial stockpile of nuclear weapons expanded into a massive arsenal.

The nuclear weapons complex did not create the Cold War, neither did it determine U.S. Cold War policy. It is impossible to map individual weapon designs or even types of weapons to particular policy decisions. Instead, policy and weapon design/production are integrally linked to one another. The complex produced a large number and variety of weapons in a relatively short time in response to the administration and defense perceptions of a communist threat in the late 1940s. Later, when the stockpile was swollen with weapons produced under the policy of massive retaliation, Kennedy was able to revisit policy and introduce flexible response precisely because there were so many weapons available, including tactical devices with lower yields. Neither policy nor technology alone conducted this dance.

The complex the AEC created is a mix of private facilities working on government contracts and what are known as GOCO facilities—government-owned, contractor-operation installations. SNL is one of the GOCO facilities, as are the other national laboratories. The complex resembles a top-heavy hourglass, with the two nuclear physics laboratories at the top, the production complex forming the bottom, and SNL as the narrow waist. The bottom of the glass is larger than the top in terms of number of facilities, but the political clout of the top portion maintains the balance.

SNL's place within the nuclear weapons complex during the Cold War was to engineer, or "weaponize," the nuclear physics packages designed by the nuclear physics laboratories—in general, SNL/NM supported LANL designs and SNL/CA supported LLNL designs. In an oversimplification, LANL and LLNL provide the physics portion of the nuclear weapons, SNL provides the engineering, and the rest of the complex produces the parts and the final weapon.

The essential outlines of the U.S. nuclear weapons complex were put in place in the early years of the Cold War. By the time SNL/CA was created in the mid-1950s, the full design and production complex was up and running. Thus, SNL/CA entered the Cold War story when the early stockpile build-up and the arms race were well underway. It and LLNL were part of expansion related to the push for additional weapons. SNL/CA does not represent a new capability within the nuclear weapons complex, however, and its existence and early activities are most usefully seen as an extension of the overall SNL mission and place within the complex.

3.1 End of WWII and Creation of SNL

Originally part of Los Alamos, SNL began as Z Division, created in July of 1945 to perform the ordnance engineering and assembly aspects of LANL's design work. Late in

1945, Z Division began the move to Sandia Base, as Los Alamos was quite crowded and the new division's work required close interaction with the military; the move was completed in February of 1947. The creation of Z Division and the move to Albuquerque represent the early effort to move the atomic bomb project from a wartime onto a peacetime footing. Until the end of 1946, LANL, Z Division, and the rest of the nuclear weapon design and production effort remained under the leadership of the Manhattan Engineer District. In January of 1947, the AEC took over all Manhattan Project property and personnel.

By 1948, Z Division had grown so much that it was made a separate branch of Los Alamos and renamed Sandia Laboratory. Still growing and with a mission distinct from that of its parent laboratory, on November 1, 1949, SNL became a separate laboratory. At President Truman's request, AT&T agreed to take over management responsibilities from the University of California. Sandia Corporation—a wholly owned subsidiary of Western Electric, the Bell System's manufacturing arm—was formed to manage the laboratory. In 1956, SNL established an additional site in Livermore, California, to support the new weapon design laboratory now known as LLNL.

3.2 Building the Complex

By 1949, the nuclear weapons complex was coming into focus, fed by early Cold War fears and budding nuclear policy. LANL's large design and testing effort for new physics package designs was in place and SNL/NM's ordnance design activities well underway. Production facilities at Hanford and Oak Ridge were still supplying nuclear material, while explosive lenses were poured at the Naval Ordnance Test Station at Inyokern in California. The component production portion of the complex was growing, with a variety of parts produced at a former Pratt & Whitney airplane-engine plant in Kansas City, as well as at the Mound Laboratory in Miamisburg, Ohio, and the Picatinny Arsenal in New Jersey. The Rock Island Arsenal in Illinois supplied steel bomb casings. The Burlington Plant of Iowa also was opened to begin taking over weapon assembly activities.

The Korean War brought nuclear weapons to the forefront of Cold War policy. The policy of deterrence was fully articulated in the consideration of using nuclear weapons in Korea. This caused a further push for additional nuclear weapons and a further expansion of the complex.

In the 1950s, the world witnessed a massive growth in both the numbers and types of nuclear weapons at the superpowers' disposal. The Nevada Test Site was established in 1950. By 1953, the nuclear weapons complex had expanded to several additional sites, including LLNL in California, and additional production facilities at Salt Wells in California, Portsmouth in Ohio, Paducah in Kentucky, and Savannah River in South Carolina. America's build-up in numbers of nuclear weapons was a deliberate part of the Eisenhower administration's New Look. While President Eisenhower himself pursued the possibility of nuclear disarmament, the nuclear weapons complex began work on at least forty new weapon programs between 1953 and 1961, some of which did not make it to the stockpile. The variety of weapons under development resulted from the

introduction of new delivery systems—namely, missiles—and the new weapon design possibilities growing out of the research conducted at LANL, LLNL, and both SNL sites.

3.3 Establishing LLNL

In 1942, the U.S. government acquired 629 acres of land to the east of the town of Livermore from rancher W. Gatzmer Wagoner and established a naval air station on the property. The Livermore Naval Air Station served as a flight training facility for approximately 4,000 pilots during World War II. Late in 1944, training activities were curtailed and the facility was converted to a stopover base for pilots operating from aircraft carriers. The station was deactivated in 1946.

In July 1952, the AEC agreed to create an additional design laboratory. The immediate purpose of the new facility was to pursue a thermonuclear weapons development program. The need for such a facility had been strongly and persistently argued by Edward Teller who was convinced that LANL was not putting sufficient energy into creating a thermonuclear design, particularly in light of the Soviet atomic bomb test in 1949. E. O. Lawrence, head of the University of California Radiation Laboratory at Berkeley, agreed with Teller and succeeded in convincing the AEC of the need for the new facility.

LLNL—initially a branch of the University of California Radiation Laboratory—was established in September 1952 on the site of the former Livermore Naval Air Station. Just over 600 acres of former naval air station land were transferred to the AEC. The site was north of East Avenue (then County Road 1518), about three miles east of the center of Livermore and forty miles east of San Francisco.

Herbert F. York was put in charge of the new laboratory. The initial activities planned for LLNL were diagnostic experiments during weapons tests. Once Mike, the first large thermonuclear device, was detonated in November 1952 in a LANL test, LLNL began work on thermonuclear weapon designs.[11]

3.4 SNL/CA Created

In 1955, the AEC acknowledged the need for ordnance engineering support from SNL for LLNL's new design efforts. By January of 1956, fourteen SNL employees were assigned to Livermore and worked with LLNL in LLNL facilities. In February of 1956, the AEC agreed to a permanent SNL facility in Livermore. The official creation date of the new facility was March 8, 1956, and it was sited just across from LLNL on the south side of East Avenue on land from the former Gunnery Range of the Livermore Naval Air Station.

SNL and the AEC decided not to duplicate every SNL/NM department and capability at the new site. Design support for LLNL was provided by a small group of engineers and support staff at SNL/CA. Other functions were not created at SNL/CA. For example,

[11] Herbert F. York, "Making Weapons, Talking Peace," *Physics Today* (April 1988): 44-45; and Lawrence Livermore National Laboratory, "Laboratory History" (Livermore: LLNL website at www.llnl.gov, 2001).

SNL/NM built several large environmental test facilities in the 1950s; there was no effort to duplicate most of these at the new site. Instead, in 1957, SNL/CA began using the LLNL Site 300 test area for some explosive testing.[12] In addition, an environmental test building for the new site was completed by the end of 1958 and some testing of new designs was done there. Tests requiring the full range of environmental test options offered by SNL/NM were done in New Mexico.

The SNL/CA operation initially grew out of and reported to the SNL/NM Vice President of Systems Development—devoted to system engineering for weapons. The site eventually received its own Vice President as it expanded beyond its original engineering and administrative support groups to include test and research capabilities.

As LLNL was created in part to provide a competitor to LANL, and as the new lab opened just before the 1953 AEC-DoD Agreement regarding the phases of design, development, and production, SNL found itself in the position of housing competitive units within its overall structure for part of the weapon design process. Once the need for a new design was established within the AEC-DoD process, both LLNL and LANL had the opportunity to propose a specific design. SNL, as the ordnance engineer laboratory responsible for weaponizing the design was part of the competition if LANL and LLNL both decided to offer designs. As a result, each SNL site supported the design of its respective physics laboratory through the competition until a design was chosen. Then both SNL sites supported, to the degree necessary, the design of the weapon to be created or modified.

The site grew steadily, with over 800 employees by the end of 1959. Weapon design efforts were underway from the beginning, and by 1959 SNL/CA was at work on the W38 warhead for the Titan I and Atlas missiles. This was the beginning of a series of extensive programs in warhead design. Support for LLNL also expanded from nuclear ordnance design to test support. SNL/CA provided effects test analysis and telemetry for LLNL nuclear tests of nuclear weapon designs. The labs also moved into evaluation of nuclear detonation as part of the Plowshare Program, which began in 1959.

3.5 Evolution of SNL/CA Mission and Activities

Plowshare was the first spin-off from direct nuclear weapons ordnance engineering at SNL/CA. Both SNL/CA and SNL/NM became involved in the Plowshare effort, which began at LLNL in 1959. LLNL remained the much larger participant in all Plowshare activities, but SNL did provide support, particularly in the area of effects and cratering. Ultimately, Plowshare ended in the early 1970s without obtaining any of the peaceful uses goals it had set, but it is interesting because it does represent the first step away from a sole focus on weapons design for the SNL/CA site.

Neither SNL/CA nor SNL/NM have lost their core mission of nuclear ordnance design and testing, but both sites have evolved along with the rest of the nuclear weapons complex. The peak of new designs entering the stockpile was past by the mid-1960s, and

[12] Site 300 is operated by LLNL and will be considered neither in this context statement nor in the building survey and assessment.

all of the sites considered diverse lines of work to add to their nuclear weapons emphasis. Most of the efforts built on or spun off from the basic weapon mission.

In the late 1960s, with its weapon ordnance design capability well developed, SNL/CA moved further into the area of scientific research. Discussed as the desire to add "technical depth" to the lab's solid engineering strengths, an ambitious new recruiting program was launched. The focus of the new effort was on bringing physicists, mathematicians, and materials specialists to the lab to work in applied research. The interest in materials research, in particular, grew directly out of earlier design efforts in creating components and systems capable of surviving in the potentially harsh environment of an individual weapon's path to target.

SNL/CA also developed, through recruiting aimed at scientists, an independent computational capability that it had not had in the first few years of its existence. This was largely developed as a support effort for design and testing activities within the lab and not as a separate function.

Similarly, SNL/CA's first moves into research on tritium grew out of the lab's familiarity with and use of tritium in components. In the late 1970s, studies were outlined and pursued in the area of tritium research and, in 1974, the first structure dedicated to tritium research at SNL/CA was completed. For nearly twenty years, tritium study was a well-respected and fully developed research program at SNL/CA

Ranging further from weapons engineering, SNL/CA also pursued combustion research. The original interest in combustion research grew out of gas-mixing studies done in support of weapon design. The combustion research moved beyond the world of nuclear weapons, however, as SNL/CA built a complex of structures in 1980 to support the effort. The program is widely known and there is a great deal of interaction with non-lab users.

Finally, during the 1973-1974 energy crisis, SNL began conducting some research into alternative energy. SNL/CA studied the feasibility of solar energy and explored engineering options in that area. Responsible for the solar central receiver facility in Barstow, the lab achieved some success in this area before solar research was consolidated at SNL/NM in the early 1980s.

The moves first into scientific research and then into broader non-weapons work (particularly combustion research), shifted SNL/CA away from its basic Cold War engineering lab atmosphere and purpose. While the lab's core mission did not change, the additional areas of research both added to the weapon design capability and gave the facility more flexibility.

4.0 SNL/CA and the Cold War

Understanding where SNL/CA fits within the broader Cold War context will allow DOE to make decisions regarding specific facilities at the SNL/CA site. If properties exemplify or represent significant contributions to the Cold War, DOE, in consultation with the California State Historic Preservation Office, may find them eligible to the National Register of Historic Places.

SNL/CA was part of the infrastructure of U.S. Cold War policy, enabling the federal government to implement policies that relied on the availability of nuclear weapons. This was a somewhat interactive process. As noted in the preceding section, the nuclear weapons complex both supported and enabled U.S. Cold War policy. Research pursuits and new designs allowed the reconsideration of some policies and the pursuit of others. For example, the great array of weapons created under Eisenhower's massive retaliation policy included a variety of strategic and tactical devices. The choices among the weapons implied a choice of options for using them. This allowed the flexible response policy of the Kennedy administration, particularly through the presence of tactical nuclear weapons. The idea of having a choice among weapon yields fed into the idea of choosing different weapons for different situations, always with the assumption of scalability. In general, however, care is required in linking specific stockpile decisions to particular policy choices. The time it took to get a weapon developed and into the stockpile combined with the malleability of policy meant that the two were largely unlinked in the sense that one did not determine the other.

This section presents the three themes articulating SNL/CA's link to its Cold War context. SNL/CA was not directly involved with policy decisions or analysis. The majority of the research and development activities undertaken by SNL/CA have been related to America's nuclear stockpile, with work centered on weapon design and testing. The site's original mission was to provide ordnance engineering for nuclear weapons designed by LLNL. The history of this assignment reveals three core themes in SNL/CA's work in support of U.S. Cold War policy and capability: weapon design, support of nuclear testing, and environmental testing.

4.1 Weapon Design

SNL/CA was created near the beginning of the peak production years (1955-1967) for nuclear weapons in the U.S. The facility existed to weaponize the nuclear physics packages designed by LLNL. The designs were predominantly for warheads, as the pursuit and advance of ballistic missile delivery of nuclear devices was underway. The basic effort was an expansion of the existing capabilities of the nuclear weapon complex. However, LLNL's physics packages and SNL/CA's weaponization of them were often different than those produced by LANL and SNL/NM.

Rather than detailing every LLNL weapon system SNL/CA worked on, the following text outlines the highlights of SNL/CA's weapon design efforts that are of particular historical interest, including early warhead development, joint test assemblies, the Polaris warhead design, and the integration of warheads with re-entry vehicles.

SNL/CA was created as nuclear warheads were joining the U.S. arsenal of nuclear bombs. The first nuclear weapon developed by LLNL and supported by SNL/NM engineers (commuting to Livermore in the mid-1950s), was the W27 warhead for the Regulus I, Rascal, and Matador missiles. The majority of the weapons designed by LLNL and SNL/CA were warheads, and the two laboratories played a significant role in the eventual development of nuclear warheads for U.S. intermediate-range ballistic missiles (IRBM) and intercontinental ballistic missiles (ICBM).

Design work began immediately at the new SNL site. In March of 1956, as SNL/CA was being established, the new site's employees were working on a firing set for the W48, which was eventually deployed with the 155mm-cannon weapon system. Later in the same year, work began on the B41, the largest-yield bomb ever placed in the U.S. stockpile. SNL/CA employees worked in LLNL buildings at this early stage, as their own facilities were not yet available.

Each weapon development effort employed new and different design elements. The active pursuit of smaller, lighter, and faster component designs led SNL/CA to develop several new technologies. For example, ferromagnetic firing sets—subjecting ferromagnetic materials to high-pressure shock waves to generate an explosion to serve as a firing set for a weapon detonator—were smaller and more powerful than previous designs, enabling the design of compact weapons. Similarly, miniature valves were developed to meet the same need. Explosion-valve technology was designed and tested at SNL/CA in the late 1950s; the basic design was eventually used in nearly all subsequent weapon systems.

In addition to specific component developments, SNL/CA designed instrumentation to evaluate weapon system performance during flight tests. Known as joint test assemblies, these sets of instrumentation were first used in tests for the W47/Polaris program, which was under development in the late 1950s.

The Polaris program is of particular note in SNL/CA's weapon design history. The warhead was designed for the Navy. The final missile and warhead design met the Navy's goal to launch a ballistic missile from a submerged submarine. SNL/CA received the Navy Certificate of Merit in 1961 for its contributions to the project.

Also significant as a breakthrough in warhead development was the mid-1960s concept to use small, lightweight warheads fully integrated with the re-entry vehicle. Integrating the warhead with the delivery vehicle reduced the weight; smaller warheads eventually allowed designers to place multiple warheads on a missile, changing the profile of the U.S. stockpile.

Throughout the succeeding decades of the Cold War, SNL/CA continued to advance the designs of weapon components. Ever-smaller components were introduced to meet, for example, the Army's specifications for a nuclear package for an artillery-fired projectile. And, as at SNL/NM, more rugged components and casings were designed to meet

specifications for laydown weapons—that is, bombs that could land on a target and delay detonation until a specified time.

With regard to the type of properties that housed the activities related to weapon design, the most likely will be offices and laboratories. Unfortunately, there is very little about design work to link it to a particular structure—that is, it can be done in a variety of settings and individual breakthroughs are not reflected in the built environment. Buildings that housed weapon design activities will need to have a well-recognized tie to a particular breakthrough to be considered historically significant and eligible to the National Register.

4.2 Support of Nuclear Testing

SNL/CA supported the first LLNL full-scale test at Enewetak in 1956 and was an active participant in nuclear testing activities in the succeeding decades. The lab provided support for both atmospheric and underground nuclear tests, working closely with LLNL and, on occasion, SNL/NM. In 1962, for example, both SNL/CA and SNL/NM provided support for Operation Dominic, the last U.S. atmospheric nuclear test series.

While not every test required the same level or type of support, SNL/CA's general role in nuclear testing was to provide fuzing and firing systems for test devices, to provide telemetry instrumentation to capture data about test device behavior and results, to implement diagnostic technology, and to capture and provide analysis of weapon effects. SNL/CA's engineers and technicians data capture and test analysis activities included meteorology and microbarographic studies, operating tracking radar and tracking mounts for optical instruments, as well as providing assistance in the assembly of the actual test devices.

With regard to the type of properties that housed the SNL/CA nuclear testing activities, the most likely will be offices and staging areas for test equipment. Much of the work done in support of nuclear testing was done at the U.S. test sites in the Pacific and in Nevada; test preparation often required SNL/CA personnel to be at the test site months before the actual test date. Certainly the tests themselves and the activity of capturing appropriate and useful data were done at the test sites. At SNL/CA itself, buildings that housed staging activities for several tests and bear some indication of that activity would be most likely to be of interest under this theme.

4.3 Environmental Testing

Environmental testing of components and system designs is one of SNL's key capabilities. A mechanical test facility was one of the first structures built for the SNL/NM site and a building to house environmental test equipment was among the first set of buildings planned and built at SNL/CA. Environmental testing exposes components, sub-systems, and even full prototypes to a variety of conditions, emulating as many potential environmental that a weapon could encounter as possible. Exposure to potential and likely environmental stresses such as heat, cold, shock, electromagnetic pulse, and vibration under test conditions improves and tests basic product design. Such testing is standard practice in most industrial development. Nuclear weapons encounter a

broader range of environments than many other products, but the basic concept is the same. Environmental testing assists designers in making choices of materials and configurations for components and weapon systems. It also helps to ensure the safety and reliability of weapons in the stockpile as it allows for predictions of what might occur under a variety of different circumstances.

SNL/CA used facilities at LLNL's Site 300 for explosives testing and Department of Defense test sites for a variety of tests. SNL/NM acquired many large outdoor test facilities in the 1950s; SNL/CA did not duplicate these. Objects for testing of that breadth were taken to Albuquerque. For example, in developing integrated warhead and re-entry vehicle systems, SNL/CA pursued the concept of hardening the systems so that they could withstand ballistic missile defenses. Testing for the concept was done at SNL/NM's Thunder Range, where facilities existed to expose items to blast loading.

However, SNL/CA did maintain the ability to conduct a variety of environmental tests at its own site. Every weapon component and sub-system design was tested repeatedly in a variety of environmental conditions and combination of conditions. The facilities ranged from basic, common environmental chambers to larger and more unusual capabilities. These were expanded and modified over time to meet changing and quite specific design testing needs. For example, an unusual shock testing machine in use in the 1960s allowed testers to perform free fall drop tests, accelerated drop tests, and impulse tests, as needed. In 1966, a fluid testing facility to test both materials and components under high hydrostatic pressures was added to the site. In 1967, a water pressure velocity generator was designed and built to measure the speed of water during tests on a data-recording capsule. These are examples of the on-going acquisition and modification of equipment to suit the testing needs of a state-of-the-art research and development facility. Equipment was purchased from manufacturers when possible or designed and built on-site when necessary.

The type of structures that would most likely reflect the environmental testing theme would be test laboratories and large individual test structures. However, it is important to distinguish between standard research and development testing equipment and test facilities designed specifically for weapon design testing work. As noted above, the ability to perform a wide variety of environmental tests is standard in research and development work within industry. Such equipment (e.g., shake tables for vibration testing, environmental chambers, shock tubes, and non-destructive testing equipment) is not of particular interest. On the other hand, test equipment designed specifically for nuclear weapons programs and used in the testing of components for multiple weapon systems that entered the U.S. stockpile are more likely to be of interest.

4.4 Beyond the Cold War

Even before the end of the Cold War, SNL/CA extended its research into non-Cold War-related areas. In addition to the Plowshare spin-off effort noted above, SNL/CA also moved into tritium research. Like Plowshare, the tritium effort grew directly out of expertise gained in nuclear weapons research and design work.

In addition to direct spin-offs from core weapons work, SNL/CA also moved into less clearly derivative areas in the 1970s, as weapons programs became fewer. In the early 1970s, for example, SNL became involved in alternative energy research—solar and wind power—and SNL/CA developed a significant capability in the area of solar power research. An even larger research effort has gone into the area of combustion research. SNL/CA has developed a large user facility in support of combustion research and works with industry to advance the understanding of combustion.

The Cold War's end also caused some research efforts to be redirected. Prior to the end of the Cold War, plans were underway to expand SNL/CA research in support of the Strategic Defense Initiative. New facilities were constructed at SNL/CA for the research, design, and exploratory development of Nuclear Directed Energy Weapon Systems. With the end of the Cold War, the buildings were redirected into manufacturing research.

Although this work is interesting and may eventually be determined to be historically significant in its own right, it cannot be seen as related to the Cold War or interpreted as being of historical interest at this juncture. The younger facilities involved will need to be evaluated as they near 50 years of age.

5.0 SNL/CA Facilities

SNL/CA facilities are located on DOE-owned land on approximately 410 acres three miles east of Livermore, California. SNL/CA's facilities organization manages the lab's structures, in the areas of both maintenance and long-term planning. Only permanent and semi-permanent structures will be included in the survey of the site; temporary and mobile structures will be excluded.

It is appropriate to consider SNL/CA's structures in comparison to those at other sites within the nuclear weapons complex. There are no large design themes or consistent construction policies apparent across the complex. While sites that inherited property from the military often have a common look—e.g., Pantex and Burlington were both originally World War II munitions assembly sites and their original designs were similar—most of the sites developed facilities to suit the particular tasks in which they were engaged. Form tends to follow function at most of the facilities, but function differs between sites and building materials and designs were chosen locally. Certainly the three nuclear weapons labs do not appear to have built from the same design concerns.

SNL/CA's facilities all fit into the general design category of Industrial Vernacular and do not represent high style architecture. The International/Modernist sensibility is reflected in many of the structures as they are unadorned with a functional emphasis. SNL/CA looks like the engineering laboratory it was created to be.

Currently, permanent and semi-permanent buildings at the site are nearly evenly divided between those built before 1980 and those built after. This reflects both the transition into additional non-Cold War related research activities even prior to the Cold War's end and the need for continual upgrades and improvements in a constantly evolving research environment.

5.1 Construction Patterns

SNL personnel providing support for the Livermore design laboratory used space within the LLNL area at first. In 1956, SNL officially expanded to Livermore and the decision was made to establish a new site to the south of LLNL on the former Gunnery Range of the Livermore Naval Air Station. By mid-1956, planning was underway for the move across East Avenue. SNL/CA personnel moved into existing facilities at the site left from World War II. In October 1956 the details of a construction plan were announced; $5,000,000 was allocated for six new permanent buildings at the site. The World War II-era structures no longer exist.

The SNL/CA site initially consisted of a long narrow strip of 50 acres of land stretching south from East Avenue. Figure 3 indicates the original site. Over time, the lab expanded by obtaining surrounding lands, primarily to provide an additional buffer between its activities and the rest of the community. The long strip of land has evolved into a much larger 410-acre, rather bell-shaped parcel (with the top of the bell at the southernmost point of the site), as shown earlier in Figures 1 and 2.

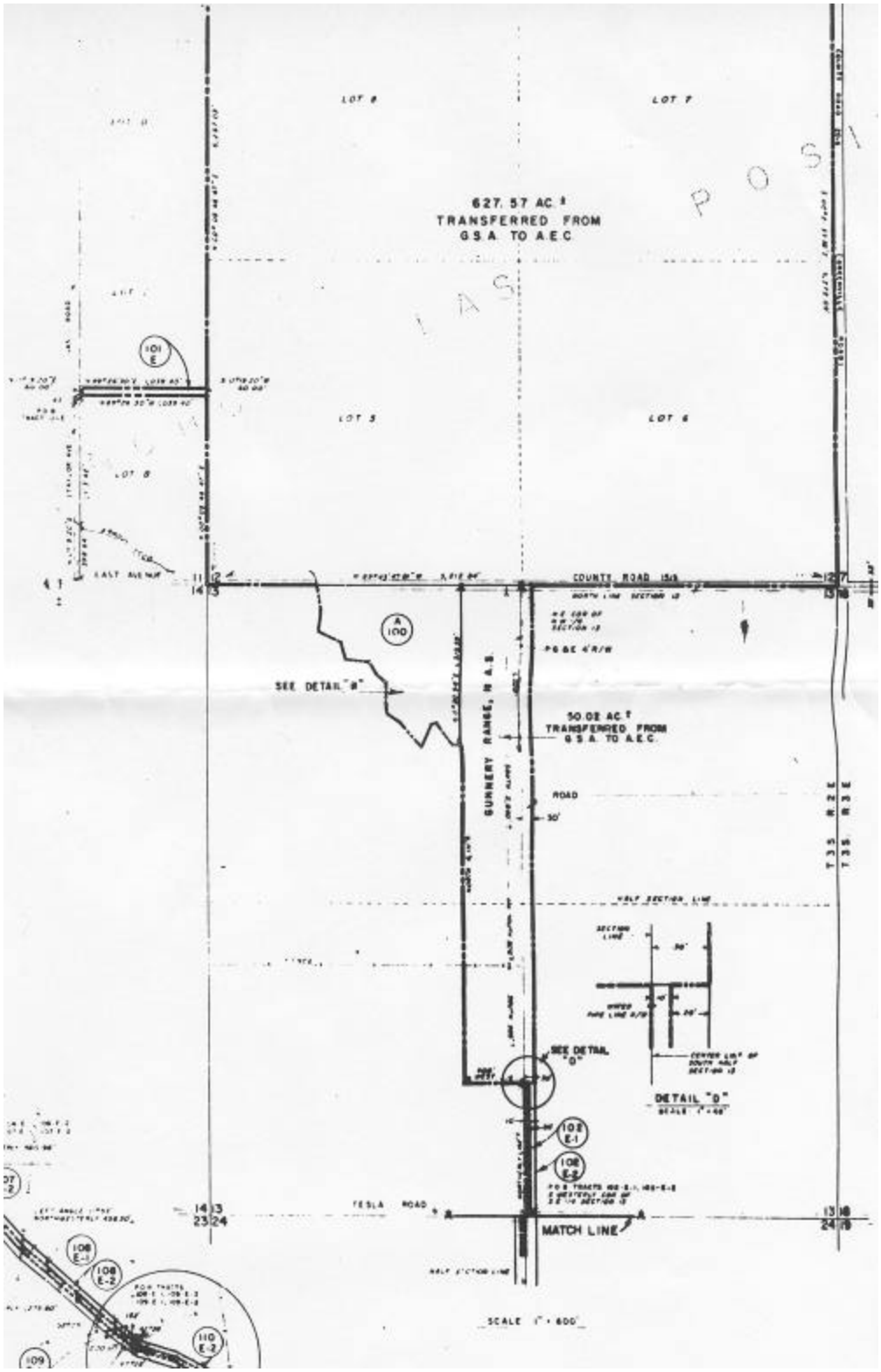

Figure 3. 1967 drawing of original SNL/CA site. The original 50.02-acre strip is in the bottom half of the illustration and is identified as "Gunnery Range, N.A.S." The triangular parcel to the left (west) of the original strip was added in 1957. The large section of 627.57 acres in the top half of the drawing is the land used by LLNL. The County Road dividing the two sections is East Avenue.

By May 1956, a plot plan was drawn indicating the structures SNL believed it needed for the Livermore site and negotiations with the AEC were underway. Increased hiring by SNL/CA created additional pressure to have space ready more quickly. The initial plan called for a personnel building to be completed by March 1958. In response to space concerns, however, the personnel building was separated from the rest of the construction schedule and was to be completed by August of 1957. By the time bids were issued in April 1957, the completion date had slipped to September 1957; personnel began moving into the building in October.[13] As construction was underway, the site acquired an additional 24 acres of land on the west side of the original lot.

The rest of the original buildings were completed in 1958—the warehouse, model shop, environmental test, and central steam plant were slated for completion in August with the office and lab building following in December.

During the 1960s more support facilities, including storage and a maintenance shop (Building 963) were built, as well as additional test facilities like the centrifuge (Building 967) and the Explosive Test Facility (Building 978). In addition to new construction the site's facilities also faced some renovation. In 1967, in an effort to meet then-current seismic criteria, concrete footings and columns were added as structural modifications to Buildings 911 and 912.

In 1970, the buffer around the area was expanded with a total of 86 acres—24 on the west side and 62 along the east side of the site. Purchases of additional land over time to supplement the buffer zone around the SNL/CA site reflect the growth of both SNL/CA and the area around it. Largely an agricultural area—cattle ranches and wineries—both at the time the SNL/CA site was established and in succeeding decades, the Livermore area has more recently witnessed the growth of the Bay Area eastward and the expanded commuter radius for residents working in San Francisco or Silicon Valley (the San Jose area).

As the SNL/CA purpose expanded beginning in the late 1960s, so did the variety of facilities the site contained. In 1974, the Tritium Research Laboratory (Building 968) opened and expansion continued with the large complex that makes up the Combustion Research Facility (Buildings 904, 905, 906, 907) completed in 1980. An additional 24 acres of land was added as a buffer zone near the Tritium Facility on the east side in 1979.

An earthquake early in 1980, as well as large anti-nuclear protests at the lab in 1982 caused a great deal of concern. The City of Livermore, observing that SNL/CA was completely dependent on East Avenue for egress from the site and that this posed problems in emergency circumstances, recommended that the facility develop an additional exit route. In 1984, SNL/CA announced it would obtain an additional 228

[13] Correspondence related to early SNL/CA construction in Collection 180, Sandia National Laboratories Livermore Land Acquisition Records, file "Historical File on Construction of Livermore Buildings," SNL Corporate Archives.

acres of property; in 1986 it did so. An emergency egress road was created to the south, allowing exit onto Tesla Road. A complete seismic upgrade was performed at the site in the mid-1980s, affecting most of the larger structures.

In November of 1998, SNL/CA undertook a small land exchange to create a consistent buffer zone boundary line. Sandia conveyed 5.41 acres and received 2.82 acres of land. The land in question was the western portion of the buffer zone adjacent to South Vasco Road. This brought the site's area down from 413 to 410 acres.[14]

5.2 Building Styles

All SNL/CA construction falls into the general category of Industrial Vernacular—that is, industrial-purpose structures that do not fall into any of the categories of high style architecture, although high style might be incorporated into or provide an influence on the design. The only direct high style architectural influence can be seen in some trace of the International/Modernist style in the unadorned aesthetic, particularly of the early construction. Emphasis is on the functional throughout, an aesthetic reinforced by the practical evaluation of costs. The scrutiny faced by federally funded construction encourages a functional aesthetic, and, as an engineering laboratory, SNL/CA was not particularly concerned about the way the structures looked.

Although there have been recent efforts to improve landscaping and create a more genial atmosphere, both the mission and the practice at the site retain a research and development atmosphere that does not encourage adornment. Recent efforts directed at improving recruiting, retention, and working with customers emphasize consistency of appearance within the site.

Although the SNL/CA architects do not expect to convert the site to a completely California look, there is an effort to have the facilities look appropriate within the environment. Earth tones are used in the designs and, without restricting the architectural and engineering firms, basic California materials are used whenever possible. There is also a large concern with seismic issues in any new design, which is probably the most deliberate reflection of the fact that the site is located in California.

Very recently, new construction reflects a philosophy of creating cornerstone facilities that essentially anchor the site and create a consistently expressed feeling within the site. This is a deliberate effort to make the environment more conducive to working with customers, partners, and visitors. While new structures do not look alike, their lobbies are designed to convey the same feeling. There are currently three cornerstone sites—the Combustion Research Facility (Buildings 904, 905, 906, and 907), the Chemical and Radiation Detection Laboratory (Buildings 967, 968, and 969), and the Micro and Nano Technologies Laboratories (Buildings 940, 941, 942, and 943). The philosophy in their design is to separate labs and offices for maximum flexibility and focus on individual needs or sets of needs, to obtain some consistency in design and feeling. Figures 4, 5, and 6 illustrate the cornerstone sites. An effort has been made to achieve some

[14] I am grateful to Shirley Sandoval of SNL/CA for providing detailed information to clarify my understanding of this land transfer.

Figure 4. The Combustion Research Facility.[15]

Figure 5. The Chemical and Radiation Detection Laboratory.[16]

[15] 2001 photograph by Lynda Hadley. Negative 30605, Still Photo Collection, SNL Corporate Archives.
[16] 2001 photograph by Lynda Hadley. Negative 30452, Still Photo Collection, SNL Corporate Archives.

Figure 6. The Micro and Nano Technologies Laboratories.[17]

consistency within the appearance of each set of buildings, although the cornerstone sites do not match one another.

SNL/CA plant engineering architects oversee planning and implementation of new construction and modifications. Large architecture and engineering design firms provide the drawings for each new site. Most of the firms are local to the Bay Area. In general, the outside firms specialize in large engineering projects more than a particular architectural style.

Buildings styles among the facilities at SNL/CA include large concrete office and laboratory buildings, relatively inexpensive manufactured office buildings, and temporary and mobile units.

The large steel-framed, concrete office and laboratory buildings tend to be boxy and unadorned. Figure 7 shows Building 912, the SNL/CA computer facility. Built in 1958, the building has a concrete foundation and concrete masonry walls. The building is typical of the early construction at the site in that it was a large structure built to house many offices and has been remodeled periodically to upgrade and reconfigure its facilities.

[17] 2001 photograph by Lynda Hadley. Negative 30516, Still Photo Collection, SNL Corporate Archives.

Figure 7. Building 912, built in 1958, displays the influence of the International Style in its horizontal strips of windows, flat roof, and unadorned exterior.[18]

A more recent expression of the large concrete box to house offices and laboratories is Building 910. The building is a clone of an SNL/NM design from a set of structures built in the same time frame at the New Mexico facility. The architects were Flatow, Moore, Bryan & Associates of Albuquerque. The intention of duplicating the design in California was to save money by using the same design repeatedly. The building's design features emphasized flexibility; the goal was to be able to up grade labs and offices without disrupting the entire facility. Unfortunately, the building does not fit into the overall appearance or practical needs of the SNL/CA site. The original structure design did not meet California's seismic requirements and additional work had to be done for seismic reinforcement. Figure 8 is a photograph of Building 910 at SNL/CA; Figure 9 is Building 890 at SNL/NM.

[18] 2001 photograph by Lynda Hadley. Negative 30593, Still Photo Collection, SNL Corporate Archives.

Figure 8. Building 910 at SNL/CA.[19]

Figure 9. Building 890 at SNL/NM.[20]

[19] 2001 photograph by Lynda Hadley. Negative 30614, Still Photo Collection, SNL Corporate Archives.
[20] 1999 photograph by Walter Dickenman. Negative 30240, Still Photo Collection, SNL Corporate Archives.

In addition to the larger concrete office and laboratory buildings, SNL/CA also uses a variety of less permanent construction to house offices. In 1977, the site obtained three buildings for office use. A step up from trailers, Buildings 920, 921, and 922 are modular constructions. They offer inexpensive, flexible space for offices. Sitting on concrete slab foundations, their exteriors are plywood with sanspray covering. Their life expectancy is 20-30 years rather than the 50 years usually preferred for permanent construction at the site. They were installed because they allowed the lab to obtain a lot of office space quickly and cheaply. Figure 10 illustrates Building 922.

Figure 10. Building 922.[21]

SNL/CA also uses temporary and mobile buildings to meet its storage and office needs. The site uses trailers to house some administrative functions. Neither temporary nor mobile structures will be included in the survey of SNL/CA as they do not house activities likely to be of historic interest and the structures themselves are not seen to have any lasting value.

Metal manufactured buildings of the Butler type are used for storage and even to house support functions like waste management. The storage structures under 1,000 gsf will not be included in the survey, but the waste management structures will be.

SNL/CA has one Quonset hut inherited from the Livermore Naval Air Station. It has been moved to its current location. Built in 1941 or 1942, Building 962, shown in Figure 11, is an outbuilding. It is used for storage—currently by the site's landscapers. It is not

[21] 2001 photograph by Lynda Hadley. Negative 30567, Still Photo Collection, SNL Corporate Archives.

occupied. In the 1990 cultural resources survey, Building 962 was not found to be historically significant; it is not more likely to be considered historically significant now as its purpose has not changed.

5.3 Property Types

SNL/CA structures can be grouped by their function within the lab. This makes the assessment of historical significance a little easier, as some categories are clearly not tied to SNL/CA's Cold War themes. For example, the infrastructure support and administrative services buildings (including the facilities organization, utilities, human resources, medical, shops, and storage) are not likely to be found eligible to the National Register based on the work they have housed as they have no direct link to the Cold War and could be found at any large industrial or research concern.

Also serving a support function, but specifically linked to the fact that SNL/CA is involved in national security research and development activities, are the security structures. These include the fences, gates, and guardhouses that protect the perimeter of and entrances to the site. Although intrinsic to the particular work housed within the fences, these security facilities are only likely to be eligible to the National Register as part of a historic district, serving as supporting structures to the main buildings in a given nomination. Should a particular set of structures be considered potentially eligible for the National Register, related supporting structures would then be evaluated.

In order to be considered potentially eligible for the National Register, a structure would have to have housed activities directly related to the three themes established earlier. However, not every building housing an activity related to an SNL/CA Cold War theme will be assessed as eligible. Structures that prove to be unique in design and purpose within the nuclear weapon complex while exemplifying a particular Cold War theme in SNL/CA's history will be investigated more thoroughly to determine their historical significance.

SNL/CA's themes of weapon design, support for nuclear testing, and environmental testing are most likely to be reflected in laboratories and test facilities. Design is very difficult to tie to particular structures as it does not necessarily require anything particular in a building to be accomplished. Test facilities, on the other hand, generally reflect their purpose—although smaller standard test equipment fits within laboratory buildings, larger test facilities tend to be their own structures. The assessment must include an investigation into the actual purpose and the nature of the potential contribution of any given set of test facilities. Industrial research generally requires a suite of test equipment; it will be important in the survey to consider whether a given set of test equipment represents the usual industrial research environment or directly contributed to the Cold War.

5.4 Integrity

The assessment of a building's integrity is a key aspect of determining historical significance and eligibility for the National Register of Historic Places. If a structure

appears to be of interest, but it no longer retains the appearance or form of the period of its significance, it is unlikely to be deemed eligible for the National Register.

Integrity must be evaluated on a building-by-building basis, since that is the manner in which renovations have been done at SNL/CA. Most SNL/CA buildings have undergone some modification over the years. SNL/CA is a science and technology laboratory that maintains a cutting-edge capability. Most equipment is upgraded frequently and facilities are redesigned and remodeled to suit user needs. A few facilities have been remodeled beyond recognition. For example, in 1976, an addition was put onto Buildings 966 and 967 connecting them and essentially merging them into one building, now numbered 966. The structure was then remodeled further in 1983. A new Building 967 was completed in 1984. The integrity of the original Building 966 or 967 has been seriously undermined and, should the original work conducted in the building prove of interest, a careful assessment of whether the structure still represents that work would need to be done.

Historical significance could be assessed in a structure based on any point in its life during the Cold War. However, most of the older buildings are more closely tied to the Cold War in the earlier period of their existence and their original purpose may prove more interesting. Integrity then becomes critical in understanding whether the building may or may not be eligible for the National Register.

6.0 Conclusion

SNL/CA's early history reflects the expansion of the nuclear weapons complex to accommodate the stockpile growth of the 1950 and 1960s. The particular contributions of the lab to the Cold War lie in the ordnance engineering design and testing of weapons that went into the U.S. stockpile.

The three themes from SNL/CA's Cold War history presented here are weapon design, support of nuclear testing, and environmental testing. These are the themes used to assess the structures at SNL/CA. Assessments articulate which theme (if any) is represented by a particular structure, how well it embodies the theme, its contributions to the Cold War, and the its integrity.

Each structure must, to demonstrate eligibility to the National Register, not just represent a theme within SNL/CA's Cold War context, but be demonstrably linked through that theme to the Cold War. In other words, all of SNL/CA's buildings built before 1970 are the direct result of U.S. Cold War policy in that SNL/CA would not exist without U.S. nuclear weapon development efforts, but that does not make them automatically eligible for the National Register.

Integrity is a key issue in assessing the structures. Even if a building embodied a theme at one time, it may not be National Register-eligible because it has been altered. Ongoing renovations, relocating of activities, and upgrading of facilities are apparent in SNL/CA's building histories and must be considered in the historical assessment.

Further, some buildings do not reflect the work they housed in any meaningful way. Design activities, in particular, are very difficult to "see" within buildings. These activities also moved around within the lab over time. Testing activities, on the other hand, are more easily understood as tied to the structures housing them.

SNL/CA is a young facility and many of its structures involved in non-Cold War related research activities will need to be re-evaluated as they approach 50 years of age. There is currently nothing in the history of SNL/CA's activities to imply exceptional significance except the recognized Cold War effort.

Overall, this initial investigation of SNL/CA's role in the Cold War does not make it seem likely that the site will have many, if any, structures of historical interest. However, a complete survey of the site's structures with the Cold War themes clearly in mind and a careful consideration of the National Register criteria will allow for conclusions in that area.

7.0 Bibliography

7.1 Archival Sources

The primary archival sources for the history of Sandia National Laboratories (SNL), its facilities, and its role in the Cold War were found in the collections of the SNL Corporate Archives, the SNL/NM Technical Library, and the SNL/CA facilities collections.

7.2 Published Sources

Advisory Council on Historic Preservation. *Balancing Historic Preservation Needs with the Operation of Highly Technical or Scientific Facilities*. Washington, DC: GPO, 1991.

Alexander, Frederic C., Jr. *History of Sandia Corporation through Fiscal Year 1963.* Albuquerque: Sandia Laboratory, 1963.

Baker, Joseph E., ed. *Past and Present of Alameda County, California.* Volume 1. Chicago: The S.J. Clarke Publishing Company, 1914.

Bohrer, Don. *The First Thirty Years of the 8100 Directorate.* Livermore, CA: Sandia National Laboratories, 1986.

Busby, Colin I., and Donna M. Garaventa. *A Cultural Resources Overview and Historic Preservation Regulatory Analysis of Sandia National Laboratories Livermore Facility, Alameda County, California.* Document Number 84-9691. San Leandro, CA: Basin Research Associates, Inc., 1990.

Busby, Colin I., Donna M. Garaventa, and Robert M. Harmon. *A Cultural Resources Assessment of Sandia National Laboratories Livermore Facility, Alameda County, California.* Document Number 84-9691. San Leandro, CA: Basin Research Associates, Inc., 1990.

Carr, B. H. *Pantex: History, 1942 to 1992.* Amarillo, TX: Pantex, 1992.

Fehner, Terrence R., and F. G. Gosling. "Coming in From the Cold: Regulating U.S. Department of Energy Nuclear Facilities, 1942-96." *Environmental History* 1:2 (April, 1996): 5-33.

Francis, Sybil. "Warhead Politics: Livermore and the Competitive System of Nuclear Weapon Design." PhD Dissertation, Massachusetts Institute of Technology, 1995.

Furman, Necah. *Sandia National Laboratories: The Postwar Decade.* Albuquerque: University of New Mexico Press, 1990.

Gudde, Erwin G, and William Bright. *California Place Names: The Origin and Etymology of Current Geographical Names.* 4th ed., revised and enlarged. Berkeley, Los Angeles, and London: University of California Press, 1998.

Herken, Gregg. *The Winning Weapon: The Atomic Bomb in the Cold War 1945-1950.* New York: Alfred A. Knopf, 1980.

Herken, Gregg. "The University of California, the Federal Weapons Labs, and the Founding of the Atomic West." In Bruce Hevly and John M. Findlay, eds., *The Atomic West.* Seattle and London: University of Washington Press, 1998. Pages 119-135.

Hevly, Bruce, and John M. Findlay, eds. *The Atomic West.* Seattle and London: University of Washington Press, 1998.

Hewlett, Richard G., and Oscar Anderson, Jr. *The New World, 1939-1946.* Vol. 1 of *A History of the United States Atomic Energy Commission.* University Park: Pennsylvania State University Press, 1962.

Hewlett, Richard G., and Francis Duncan. *Atomic Shield, 1947-1952.* Vol. 2 of *A History of the United States Atomic Energy Commission.* University Park and London: The Pennsylvania State University Press, 1969.

Hewlett, Richard G., and Jack M. Holl. *Atoms for Peace and War, 1953-1961: Eisenhower and the Atomic Energy Commission.* Vol. 3 of *A History of the United States Atomic Energy Commission.* Berkeley: University of California Press, 1989.

History Associates Incorporated. *History of the Production Complex: The Methods of Site Selection.* Prepared for the U.S. Department of Energy. DOE/NV/10594-H1. Washington, DC: U.S. Department of Energy, 1987.

Johnson, Leland. *Sandia National Laboratories: A History of Exceptional Service in the National Interest.* Albuquerque: Sandia National Laboratories, 1997.

Johnson, Leland. *Tonopah Test Range: Outpost of Sandia National Laboratories.* SAND96-0375. Albuquerque: Sandia National Laboratories, 1996.

JRP Consulting Services. "Historic Context for Evaluating the National Register Eligibility of World War II-Era and Cold War Era-Buildings and Structures, Naval Air Weapons Station (NAWS), China Lake, California." Prepared for Engineering Field Activity, West, Naval Facilities Engineering Command, and Naval Air Weapons Station, China Lake. November, 1996.

Lawrence Livermore National Laboratory. "Laboratory History." Livermore: LLNL website at www.llnl.gov, 2001.

Lawrence Livermore National Laboratory. "The Livermore Naval Air Station." Livermore: LLNL website at www.llnl.gov, 2001.

Livermore High School. *Our Valley: Yesterday & Today.* Livermore: California History, Livermore High School, 1979.

Loeber, Charles R. *Building the Bombs: A History of the Nuclear Weapons Complex.* SAND2002-0307P. Albuquerque and Livermore: Sandia National Laboratories, 2002.

Mitchell, Kris C. "Rhetoric to Reality: A Cold War Context Statement for the Pantex Plant." DRAFT. Prepared by Mason & Hanger Corporation, Waste and Environmental Management Department for U.S. Department of Energy, Amarillo Area Office. September, 1999.

Mosier, Page, and Dan Mosier. *Alameda County Place Names.* Fremont, CA: Mines Road Books, 1986.

Munro-Fraser, J.P., and M. W. Wood. *History of Alameda County, California, including its Geology, Topology, Soil, and Productions.* Oakland: M. W. Wood, Publisher, 1983.

Nash, Gerald D. *The American West Transformed: The Impact of the Second World War.* Lincoln and London: The University of Nebraska Press, 1985.

National Historic Preservation Act. US Code. Vol. 16, sec. 470 (1966), as amended.

Newhouse, John. *War and Peace in the Nuclear Age.* New York: Alfred A. Knopf, 1989.

O'Donnell, Eleanor. *National Register Bulletin 39: Researching a Historic Property.* Washington, DC: National Register of Historic Places, National Park Service, U.S. Department of the Interior, 1995.

Recollections for Tomorrow: In Observance of the 40th Anniversary of Sandia National Laboratories. Albuquerque: Sandia National Laboratories, 1989.

Rhodes, Richard. *Dark Sun: The Making of the Hydrogen Bomb.* New York: Simon & Schuster, 1995.

Rhodes, Richard. *The Making of the Atomic Bomb.* New York: Simon & Schuster, 1986.

Sagan, Scott D. *The Limits of Safety: Organizations, Accidents, and Nuclear Weapons.* Princeton Studies in International History and Politics. Princeton: Princeton University Press, 1993.

Sagan, Scott D. *Moving Targets: Nuclear Strategy and National Security.* Princeton: Princeton University Press, 1989.

Sandia National Laboratories. *Sites Comprehensive Plan, FY 2001 to FY 2010.* SAND2001-0034P. Albuquerque: Sandia National Laboratories, 2001.

Sandia National Laboratories. *Site Development Plan.* Albuquerque: Sandia National Laboratories, 1984.

Sandia National Laboratories. *Site Development Plan.* Albuquerque: Sandia National Laboratories, 1989.

Sherfy, Marcella, and W. Ray Luce. *National Register Bulletin 22: Guidelines for Evaluating and Nominating Properties that Have Achieved Significance Within the Last Fifty Years.* Washington, DC: U.S. Department of the Interior, National Park Service, National Register of Historic Places, 1979; internet edition 1998.

Tuttle, Chris. *Historic Building Inventory and Evaluation, 377th Air Base Wing, Kirtland Air Force Base, New Mexico.* Kirtland Air Force Base, New Mexico: 377th Air Base Wing, Environmental Management Division, Kirtland Air Force Base, 1999.

Ullrich, Rebecca. *A History of Building 828, Sandia National Laboratories.* SAND99-1941. Albuquerque: Sandia National Laboratories, 1999.

Ullrich, Rebecca. "Sandia in the Cold War: A Statement of Historic Context for Sandia National Laboratories/New Mexico." DRAFT. Albuquerque: Sandia National Laboratories, November, 2000.

Ullrich, Rebecca. *Tech Area II: A History.* SAND98-1617. Albuquerque: Sandia National Laboratories, 1998.

US Department of Defense. *Coming in from the Cold: Military Heritage in the Cold War: Report on the Department of Defense Legacy Cold War Project.* Washington, DC: Department of Defense, 1994.

U.S. Department of Energy, Office of Environmental Management. *Linking Legacies: Connecting the Cold War Nuclear Weapons Production Processes to Their Environmental Consequences.* DOE/EM-0319. Washington, DC: Department of Energy, 1997.

U.S. Department of Energy and University of California. *Final Environmental Impact Statement and Environmental Impact Report for Continued Operation of Lawrence Livermore National Laboratory and Sandia National Laboratories, Livermore.* 5 vols. DOE/EIS-0157. Livermore, CA: Department of Energy and University of California, 1992.

U.S. Department of the Interior, National Park Service, Interagency Resource Division. *National Register Bulletin 15: How to Apply the National Register Criteria for Evaluation.* Washington, DC: USGPO, 1991.

Weitze, Karen J. *Cold War Infrastructure for Air Defense: The Fighter and Command Missions.* Prepared for Headquarters, Air Combat Command under United States Army Corps of Engineers, Fort Worth District, Contract DACA63-98-P-1363. Langley Air Force Base, VA: United States Air Force, Air Combat Command, 1999.

Weitze, Karen J. *Cold War Infrastructure for Strategic Air Command: The Bomber Mission.* Prepared for Headquarters, Air Combat Command under United States Army Corps of Engineers, Fort Worth District, Contract DACA63-98-P-1354. Langley Air Force Base, VA: United States Air Force, Air Combat Command, 1999.

West, George T. *United States Nuclear Warhead Assembly Facilities (1945-1990).* Amarillo, TX: Mason & Hanger—Silas Mason Co., Inc., Pantex Plant, March, 1991.

Wheeler, Michael O. *Contributions of Nuclear Weapons to American Security During the Cold War.* Final Report. Contract No. 77501. San Diego, CA: SAIC, 1999.

White, Richard. *"It's Your Misfortune and None of My Own": A History of the American West.* Norman and London: University of Oklahoma Press, 1991.

Worden, Amy, and Elizabeth Calvit. "Preserving the Legacy of the Cold War." *Cultural Resources Management* 16:6 (1993).

Wyatt, Barbara. "The Challenge of Addressing Vernacular Architecture in a State Historic Preservation Survey Program." In *Perspectives in Vernacular Architecture, II,* edited by Camille Wells, 37-43. Columbia, MO: University of Missouri Press for the Vernacular Architecture Forum, 1986.

York, Herbert F. "The Great Test-Ban Debate." *Scientific American* 227:5 (November, 1972): 15-23.

York, Herbert F. "Making Weapons, Talking Peace." *Physics Today* (April 1988): 40-52.

York, Herbert F. *Making Weapons, Talking Peace: A Physicist's Odyssey from Hiroshima to Geneva.* New York: Basic Books, 1987.

DISTRIBUTION:

2	MS	0184	Susan Lacy, DOE/NNSA
10		0612	Rebecca Ullrich, 9612-2
10		9221	Barbara Larsen, 8516
1		9018	Central Technical Files, 8945-1
2		0899	Technical library, 9616
1		0612	Review & Approval Desk, 9612 For DOE/OSTI