LAWRENCE LIVERMORE NATIONAL LABORATORY, HAER No. CA-2349
PLUTONIUM FACILITY
(Building 332)
7000 East Avenue
Livermore
Alameda County
California

WRITTEN HISTORICAL AND DESCRIPTIVE DATA
PHOTOGRAPHS

HISTORIC AMERICAN BUILDING SURVEY
Pacific West Region
National Park Service
U.S. Department of the Interior
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Part I. HISTORICAL INFORMATION

A. Physical History[1]

1. Date of erection:

Building 171[2] the Metallurgy Laboratory (Increment I)
Designed: May 12, 1958
Construction Begun: 1958
Building completed: May 1961

Building 332 Microprobe Laboratory (Increment II)
Designed: October 3, 1967
Construction Begun: 1967
Building completed: December 13, 1968

Building 332 Plutonium Materials Engineering Building (Increment III)
Designed: 1971
Construction Begun: 1974
Building Completed: 1976

Building 332 Office Addition and Renovation
Designed: 1989
Construction Begun: 1991
Building Completed: November 1994

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[1] The following documents were used in determining the correct dates of the physical history of Building 332. They are listed in the order of the information presented. Documents with PLZ numbers are drawings, which are held in the Lawrence Livermore National Laboratory Plant Engineering Library: "Facility 171, University of California Radiation Laboratory for the U.S. Atomic Energy Commission, Plot Plan," 1961, PLZ 61-332-001J; "Facility 171, University of California Radiation Laboratory for the U.S. Atomic Energy Commission, First Floor Plan," 1961, PLZ 61-332-002J; "Facility 171, University of California Radiation Laboratory for the U.S. Atomic Energy Commission, Fan Loft Floor Plan," 1961, PLZ 61-332-003J; "Facility 171, University of California Radiation Laboratory for the U.S. Atomic Energy Commission, North and South Elevations," 1961, PLZ 61-332-004J; "Livermore's Metallurgy Facility Opens," *The Magnet,* June 1, 1961; "Microprobe Laboratory Building 332, Site Plan and General Notes," 1968, PLZ68-332-001JA; "Microprobe Laboratory Building 332, Plans, Elevations, and Details," 1968, PLZ68-332-002-JA; "Microprobe Laboratory Building 332, Structural Plans, Sections, and Details," 1968, PLZ68-332-003-JA; "Plutonium Materials Engineering Building 332, First Floor Plan and General Notes," 1971, PLZ71332-014J; "Basement Floor Plan, Legend, Symbols, and Abbreviations," 1971, PLZ71-332-013J; "Building 332 Office Addition and Renovation, Floor Plan," 1989, PLZ89-332-01OE; and "Building 332 Office Addition and Renovation, Exterior Elevations, Sections, and Details," 1989, PLZ89-332-0012E.

[2] Building 332 was originally called Building 171, the Metallurgy Building. However, in 1967, during a Laboratory-wide renumbering, Building 171 was designated as Building 332.

2. **Architect:** Shaw, Metz, and Dolio (Increment I); B. D. Bohna and Company (Increment II); C. F. Braun (Increment III); and Vickerman Zachary Miller (Office Addition and Renovation).

   Shaw, Metz, and Dolio designed and built Increment I of Building 332 (known at the time as the Metallurgy Laboratory, Building 171).[3] It housed the Chemistry Division's research and development activities on radioactive metal and alloys for nuclear weapons projects. Shaw, Metz, and Dolio was a prominent Chicago architectural firm specializing in concrete and glass skyscrapers in the post-World War II (WWII) modern European style. Alfred P. Shaw, the company's founder, began his career with the prestigious Chicago firm of Graham, Probst, Anderson, and White. His early style and influence are reflected in the Art Deco touches of the Field Building (1928), the Chicago Civic Opera (1929), and Merchandise Mart (1930). After Graham's death in 1937, Shaw formed a 10 year partnership with Sigurd Neuss and Charles F. Murphy. He founded Shaw, Metz, and Dolio in 1947. The firm became Alfred Shaw Associates in 1972. Buildings attributed to Shaw, Metz, and Dolio, and Alfred Shaw and Associates include 3950 North Lakeshore Drive (1957); 3600 North Lakeshore Drive (1959); Unitron Building (1962); 777 North Michigan Avenue (1964); and the Mid Continental Plaza (1972). His post-war work reflects the modern style and is absent of his earlier art deco touches.

   B. D. Bohna & Company designed Increment II of Building 332. A local engineering firm from San Francisco, B. D. Bohna worked on several other buildings for LLNL, most notably Buildings 812, 827, and 855 at Site 300.

   C. F. Braun, a prestigious California engineering firm, designed Increment III of Building 332. Braun was a family-run company established in 1922 in Alhambra, California, on a 45-acre corporate campus. C. F. Braun was noted for its expertise in constructing gas processing plants, cooling towers, and heat exchangers. The firm was purchased by Santa Fe International Corporation in 1980 and worked on petroleum projects in Kuwait. The firm was purchased by Halliburton Company in 1989.

   Vickerman Zachary Miller Architects/Engineers, a division of Transystems, of Oakland, California, designed and built the Office Addition of Building 332. Vickerman Zachary Miller Architects/Engineers specialized in seismic designs.

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[3] Shaw, Metz, & Dolio, Architects and Engineers. "Phase I (Title I) Design Criteria for Metallurgy Building, Facility 171." 22 August 1957. AB-00025. Building 332 Records Room. Lawrence Livermore National Laboratory.

3. **Original and subsequent owners, occupants, uses:**
The building has always been owned by the U.S. Government, as part of LLNL, one of the laboratories of the Atomic Energy Commission (AEC) and its successor agencies (currently the Department of Energy/National Nuclear Security Administration [DOE/NNSA]).

Building 332 originally housed research on plutonium metals and the design and development of nuclear weapon pits for LLNL-designed weapons. As weapons design work slowed in the 1980s and required less space in the building, Building 332 facilities also were used for the Laser Isotope Separation (LIS) Program. Currently, the facilities house plutonium research and development activities in support of the U.S.'s nuclear stockpile maintenance.

4. **Builder, contractor, suppliers:**
Increment I: Shaw, Metz, and Dolio was both the architect/engineer and the construction manager for the project.

Increment II: B. D. Bohna was the architect/engineer and Hayco Incorporated was the construction manager for the project.

Increment III: C. F. Braun was the architect/engineer and Ralph Larsen and Son Incorporated was the construction manager for the project.

Office Addition and Renovation: Vickerman Zachary Miller was the architect/engineer and The Engineering Enterprise was the construction manager for the project.

5. **Original plans and constructions:** In 1958, Shaw, Metz, and Dolio completed the design for Increment I of Building 332; construction was completed in 1961. Increment I had approximately 60,837 square feet. It was a two-story, fireproof building made of concrete block and precast concrete panels with a flat roof. The first floor housed all offices and laboratories and the second floor was a large fan loft that housed all heating, ventilation, and air-conditioning (HVAC) and air filtration systems.[4] The interior of the building included an equipment room, office area, locker room, toilets, and a work area. Because the work area accommodated research on radioactive material, it was separated from the rest of the building by a set of double vault doors and air lock doors. The Radioactive Materials Area (RMA) comprised nineteen separate rooms of 988 square feet each. The rooms provided facilities for the following research and development activities: casting, machining, canning, recovery, reduction, research, development, analysis, inspection, testing, and assembly. The majority of the rooms were behind both the air lock

[4] "Facility 171, Elevation and Sections," 1961, PLZ61-332-004J.

doors and double vault doors, with the exception of the cold instrument room and machine shop, which were between the double vault door and the air lock. The equipment room, offices, locker room, and toilets were all located outside both sets of protective doors.[5]

6. **Alterations and additions:** In 1967, the engineering firm of B. D. Bohna completed designs for Increment II of Building 332; construction was complete in 1968. Increment II, called the Microprobe Laboratory, was a small (33'-4" x 21'-9") one-story concrete block addition of approximately 690 square feet. It had a flat roof and a roof screen. The addition consisted of two new laboratories on the east side of the original building. One lab housed a Norelco Microprobe and the other a Materials Analysis Company (M.A.C.) microprobe.[6]

   In 1971, C. F. Braun, a nationally recognized expert in chemical engineering designed Increment III of Building 332. Due to the extensive review of the design's application of rigorous safety standards, DOE did not approve a final version of the design until 1973, and construction was finally completed in 1976. Increment III was a single-story, reinforced concrete addition of approximately 15,000 square feet to the east side of Increment I. It had a flat tar and gravel roof and a basement for all mechanical equipment and HVAC. The interior housed four laboratories, a materials management area, storage vault, control room, and air locks.[7] Increment III was designed to withstand the worst natural disasters likely to occur in the Livermore area. When finished the building could withstand fires, earthquakes, tornadoes, lightning, or any combination of these occurrences.[8]

   Additional renovations included an expansion of the machine shop in 1977, an upgrade to Increment I in 1979, a structural upgrade to the entire building in 1980, the addition of a plenum building on the west side of the building in 1981, a new air conditioning system in 1986, and a 166'-6" x 86'-0" office addition (Office Addition and Renovation) to the south side of the building in 1994. The building's equipment has been replaced and upgraded frequently over the years.

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[5] Shaw, Metz, & Dolio, Architects and Engineers, "Phase I (Title I) Design Criteria for Metallurgy Building, Facility 171," AB-00025, Building 332 Records Room, Lawrence Livermore National Laboratory.
[6] "Microprobe Laboratory Building 332," Plans, Elevations, and Details," 1968, PLZ68-332-002JA.
[7] "Building 332 Increment III, Elevations," 1973, PLA73, 005J; "Building 332 Increment III, First Floor Plan", 1973, PLA73, 0020J; "Building 332 Increment III, Basement Plan", 1973, PLA73, 003D; University of California, Lawrence Radiation Laboratory, "Design Criteria for Plutonium Engineering Building 332, Livermore Site," February 1973, FAC-00048, Building 332 Records Room; and "We have more than $35 million worth of major projects in either the design or construction stage," (LLNL) *Newsline,* May 1974, 1-2.
[8] "Plutonium addition dedicated; Dorough lauds 14 years work," (LLNL) *Newsline Weekly Bulletin,* 6 October 1976.

B. Historical Context:

The historic context for the LLNL built environment has been documented in detail in the "Historic Context and Building Assessments for the Lawrence Livermore National Laboratory Built Environment"[9] and is summarized below.

The primary historic context for assessing the significance of LLNL buildings is the Cold War. The Cold War, although still a fairly recent event in US history, has been universally recognized as an event of exceptional significance within the nation's history. The Cold War spanned the forty-six years from 1945 to 1991 and encompassed a series of events, policy decisions, and conflicts between the United States and Soviet Union over the economic and political orientation of various countries in Europe, Asia, and the Middle East. In essence, the United States and the Soviet Union had incompatible and conflicting visions for the fate of the post-war world. The US was wedded to a world that closely mirrored its capitalist and democratic economic and political structure, while the Soviet Union hoped for a world that resembled its communist political and economic structure. The Cold War dominated almost every aspect of American life—diplomatic, military, social, economic, scientific, and political. Nevertheless, only two aspects of Cold War history are relevant to LLNL, the history of the arms race and the more general history of nuclear science.

LLNL was established as a direct response to U.S. policy makers' Cold War concern over the 1949 Soviet detonation of its first nuclear weapon. In 1952, the Atomic Energy Commission (AEC) designated LLNL as a second nuclear weapons design laboratory. LLNL's original mission was to develop a deliverable thermonuclear weapon and to support Los Alamos National Laboratory (LANL) nuclear weapons design and testing programs. As LLNL's mission evolved, it also incorporated more general scientific nuclear research as part of the U.S. push to maintain scientific, nuclear, and technological superiority over the Soviet Union. Most of the buildings at LLNL were built during this time frame.

Completed in 1961, Building 332 originally provided a capability for handling special nuclear materials, primarily plutonium, for nuclear weapons research. LLNL was one of only two laboratories in the country that designed nuclear weapons for the U.S. stockpile. Building 332 housed all LLNL nuclear weapon pit design and prototype pit production. A pit, sometimes called the core, is the part of a nuclear weapon that produces the sustained nuclear reaction and detonation. It produced a fission reaction in early nuclear weapons and both fission and fusion in later, thermonuclear designs. From 1961 to 1989, the pits of all LLNL-designed nuclear weapons that entered the stockpile were researched, developed, and tested in Building 332. Research conducted there also contributed to the development of processes for the fabrication of plutonium weapons parts.

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[9] Michael Anne Sullivan and Rebecca A. Ullrich, *Historic Context and Building Assessments for the Lawrence Livermore National Laboratory Built Environment,* UCRL-TR-234717 (Livermore, CA: Lawrence Livermore National Laboratory, 2007).

As weapons work slowed in the late 1980s, Building 332 activities expanded to include the Laser Isotope Separation Program. In recent years, the Plutonium Facility focuses on researching the effects of aging on the weapons in the U.S. nuclear stockpile.

1. WWII Context

World War II (WWII) was both a national and international historic event of epic proportions. It engulfed all of Western and Eastern Europe, as well as much of Asia. The United States joined the war on the side of the Allies in 1941 after the Japanese military attached the American naval base at Pearl Harbor, Hawaii on December 7.

The Manhattan Project was the U.S. program officially created in 1941 to develop atomic bombs during WWII.[10] A large, secret, well-funded program located administratively under the Manhattan Engineer District, the project oversaw the design, production, manufacture, and delivery of two different nuclear weapons designs during the war. Agencies predating the Manhattan Project were first formed in 1939 by President Franklin D. Roosevelt, including the Advisory Committee on Uranium, which consisted of a team of scientists and military officials researching the potential use of uranium as a weapon. The committee's findings led to U.S. government-funded research on radioactive isotope separation and nuclear chain reactions. The Committee's name was changed in 1940 to the National Defense Research Committee, and in 1941 to the Office of Scientific Research and Development (OSRD). The OSRD formed the Manhattan Engineer District in 1942. The Manhattan Project was formed in December 1942 with the goal of weaponizing nuclear energy through research and tests to be conducted at various facility locations, including New Mexico.[11]

In January 1945, President Roosevelt met with Soviet Premier Joseph Stalin and British Prime Minister Winston Churchill to discuss the post-war world. In April 1945, Roosevelt died in office and Harry Truman became President of the United States. In July 1945, after the surrender of Germany, Truman met with Stalin and Churchill to continue post-war negotiations. During negotiations, Truman learned of the successful detonation of the first atomic bomb at Trinity in New Mexico.[12] This hardened his resolve and changed his manner in dealing with Stalin. Truman no longer needed Stalin's help with Japan. On August 6, 1945, the United States dropped an atomic bomb known as "Little Boy" on the Japanese city of Hiroshima. On August 9, another atomic bomb, known as "Fat Man" was dropped

[10] An atomic bomb, or fission bomb, derives its power from a sudden release of energy produced by splitting the nuclei of the fissile elements making up the bomb's core. F.G. Gosling, 1999.
[11] Manhattan Project Chronology. F.G. Gosling, 1999.
[12] The first fission bomb, known as "The Gadget", was detonated during the Trinity Test in New Mexico on July 16, 1945. F.G. Gosling, 1999.

on the city of Nagasaki.[13] Japan surrendered on August 14, 1945, ending the war in the Pacific.

2. Post-WWII Nuclear Weapon Design

The U.S. Congress, the military, and civilian scientists and engineers struggled with the issue of military versus civilian control of atomic energy immediately after the war. The debate was heated and occasionally acrimonious. It resulted in the Atomic Energy Act of 1946, which 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 AEC. The management of atomic energy and weapons featured in all post-war negotiations between former combatants and came to overshadow all post-war diplomacy. The fact of sole U.S. possession of the new type of weapon influenced the actions of all players in international diplomacy.

In the years following WWII, the AEC recommended the creation of an arsenal of nuclear weapons. Post-war atomic weapon designers faced several design challenges. Fat Man and Little Boy, the first two nuclear weapons, weighed close to 10,000 pounds each. Each weapon had the destructive equivalent of approximately 20,000 tons of high explosive. A single atomic bomb could accomplish the same objective as thousands of individual conventional bombs. However, they were cumbersome, heavy, and not easily deployed. Therefore, scientists at LANL[14] concentrated on design improvements that made weapons lighter, smaller, and easier to use. The first improvements included advances in high explosives, pit design, tampers, and initiators. Other improvements included developing a lighter casing and improved fuzing and firing subsystems.[15]

In addition to perfecting the fusion weapons designed during WWII, post-war scientists also pursued an alternative design. As early as 1941, scientists at LANL had been interested in the creation of a hydrogen, or thermonuclear, weapon. This design used a fission reaction to create fusion (the joining of hydrogen with a heavier element), thereby boosting the detonation and creating an explosion significantly more powerful than achievable from the WWII designs. Time pressure and limited resources left thermonuclear research shelved for the duration of the war in favor of the Fat Man and Little Boy designs. Renewed interest in the creation of a thermonuclear weapon drove post-war nuclear

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[13] The U.S. developed two types of atomic bombs (fission bombs) during WWII—Little Boy and Fat Man, which utilized different elements and separate methods of construction. Little Boy detonated due to a fission chain reaction involving isotopes of uranium, while Fat Man used plutonium's form. F.G. Gosling, 1999.

[14] Originally, the laboratory was called Los Alamos Scientific Laboratory. It was designated a national laboratory via legislation passed by Congress and signed by President Carter in 1979. Los Alamos National Laboratory (LANL) will be referred to by its current name throughout this report.

[15] For information on the construction of the post-WWII nuclear arsenal and the nuclear weapons complex see Charles R. Loeber, *Building the Bombs: A History of the Nuclear Weapons Complex* (Albuquerque, NM: Sandia National Laboratories, 2002).

research, leading to the creation of LLNL, a second nuclear weapons design laboratory, to lend increased impetus to this mission.

In May of 1951, LANL scientists tested their first thermonuclear device at the Enewetak atoll, proving the concept worked, and initiating the most significant post-war technological advance in nuclear weapon design. Like their fission-only counterparts, the first thermonuclear devices were large and unwieldy. Scientists still needed to perfect the design and develop a deliverable weapon.

3. Early LLNL History

In September of 1952, the AEC established LLNL as a second nuclear weapons design facility. LLNL was the brainchild of E. O. Lawrence and Edward Teller, physicists affiliated with the Manhattan Engineer District. They advocated the founding of a second laboratory to accelerate the design and production of a thermonuclear weapon, arguing that these were the next advances in nuclear weaponry. Neither Lawrence nor Teller felt that LANL was working aggressively enough to achieve this goal. Their argument was well-received within the AEC, as the Soviet Union had detonated its first atomic weapon in 1949, and nuclear policymakers felt an urgency to stay ahead of the Soviet Union both technologically and militarily. American policymakers, fearing the potential actions of an enemy armed with nuclear weapons, determined to deter their use by significantly increasing the U.S. stockpile. They were convinced that a second laboratory would accelerate the process of building up a nuclear arsenal.[16]

Herbert York, the first Director of LLNL, articulated four missions for the new laboratory. The four LLNL research directives were designing thermonuclear weapons, providing diagnostic measurements for weapons tests for LANL and LLNL, developing a controlled thermonuclear reaction for power sources, and basic physics research. York felt strongly about pursuing both weapons- and non-weapons-related research. He felt that LLNL needed to have a diversified research program in order to attract the brightest young scientists in the country.[17]

Although LANL developed and tested the first thermonuclear device, LLNL was not far behind. Just six months after LLNL opened its doors, its scientists fired their first test device at the Nevada Test Site (NTS). The device, code-named Ruth, fired below expectations. The next several LLNL test shots also had mixed results. But, by the 1955 test season, LLNL scientists had fine-tuned their designs and successfully tested a thermonuclear device during the Teapot test series at

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[16] Michael Anne Sullivan and Rebecca A. Ullrich, *Historic Context and Building Assessments for the Lawrence Livermore National Laboratory Built Environment,* UCRL-TR-234717 (Livermore, CA: Lawrence Livermore National Laboratory, 2007), 44-46.

[17] University of California, Lawrence Livermore National Laboratory, *30 Years of Technical Excellence* (Livermore, CA: Lawrence Livermore National Laboratory, 1982), 4; and Herbert York, "Making Weapons, Talking Peace," *Physics Today* (April 1988): 44–45.

NTS. Soon, both LANL and LLNL were focused on designing thermonuclear weapons for the Army and Navy.[18]

In the summer of 1955, LLNL received its first weapon assignment, to develop a small warhead for the Regulus II Navy missile, designated the W27. Other early weapon assignments included the W45 for the Army's Little John and Terrier tactile missile systems (1956); the W48 for the 155-millimeter howitzer atomic projectile (1956); and the W47, a small warhead to fit the Polaris, a submarine-launched ballistic missile (1957). LLNL received an award from the Navy in 1961 for the Polaris weapon design.[19]

The LANL-designed B14, the first thermonuclear weapon, entered the stockpile in 1954. The LLNL-designed B28 and W27, the first small two-stage thermonuclear weapons, entered the stockpile in 1958. By 1958, thermonuclear weapons, by comparison to the first atomic bombs, were marvels of efficiency, far easier to use and significantly more powerful.[20]

Since 1958, forty-three different weapon designs have entered the nuclear stockpile. Of these, LLNL designed seventeen and LANL designed twenty-seven.[21]

4. The LLNL Metallurgy Laboratory

The LLNL site was a naval aviator training base during WWII. In 1952, when the new laboratory opened, there were few suitable facilities for conducting nuclear weapons research. The main weapons facilities were constructed within the first two decades of LLNL's operation. Initial weapons design and development took place in Building 121 (Physics Complex Offices and Laboratories) and Building 231 (Development and Assembly Engineering). Built in 1955 and 1954, respectively, the two facilities were among the first wave of new construction at the site.

As early as 1955, LLNL weapon designers argued for the construction of a metallurgy laboratory to conduct research on plutonium and other alloys. Only a handful of people at LANL, Argonne National Laboratory, and Pacific Northwest National Laboratory (a.k.a. Hanford Site) did research on plutonium and LLNL chemists believed that the success of the U.S. nuclear weapons program depended on increased knowledge about this vital element and its properties. LLNL scientists noted that little was known about the alloying of plutonium, the tensile strength of plutonium during its different phases, its chemical corrosion, impurities that could affect plutonium's mechanical properties, or anything about fabrication techniques used in making it into a weapon. Additionally, they argued that having a plutonium facility on site was integral to their weapons program,

[18] Sullivan and Ullrich, 57-59.
[19] Sullivan and Ullrich, 58-59.
[20] Loeber, 87.
[21] Sullivan and Ullrich, 59.

making it possible to avoid delays that might be caused by having to wait to use facilities located elsewhere in the Nation's weapons complex. LLNL also hoped to acquire its own set of facilities for prototype pit development and the fabrication of other parts for test shot devices.[22]

The Metallurgy Laboratory was designed in 1958, with construction completed in 1961. The facility provided a dedicated space for plutonium research and development activities for the nuclear weapons program. There were a total of eighteen individual laboratories in the protected RMA section, most with Berkeley-style boxes fitted with special gloves to protect workers from coming in contact with radioactive material. The air inside the boxes never mingled with the air in work areas but instead traveled directly to a fan loft where it was filtered before being released to the outside.[23] There were also twelve offices, a machine shop, equipment room, locker room, decontamination room, and bathrooms. These rooms were not used to work with radioactive material and were separated from the other laboratories by an air lock and special protective doors.

Building 332 was mainly used by the Plutonium Metallurgy Section of the Chemistry Department and supported by the Research Engineering Division. The Plutonium Metallurgy Department worked on research and development of radioactive metals and alloys in support of LLNL's weapons projects. The Metallurgy Laboratory RMA was essentially an industrial facility with the equipment enclosed in radiation proof boxes. The equipment was used to perform research and development activities pertaining to plutonium pit design and fabrication, including casting, machining, canning, recovery, reduction, research, development, analysis, inspection, testing, and assembly. In general, the laboratories were grouped together according to their function. Laboratories at the south end of the building were chemical analysis and x-ray facilities, laboratories in the central part of the building were used for pit fabrication and mechanical properties testing, and laboratories at the northern end of the building were waste and recovery facilities. The list below groups the rooms, by function, and lists their original function, set-up, and equipment.[24] The current room numbers are added in parentheses to the room number listing to facilitate understanding when reviewing the building's current floor plans (Fig. 1-4).

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[22] W. B. Reynolds to H. A. Fidler, 10 September 1955, E. O. Lawrence Declassified Records, Box 4, File 19-10-364, LBNL Archives, 1.
[23] Shaw, Metz, and Dolio, Architects and Engineers, "Phase I (Title I) Design Criteria for Metallurgy Building, Facility 171," 4.
[24] For information on the original laboratory setup and equipment, see Shaw, Metz, and Dolio, Architects and Engineers, "Phase I (Title I) Design Criteria for Metallurgy Building, Facility 171," 8-20; and "Facility 171, University of California Radiation Laboratory for the U.S. Atomic Energy Commission, First Floor Plan," 1961, PLZ 61-332-002J.

Chemical Analysis and X-Ray Facilities (Rooms 29, 30, 31, 32, 33, and 34)[25]
These sets of rooms provided support functions for the entire laboratory. They were used to assay alloys, waste, ashes, and samples for transuranium elements and other impurities. X-ray facilities examined the microstructure of plutonium to learn as much about the element and how it functioned as possible. Over the years, chemical analysis and x-ray capabilities expanded to include accelerated aging processes, scanning electron microscopy, laser particle size analysis, and microprobe analysis.[26]

Room 29 (1313): Stores and Solution Preparation
This room housed two portable dielectric sealers in self-contained units mounted on double ball bearing casters. The dies and sealing press were used for sealing vinyl-chloride sheets and plastic.

Room 30 (1314): Vault and Health Chemistry
This room was divided into two areas. The vault area (which is no longer used as a vault) was an enclosed space of 9"-thick concrete and a vault door. The other area was an office.

Room 31 (1321): Analysis and X-Ray Room
This room housed a darkroom, enclosed x-ray machine, fluorescent x-ray machine, power supply, and recorder.

Room 32 (1322): Radiography
This room had a radiography cell equipped with a cobalt-60 source. The source was contained in a lead-lined box in the floor and handled mechanically. The room also had a darkroom, drafting board, and viewer.

Room 33 (1329): Analysis
This room housed a glove box with a combustion apparatus and neutron counter.

Room 34 (1330): Experimental Metallurgy Room
This room housed two glove boxes with recorders and a rolling mill.

Physical and Mechanical Properties Testing (Rooms 35, 36, and 38)[27]
Physical and mechanical testing determined how plutonium metal reacted under stress. This helped in determining how components of nuclear weapons would react in extreme environments like heat, stress, pressure, and cold. In more recent

[25] Laboratories were renumbered in the mid-1960s. Rooms 29, 30, 31, 32, 33, and 34 became 1313, 1314, 1321, 1322, 1329, and 1330, respectively.
[26] "Building 332 DSA: Facility Description," December 2005, Lawrence Livermore National Laboratory, 2-11 - 2-13.
[27] Laboratories in the Plutonium Facility were renumbered in the mid-1960s. Rooms 35, 36, and 38 became Room 1337, 1338, and 1346, respectively.

years compatibility testing, mechanical deformation of materials, and gas sampling have been added to the physical and mechanical testing capabilities.[28]

Room 35 (1337): Testing
This room housed two test cells made of 1'-thick reinforced concrete with steel bulletproof doors and windows. The protective features ensured that testing remained contained.

Room 36 (1338): Physical Properties Room
This room housed three glove boxes with a camera microscope, tensile testing machine and press, and hardness tester.

Room 38 (1346): Thermodynamic Properties
This room housed a glove box with an induction furnace and vacuum system.

Pit Fabrication Facilities (Rooms 37, 39, 40, 41, 42, and 43)[29]
In pit fabrication, a disk of plutonium is pressed into the right size and shape; it is then machined to its final specifications. Machining processes include milling, drilling, reaming, and lapping. The pit fabrication process also included welding, which consisted of the welding of plutonium metal and alloys and seal welding of encapsulating materials. Laser welding and electron-beam welding capabilities were added in later years.[30]

Room 37 (1345): Canning and Welding
This room housed an oven, furnace, arc welder, resistance welder, and dielectric sealer. Each of these was enclosed in a glove box.

Room 39 (1353): Assembly No. 1
This room housed two glove boxes; one for assembling machine parts and another for the dielectric sealer.

Room 40 (1354): Assembly No. 2
This room housed two glove boxes. One had a deep freeze in it and the other a vacuum pump beneath the box.

Room 41 (1361): Machining
This room housed four glove boxes with a mill and inspection station, drill, tracer lathes, and hack saw.

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[28] "Building 332 DSA: Facility Description," December 2005, 2-13 - 2-16.
[29] Laboratories in the Plutonium Facility were renumbered in the mid-1960s. Rooms 37, 39, 40, 41, 42, and 43 became 1345, 1353, 1354, 1361, 1362, and 1369, respectively.
[30] Information on pit fabrication and fabrication facilities is compiled from the following documents: Joseph A. Sefcik, "Inside the Superblock," *Science and Technology Review,* March 2001, 7; and "Building 332 DSA: Facility Description," December 2005, 2-10 - 2-11.

Room 42 (1362): Inspection
This room housed two glove boxes. One had an optical comparator with built-in helix table and the other contained a surface plate.

Room 43 (1369): Casting
This room housed two rows of glove boxes. Each row contained a furnace—one a National Research Foundation furnace and the other an ingot casting furnace.

Waste and Recovery Facilities (Rooms 44, 45, and 46)[31]
All plutonium and radioactive materials used in Building 332 were strictly accounted for. Metal shavings and other waste accumulated in the analysis, fabrication, and testing process were recovered, processed, and returned to the inventory. In recent years, activities have expanded to include the assembly and disassembly of fissionable material parts, the packaging and repacking of plutonium or uranium parts, the coating of molds for the casting process, preparation of glass and ceramic precursor powders, and the inspection of uranium-235 enrichment.[32]

Room 44 (1370): Liquid Recovery
This room housed glove boxes with equipment for liquid recovery inside them.

Room 45 (1377): Reduction
This room housed two 25' long rows of glove boxes with process equipment inside patterned after a Rocky Flats design.[33] Included in this set-up were glove boxes for crucible separation, pickling, and weighing.

Room 46 (1378): Solid Recovery
This room housed two glove boxes with a grinder, small hand crusher, and blender inside.

5. Microprobe Laboratory

In 1968, LLNL completed construction of Increment II of Building 332. Increment II consisted of just 690 square feet and housed two laboratories for microprobe research. Microprobes used a nondestructive electron beam to provide a quantitative chemical analysis of inorganic solids at the micron level. The addition was costly, but the Chemistry Department determined that work in the Metallurgy Facility required its own microprobe research facilities. The conditions for microprobe work elsewhere at LLNL were crowded and the facilities available were not suitable for plutonium research.

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[31] Laboratories in the Plutonium Facility were renumbered in the mid-1960s. Rooms 44, 45, and 46 became 1370, 1377, and 1378, respectively.
[32] "Building 332 DSA: Facility Description," December 2005, 2-15 - 2-16.
[33] Rocky Flats was the U.S. nuclear weapons complex location responsible for pit manufacturing.

The new laboratories were equipped with a Norelco Microprobe and a M.A.C. Microprobe. In 1976, when Increment III was added to the east side of the building, Increment II was modified to create a corridor connecting Increment III to the rest of the building. The Increment II laboratories were significantly reduced in size. In the 1980s, Increment II laboratories were converted into the Salt Preparation Laboratory. This laboratory provided the capabilities to dry and purify reagent salts. The Salt Preparation Laboratory remains in operation (Photo 27).[34]

6. Plutonium Materials Engineering Building

In 1971, planning began for Increment III (referred to as the Plutonium Materials Engineering Building Addition) a large addition of approximately 15,000 square feet on the east side of Building 332. Due to repeated review of the stringent conditions for plutonium-handling facilities, the AEC did not approve a set of plans until 1973 and construction was not completed until 1976.

The Plutonium Materials Engineering Building Addition was designed to withstand multiple natural disasters, including fire, earthquake, lightning, and tornadoes without releasing radioactivity into the environment. Increment III also had enhanced safety features to protect workers against contamination from working with plutonium. These included improved ventilation, airlocks, high efficiency particulate air (HEPA) filtration for glove boxes, monitoring and alarm systems, and emergency generators.[35]

The addition housed four laboratories built to accommodate the expansion of pit design and fabrication. Room 1007 provided new machining, welding, and downdraft assembly facilities. Room 1011 was used for inspection processes. Rooms 1006 and 1010 were used for instrumentation, assembly, and testing of assemblies.[36]

In the late 1980s, as weapons work slowed down, Increment III laboratories were reconfigured for the LIS program. The LIS program developed and built the Engineering Demonstration System (EDS), which used the Atomic Vapor Laser Isotope Separation (AVLIS) process to enrich fuel-grade plutonium. The EDS laboratories have since been dismantled.[37] Currently, Room 1010 is used for

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[34] For information on Increment II, see "W. B. Harford to P. M. Goodbread, 30 August 1967, Administrative Files Donald Cooksey, Lawrence Berkeley Laboratory, 1967, Folder Plant Engineering, Livermore Building 332/171, LBNL Archives; "Safety Analysis Report, Plutonium Facility Building 332," 12 August 1987, Lawrence Livermore National Laboratory, LLNL Archives, Collection 091.01.06, Safety Analysis Reports 1973-1990, Box 1, Folder 2, 4-2; and "Building 332 DSA: Facility Description," December 2005, 2-4.

[35] "Safety Analysis Report for Building 332," Lawrence Livermore National Laboratory, 20 June 1974, LLNL Archives, Collection 091.01.06, Safety Analysis Reports 1973-1990, Box 1, Folder 5, 4-2.

[36] Byron N. Odell and Arthur J. Toy, "Final Safety Analysis Report for Building 332, Increment III," 14 June 1976, Lawrence Livermore National Laboratory, Building 332 Records Room, AB-SAR-00037, 4-1 - 4-3.

[37] "Building 332 DSA: Facility Description," December 2005, 2-5.

pyrochemical process development and contains gloveboxes with specially built furnaces for these procedures (Photo 19). Room 1009 in Increment III is empty (Photo 20).

7. Seismic Upgrade

On 24 January 1980, an earthquake of magnitude 5.5 shook the north Livermore Valley, along the Greenville-Diablo fault. The Livermore Valley had seen no serious earthquake activity since 1850. The majority of damage occurred in the town of Livermore, where windows were broken, shop merchandise tumbled from shelves, gas lines burst, mobile homes separated from foundations, and structures cracked. LLNL, just 3 miles from the city center, sustained over $10 million worth of damage. Most damage consisted of broken piping and trailers knocked off their moorings. As a result of the earthquake, LLNL decided to re-evaluate many of its facilities and upgrade many of its structures.[38]

The Plutonium Facility weathered the earthquake with minor damage. Increment I suffered some minor cracking, spalling in the pre-cast concrete panels, and more significant damage to a masonry wall enclosing the mechanical equipment room. A seismic review was initiated and upgrades undertaken, including strengthening the lateral walls of the mechanical loft and mechanical equipment room, replacing or strengthening all masonry walls, and injecting epoxy into any cracks in the exterior walls.

8. Plutonium Research

From 1961 until 1989, the mission of Building 332 remained remarkably consistent. Although equipment was constantly upgraded and occasionally moved from one room to the next, the kinds of research and development work conducted there for the weapons program stayed constant. The Plutonium Metallurgy Department, which was the main user of the facility, performed three main types of activity: fundamental and applied research in plutonium metallurgy, the development and demonstration of improved or unique fabrication techniques, and safe handling of plutonium-bearing engineering assemblies during various testing operations.[39]

The laboratories initially used for x-ray and chemical analysis, pit fabrication, physical and mechanical testing, and recovery operations conducted similar types of work over the years. Laboratory equipment was upgraded over the years and some capabilities expanded or contracted. For instance, the casting, welding, and machining activities used in pit fabrication sometimes moved from one laboratory to another. Yet, they remained in the initial set of laboratories used for these

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[38] The discussion of the Greenville earthquake and subsequent upgrades to Building 332 are from H. J. Degenkolb, Brandow and Johnston, Structural Mechanics Associates, Dr. William J. Hall, and Dr. Mete A. Sozen, "Appendix C: Seismic Evaluation of the LLNL Plutonium Facility (Building 332)," March 1982, Department of Energy San Francisco Operations Office, LLNL Archives, Collection 091.01.06, Safety Analysis Reports 1973-1990, Box 1, Folder 4, 1-4 - 1-5.

[39] "Safety Analysis Report for Building 332," 20 June 1974, 4-1.

processes. In 1976, Increment III was added to facilitate the expansion of pit fabrication and design.

As weapons work slowed down with détente and the eventual waning of the Cold War, the building began to accommodate new programs. By 1979, the Increment III laboratories were being used for the LIS Program. The LIS project endeavored to use lasers to enrich uranium for the nuclear fuel industry; a process that would replace gaseous diffusion.[40, 41] The LIS Program's EDS was placed in two of the Increment III laboratories. The EDS demonstrated the full separator cycle using the AVLIS process. In the 1990s, Congress cut funding for laser isotope separation research and the EDS was subsequently abandoned and partially dismantled. [42]

In recent years, work in Building 332 has centered on stockpile stewardship and waste and recovery operations. The Plutonium Metallurgy Group uses Building 332 facilities to research the properties of plutonium as it ages. This gives them the ability to predict how weapons will perform after sitting in the stockpile for decades. Building 332 scientists developed a unique process using alloys spiked with plutonium-238, which ages faster than weapons grade plutonium, to accelerate the aging process of plutonium pits. Another critical stockpile stewardship program explored new ways to re-fabricate damaged pits or those removed while testing the non-fissile weapon components of a nuclear device.

Many Cold War-era weapons have been removed from the stockpile and dismantled. Building 332 contains several programs that examine ways to dispose of the plutonium waste in these decommissioned weapons.[43] Building 332 activities also include actinide material storage; basic and applied research in the metallurgy and chemistry of plutonium and uranium isotopes, compounds, and certain actinide elements; development and demonstration of pyrochemical processing methods; and material development, including plutonium coatings and fabrication.[44]

The distribution of these activities in the building evolved over time. However, the recent configuration of laboratory assignments reflects the ongoing capability in the building, in particular of the rooms in the RMA (Fig. 1).

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[40] Sullivan and Ullrich, 90.
[41] When early research concluded that uranium isotopes might serve as a fuel source for an explosive device, finding the most cost-effective method of isotope separation was a high priority. Techniques of physical separation included the electromagnetic method and gaseous diffusion. The electromagnetic method was determined to take too long to separate in quantities sufficient to be useful in the current war. Gaseous diffusion appeared more promising than the electromagnetic method, but similarly would be too costly. F.G. Gosling, 1999.
[42] "Building 332 DSA, Facility Description," December 2005, 2-5.
[43] Sefcik, 7-8.
[44] "Building 332 DSA, Facility Description," December 2005, 2-5.

Rooms 1313, 1313A, and 1313B: Sample Characterization Laboratory
Rooms 1314 and 1314A: Materials Management Operations
Rooms 1321 and 1321A: Analytical Chemistry Laboratory
Room 1322: Metallography Laboratory
Room 1322A: Scanning Electron Microscopy
Room 1329: Programmatic Activities, as needed
Room 1330: Drum Storage and Repackaging
Room 1330A: Microprobe Laboratory
Room 1337: Material Inspection and Packaging
Room 1337A: Gas Operations Laboratory
Room 1337B: Materials Management Calorimeter
Room 1345: Machining and Pit Surveillance (Photo 25)
Room 1346: Radiography, Thermal Testing, Device Assembly, and Criticality Safety Training
Room 1353: Machining Facility (Photos 23 and 24)
Room 1354: Downdraft Table and Electron-Beam Welding Facility. Downdraft Table is no longer in use (Photo 26)
Room 1361: Super Dri-Box and Laser Welding Laboratory
Room 1362: Inspection Laboratory
Room 1369: Physical Testing Laboratory (Photo 22)
Room 1370: Foundry and Thermocycling Laboratory (Photo 21)
Room 1377: Drum Assay Laboratory
Room 1378: Plutonium Recovery, Uranium Recovery, and Waste-Handling Laboratory

Part II. ARCHITECTURAL INFORMATION

A. General Statement:

1. **Architectural character:** The Plutonium Facility (Building 332) is a two-story concrete structure with a fan loft and basement. Built in three main increments, it was designed to house plutonium research and development activities for the nuclear weapons program. It is an industrial building. There is no standard type of plutonium research building; however, it is clear that work in Building 332 influenced its design. The particular hazards involved in working with plutonium are reflected in protective features that an ordinary laboratory or industrial building—or one housing different hazards—would not possess. Building 332 has three levels of protection from radiation contamination: the building structure, the ventilation system, and glove boxes.[45]

   The building is constructed of exterior and interior reinforced concrete block walls. All laboratories that work with plutonium are in the RMA,

[45] Information regarding Building 332's architectural character is found in Odell and Toy, "Final Safety Analysis Report for Building 332, Increment III," 14 June 1976, 3-1; and "Safety Analysis Report (Draft), Plutonium Facility Building 332," 12 August 1987, 4-1 - 4-36.

which is located behind two sets of doors: a double set of vault doors and a set of air lock doors.

The ventilation system is centered in the fan loft, which houses exhaust fans, filter chambers, and process utility mains, a house vacuum system, air sampling system, and other process equipment. The fan loft is ventilated all year round with six air changes per hour of 100 percent outdoor air. Exhaust air is filtered through high efficiency filters before being released into the outdoors.

Glove boxes also provide protection from contamination. They are made of stainless steel with Plexiglas or polycarbonate windows. Glove boxes are pressurized with air or nitrogen and installed with an alarm system that signals when air pressure falls below a specified level. Glove box air is not re-circulated but exhausted through at least two HEPA filters. Additionally, glove boxes are capable of being manually flushed by operators.

2. **Condition of fabric:** The current condition of the Plutonium Facility is good. The building is in active use and maintained by LLNL's plant engineering organization. Although most laboratories have been upgraded or changed in recent years, the building houses work similar to its original mission. The building retains its structural and historical integrity. Overall, it reflects the historic activities it housed and the related design features that make it significant.

B. Description of Exterior:

1. **Overall dimensions:** The building is approximately 546'-6" long. It is 125'-1" wide on the south end and 87'-4" wide on the north end. The fan loft rises to 26'-1-1/2"; the remaining one-story portion of the building is 11'-2-1/2" high.

2. **Foundations:** The foundation is reinforced concrete. It is an 8" poured concrete slab resting on compacted fill.

3. **Walls:** Exterior walls are made of concrete block, pre-cast concrete panels and metal. The exterior walls of the fan loft are all constructed of pre-cast concrete panels (Photos 6 and 7). The exterior walls of the Machine Shop expansion (Room 1309) are concrete block (Photo 9). The exterior walls of the Machine Room (Room 1200) are corrugated metal (Photos 10 and 11). The exterior walls of the RMA (Rooms 1313 and 1314 on the south to 1377 and 1378 on the north and Room 1051 on the west to 1010 and 1013 on the east) are poured concrete, reinforced and thicker in the east-west section than in the north-south section (Photos 7 and 10). The Office

Addition exterior walls of the southeast section of the building are load-bearing concrete tilt-up walls (Photos 1 and 2).[46]

4. **Structural system, framing:** Increment I (Room 1200 running north to Rooms 1377 and 1378, and the fan loft) of Building 332 has cross-braced interior steel framing system supporting a metal deck roof spanning between steel bar joists (Photo 34). The roof and floor of Increment III (extending east from Room 1051 to Rooms 1013 and 1010, and the basement) are supported by two 26" diameter reinforced concrete columns (Photo 20). The exterior walls are supported on continuous wall-footings.[47] The Office Addition (the southeast section of the building) is structurally independent from the rest of the building and its exterior walls are load-bearing (Photos 1 and 2).

5. **Porches, stoops, balconies, porticoes, bulkheads**: There is a balcony in the center of the second floor of the north side of the building (Photo 7). It is accessible by a stationary ladder affixed to the outside of the building and a set of metal stairs with a hand railing. The balcony leads to a double set of doors, which function as an emergency exit from the fan loft.

6. **Chimneys:** There are no chimneys.

7. **Openings:**
    a. **Doorways and doors:**
        1. **Pedestrian doors:** Building 332 offers several pedestrian entrances. The main entrance is on the south side of the building and enters into the new Office Addition portion of the building. It is a double metal door leading into a vestibule with double metal-framed glass doors into the building (Photos 1 and 12). There are single metal pedestrian doors on the north (1), south (1), east (3), and west (1) sides of the building (Photos 7, 11, 3, and 9).

        2. **Emergency Exit doors:** Originally, there were a series of emergency exit doors fitted at regular intervals along the exterior of the RMA—on the building's west side and outside of Rooms 1346, 1354, 1362, 1370, and 1378 on the east (Photo 7). They were designed as hollow core wood

[46] Information on Building 332's walls is from the following documents: "Safety Analysis Report, Plutonium Facility Building 332," 12 August 1987, 4-7 - 4-16; and "Building 332 DSA, Facility Description," December 2005, 2-7.
[47] H. J. Degenkolb, Brandow and Johnston, Structural Mechanics Associates, Dr. William J. Hall, and Dr. Mete A. Sozen, 3-1.

doors, clad on both sides with 3/16" steel plate, and crash hardware on the inside.[48]

3. **Roll-up doors:** There is a metal roll-up door providing equipment access on the north side of the Mechanical Room (Photo 16).

b. **Windows and shutters:** Bands of windows run along the south and east side of the building in the new Office Addition. The windows are 2'-6" tall, with the top edge 9' from the ground (Photo 2). There are no windows on the building's north or west sides; there are also no windows along the east side of the RMA where laboratories are located (Photos 5, 6, and 7). There are fixed metal louvers on the south side of the Machine Room for ventilation (Photo 11).

8. **Roof:** Increment I of Building 332 has a flat, tar and gravel roof built up over incombustible insulation. Additionally, the roof system is constructed with welded and bolted connections throughout. The roof system consists of 12 wide flange roof beams, 18" deep open web steel bar joists and horizontal trusses with steel angle diagonals. The 18-gauge metal roof decking is made of fluted sheet metal with very narrow ribs and is connected directly to the top chords of the bar joists by welding.[49]

   Increment III of Building 332 has a 12" thick concrete roof, with a build-up of noncombustible insulation covered by asphalt and gravel.

   The roof of the Office Addition is constructed of metal decking on open web steel joists supported by steel girders and columns.

C. Description of Interior:

1. **Floor plans:** The Building 332 floor plan is most easily understood in three sections: west, east central, and southeast. The west section has a north-south running hallway and contains all of the 1300-series rooms and Rooms 1200 and 1235 (Fig. 1). It also has a second story that serves as the fan loft (Fig. 3). The east central section has a corridor that runs east-west and contains the 1000-series rooms and Rooms 1252 and 1256 (Fig. 1 and 2). The east central section also includes the basement, with B100 series rooms (Fig. 4). The southeast section of the building houses all of the 1100-series rooms and the remaining 1200-series rooms. These rooms are

[48] Shaw, Metz, and Dolio, Architects and Engineers, "Phase I (Title I) Design Criteria for Metallurgy Building, Facility 171," 25.
[49] "Safety Analysis Report, Plutonium Facility Building 332," 12 August 1987, 4-9.

primarily offices accessed by several corridors running both north-south and east-west.

The west section is the original Increment I of Building 332. It housed all of the original plutonium research laboratories in the RMA, the cold instrument room, equipment room, and changing rooms. The RMA laboratories were separated from the rest of the building by an airlock. All of the laboratories behind the airlock are still being used for plutonium research. The mechanical and equipment rooms also retain their original function.

The east central section is Increments II and III. Increment II was a concrete addition of just 690 square feet that housed two microprobe laboratories. When Increment III was added the Increment II space was modified and its laboratory space significantly reduced to create a corridor leading into Increment III. Increment III was a concrete windowless structure that housed four laboratories to accommodate plutonium fabrication processes. In the late 1970s the Increment III laboratories were taken over by the LIS project. Currently, these laboratories house the Salt Project, furnace activities, and barrel storage (Photo 27).

The southeast section of the building is the old office section of Increment I and the Office Addition (Fig. 1). The offices are separated by three north-south running corridors and two east-west running corridors. The old Increment I offices were modified and incorporated into the new Office Addition.

2. **Stairways:** There are three stairways in Building 332, two that lead to the basement and one that leads to the fan loft. The basement stairs are located on the east and west side of the east central section (Fig. 1 and 2). They are both half-turn stairs made of concrete with blue metal railings (Photo 17). Both stairwells function as airlocks separating the basement from any contamination in the laboratories above.

   The stairway to the fan loft is located outside the airlock and north of the machine shop in the southwest end of the building (Fig. 1). It is a half-turn stairway with railings. There are no other internal stairs leading to the fan loft, but there is a door leading to a balcony on the north end of the fan loft and a set of external metal stairs leading to the ground. There is also a metal ladder affixed to the building's exterior (Photo 7).

3. **Flooring:**
   a. **Basement:** The basement floor is poured concrete slab as are the stairs and stairwell floors (Photos 31 and 17).

b. First Floor:

1. West section: The laboratories, changing room, and mechanical room in Increment I all have 12" x 12" beige industrial tile flooring (Photos 21 and 23). The corridor of the RMA has raised dams at each end to prevent contaminated water from spilling past the RMA into the airlock and beyond (Photos 14 and 15).

2. East central section: The laboratories of Increment III all have a poured concrete floor slab. Any laboratory that works with radioactive materials has a finished floor covering of 12" x 12", 1/8" thick industrial tile (Photo 25). Room 1009 currently has 3' x 3' floor tiles from a modification to support the LIS program (Photo 26). There is also a system of dams at door thresholds to prevent the spread of water-borne contaminates in the case of accidental spills. Corridors and non-laboratory space have exposed concrete flooring with a steel trowel finish (Photo 18).

3. Southeast section: The Office Addition in the southeast section of the building has low pile industrial blue carpet with cream stripes (Photo 12).

c. Second Floor: The floor of the fan loft is concrete (Photo 34).

4. Wall and ceiling finish:

a. Basement: The basement walls and ceiling are concrete (Photo 31).

b. First Floor:

1. West section: The ceilings (9" thick) and walls (8" thick) of the original laboratories in the Increment I RMA are concrete (Photo 16).

2. East central section: The ceilings and walls of the Increment III laboratories are concrete covered by waterproof gypsum board (Photo 20). The exception is the control room and mechanical room, which have lowered ceilings of acoustical tiles.

3. Southeast section: The ceilings in the corridors of the office section arch up and have fluorescent lights in a channel along the top (Photo 12). Air vents and speakers are also in the ceiling. The walls of the office addition are painted

gypsum board (Photo 12). The interiors of exterior walls are concrete covered with gypsum board and then painted.

c. **Second Floo**r: The walls and ceiling of the fan loft are 9" thick concrete (Photo 35).

5. **Openings:**
   a. **Doorways and doors:** There are both wood and metal doors providing pedestrian access to offices and labs throughout the building. Office doors tend to be wood with wood transom panels. Doors to laboratories are made of metal with glass insets.

      There are security vault doors and air lock doors in the building that separate the areas where there is radioactive material from the rest of the building. There is a single security door to the plutonium storage vault and double security doors into the RMA (Photo 13). They are steel-framed doors that swing 180 degrees, are reinforced with 1/2" diameter steel rods, have a 4-hour fire rating, and are bolted with 7/8" bolts. The air lock doors are hollow metal type doors, 1-3/4" thick, with flush panel, 1-1/2-hour fire rating, and glass panels for visual access.[50]

      There are also a few glass doors throughout the building. The first is a set of double glass doors that separate the vestibule of the office area from the offices (Photo 12). The other is a glass door by the access booth before the radioactive materials laboratories (Photo 13).

   b. **Windows:** The only indoor windows are in the office section. Each office has a window panel in the office wall next to the door that is the height of the door (Photo 12).

6. **Decorative features and trim:** There are no decorative architectural features on the building.

7. **Hardware:** There is no historic hardware.

8. **Mechanical Equipment:**
   a. **Heating, air conditioning, ventilation**: The HVAC system in Building 332 is designed specifically for the kind of work carried out in its laboratories and provides special protection against radioactive contamination. The HVAC system is located in three different locations: the equipment room, fan loft, and basement.

[50] Shaw, Metz, and Dolio, Architects and Engineers, "Phase I (Title I) Design Criteria for Metallurgy Building, Facility 171," 25.

Additionally, areas outside the RMA are maintained at a different static pressure to prevent the spread of any airborne plutonium contamination.[51]

Equipment Room: The equipment room provides the normal building services such as air conditioning, electricity, and process equipment. It also provides ventilation for the nonradioactive material work areas in the building. These include the administrative offices, fan loft, work area corridor, and equipment room. The ventilation system provides a minimum of six air changes per hour of 100 percent outdoor air.

Fan Loft: The fan loft provides ventilation for the RMA of the building. There are two ventilation subsystems in the fan loft: one for glove boxes and fume hoods and one for the workrooms. Each subsystem has its own duct work, system control, and HEPA filters (Photos 32 and 33). The fan loft also houses the house vacuum system, air sampling systems, and process utility mains (Photo 34).

The subsystem that provides air to the RMA workrooms collects air through intake vents in Room 1200. It is then drawn sequentially through a pre-filter, one standard filter, a power damper, and a fan assembly. The ducts then split the air into two supply headers and enter the RMA labs. The exhaust system collects air from each laboratory via a pair of room exhaust ducts, located in the fan loft. The exhaust ducts are equipped with both a pre-filter and a HEPA filter. The exhaust air is then sent over to the Plenum Equipment Building located along the west wall of Increment I, adjacent to Rooms 1329 and 1345.

The subsystem that provides air to the glove boxes pumps either air or inert gas (argon) from the process utility mains in the fan loft directly into the glove boxes. Glove boxes in the east and west rooms are serviced by separate but identical glove box exhaust lines. Each line consists of a collection of ducting, a manual shutoff damper, a spray/de-mister plenum for fire protection, a HEPA filter plenum for final filtration and redundant exhaust fan/control damper lines. Filtered exhaust gases are directly released into the atmosphere through exhaust stacks.

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[51] The description of the HVAC system in Building 332 is compiled from the following documents: Shaw, Metz, and Dolio, Architects and Engineers, "Phase I (Title I) Design Criteria for Metallurgy Building, Facility 171," 4-8, 28-30; "Safety Analysis Report, Plutonium Facility Building 332," 12 August 1987, 4-22 - 4-39; and H. J. Degenkolb, Brandow and Johnston, Structural Mechanics Associates, Dr. William J. hall, and Dr. Mete A. Sozen, 4-1 - 5-1.

There is one vacuum pump and two positive piston displacement pumps in the fan loft for air monitoring. The vacuum pump maintains a minimum of –8 in. Hg in the house vacuum at all times. The discharge is filtered before release to the outside. Each work room has four air samplers for monitoring. There are four air samplers in the RMA corridor. The positive piston displacement pumps provide a minimum of –25 in. Hg in the house vacuum system at all times. Each vacuum branch is pre-filtered into each laboratory.

Basement: The ventilation subsystems (both supply and exhaust) for all Increment III laboratories and corridors are housed in the basement (Photos 30 and 31). The supply subsystem provides pre-filtered air to the rooms. The supply is provided by a single motor fan assembly. The supply is dynamically handled by a dedicated bypass damper subsystem. These subsystems each utilize a pressure differential indicating controller to modulate room supply flow into each laboratory. Rooms maintain a lower air pressure than hallways. The exhaust subsystem is provided by a redundant pair of exhaust fans. The exhaust subsystem collects air from each laboratory and the basement and releases it to the atmosphere through serially placed HEPA filters.

b. **Lighting:** There are no historically significant lighting fixtures. Fluorescent lighting is used throughout the building with the exception of the fan loft, equipment room, and shipping and receiving, which use incandescent lighting (Photos 12, 13, 27, and 32).

c. **Plumbing:** There are no historically significant plumbing fixtures. Water is supplied via LLNL's infrastructure.

Fire suppression for Increment III is supported by water tanks in the basement (Photos 28 and 29).

9. **Original Furnishings:** There is no historic furniture. However, equipment from the Cold War era does contribute to the building's historic significance. Most of the research and development activities in Building 332 are performed in glove boxes that contain a variety of normal manufacturing equipment like lathes, drills, presses, furnaces, and crucibles (Photos 21, 22, 23, and 25). This equipment was used to create and shape pits used in the prototype development of LLNL stockpile designs. The glove boxes themselves have been updated as needed over the years.

D. Site: Beginning in 1952, the southwest quadrant of the LLNL site was used for buildings associated with the weapons program. Currently, Building 332 is part of the Superblock, a set of buildings with limited access and several layers of security.

1. **Historic landscape design:** Building 332 does not have a historic landscape design. Initial building plans made provisions for some landscaping; however, these plans were never executed. The area around the building is paved, with no plant matter in evidence (Photos 2, 3, 5, 7, 9, and 11).

2. **Outbuildings:** The outbuildings of Building 332 consist of the Plenum Building and the Waste Accumulation and Retention areas (Photo 8). These were late-addition support buildings of no historic significance. Building 335 was built to connect to Building 332 in 1980 (Photo 5). However, it is not related to the nuclear weapons program or the Cold War activities in Building 332, and is not itself historically significant.

Part III. SOURCES OF INFORMATION

A. Architectural Drawings: Architectural drawings are held in the Lawrence Livermore National Laboratory Plant Engineering Library.

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"Facility 171, University of California Radiation Laboratory for the U.S. Atomic Energy Commission, First Floor Plan," 1961, PLZ 61-332-002J.

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"Plutonium Materials Engineering Building 332, First Floor Plan and General Notes," 1971, PLZ71332-014J.

"Basement Floor Plan, Legend, Symbols, and Abbreviations," 1971, PLZ71-332-013J.

B. Early Views: Very few early views of Building 332 were located. A few historic photographs of work conducted in Building 332 reside in the LLNL Archives.

C. Interviews: No oral history interviews were conducted.

D. Bibliography:

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"Design Criteria for Plutonium Engineering Building 332, Livermore Site." February 1973. FAC-00048. Building 332 Records Room. Lawrence Livermore National Laboratory.

"We Have More than $35 Million Worth of Major Projects in Either the Design or Construction Stage." (LLNL) *Newsline,* May 1974.

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

E. **Likely Sources Not Yet Investigated:** The collections at DOE Headquarters in Germantown, Maryland, and at the National Archives in College Park, Maryland, were not investigated. It is not anticipated that they would reveal more about Building 332's design, construction, and use. However, they may contain more information regarding the discussions surrounding the need for the original building and its modifications over time.

F. **Supplemental Material:** None.

Part IV. PROJECT INFORMATION

This report was prepared in 2008 by Michael Anne Sullivan and Rebecca Ann Ullrich under LLNL Memorandum Purchase Order (MPO) No. B558133 with Sandia National Laboratories.

In 2005, LLNL and DOE/NNSA completed consultation with the California State Historic Preservation Officer regarding the historic significance and eligibility of Building 332 to the National Register of Historic Places. Building 332 was found eligible under Criterion A for its association with the Cold War era in national and world history, and under Criterion C for its architectural significance as a state-of-the-art plutonium handling facility.

The operation of LLNL involves research and development activities that require frequent modifications of facilities and equipment to adapt them to meet mission requirements. Additionally, the scientific research process requires flexibility in the planning and execution of work to the extent that it is difficult to state precisely what are the consequences of individual work undertakings with regard to physical effects on historic equipment or facilities. Therefore, this report is mitigation for potential negative effects of undertakings that may take place in and around Building 332.

Large-format photographs were taken by LLNL photographer Michael Anthony. Kenneth Perkins provided early access with a related tour by Bill Egbert. More recent access and an in-depth tour of the facility and its features were provided by Jim Sloan. Maxine Trost and Xiaorong Zhang of the LLNL Archives provided research advice, access to collections, and copies of relevant documents. Mary Judkins of the Building 332 Records Room provided extensive research support and access to pertinent materials. Kelly Heidecker, LLNL Cultural Resources Specialist, oversaw the project and offered extensive research support and guidance. Crystal Quinly and Jeanette Price oversaw the final phase of the project including response to comments provided by the National Park Service.

PART V. FIGURES

Figures 1 through 4 are key plans of Building 332. Original engineering drawings are located in the LLNL Plant Engineering Library.

Figure 1 Drawing PKB96-332-001BF, Rev. F, January 2002.
FACILITY KEYPLAN, BUILDING 332, FIRST FLOOR, 1.

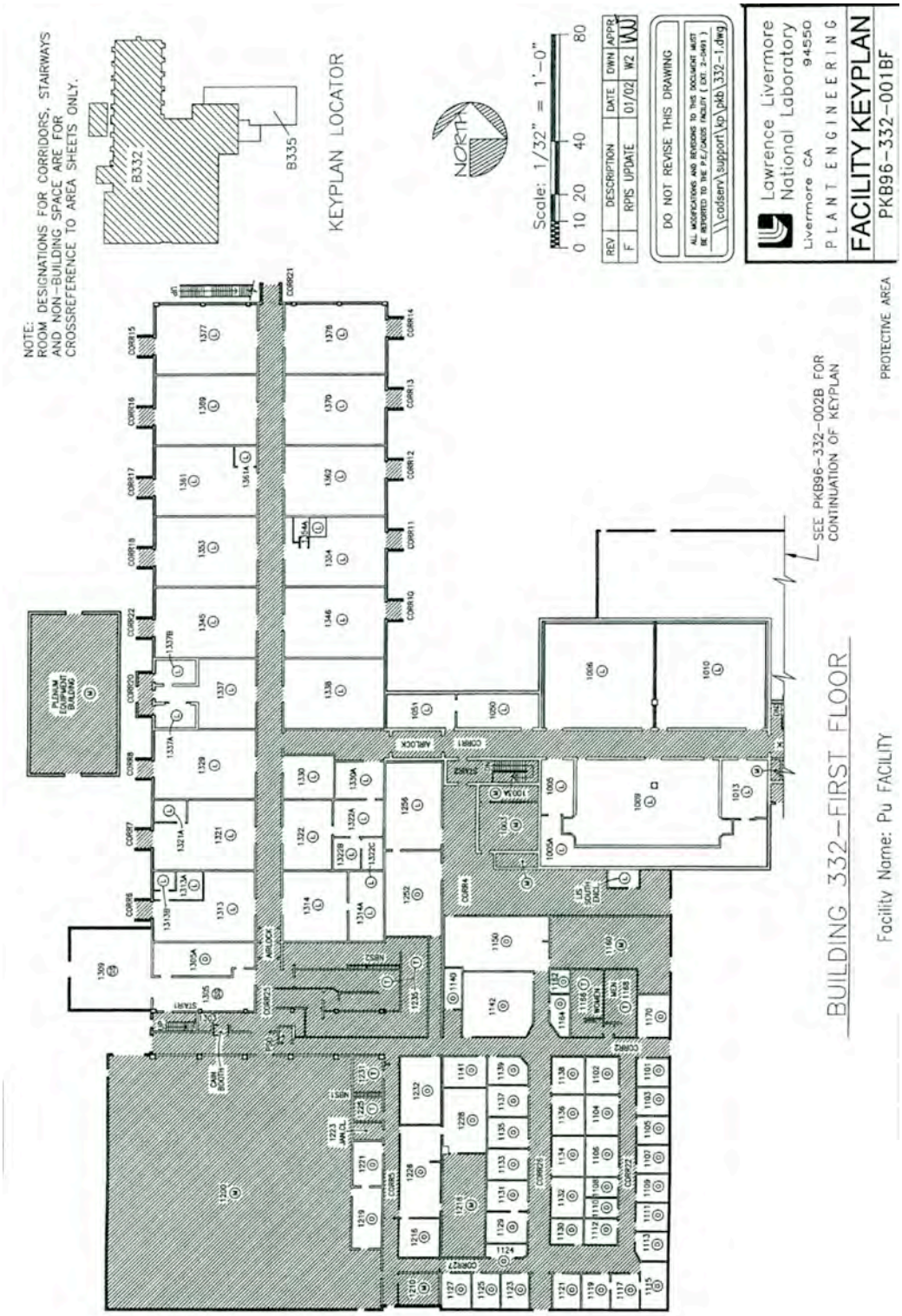


Figure 2 Drawing PKB96-332-002BF, Rev. F, January 2002.
FACILITY KEYPLAN, BUILDING 332, FIRST FLOOR, 2.

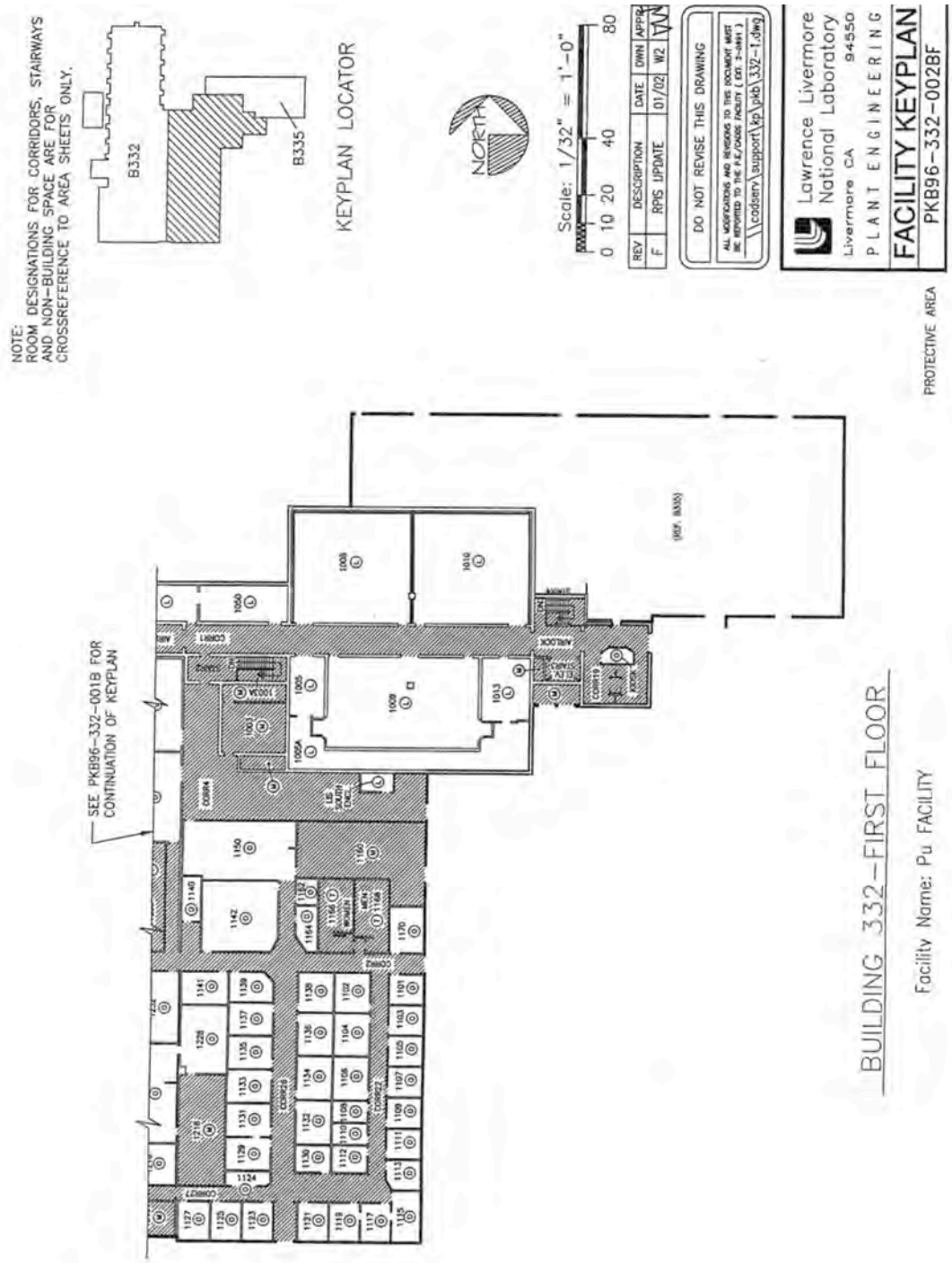


Figure 3 Drawing PKB96-332-003BC, Rev. C, January 2002.
FACILITY KEYPLAN, BUILDING 332, SECOND FLOOR.

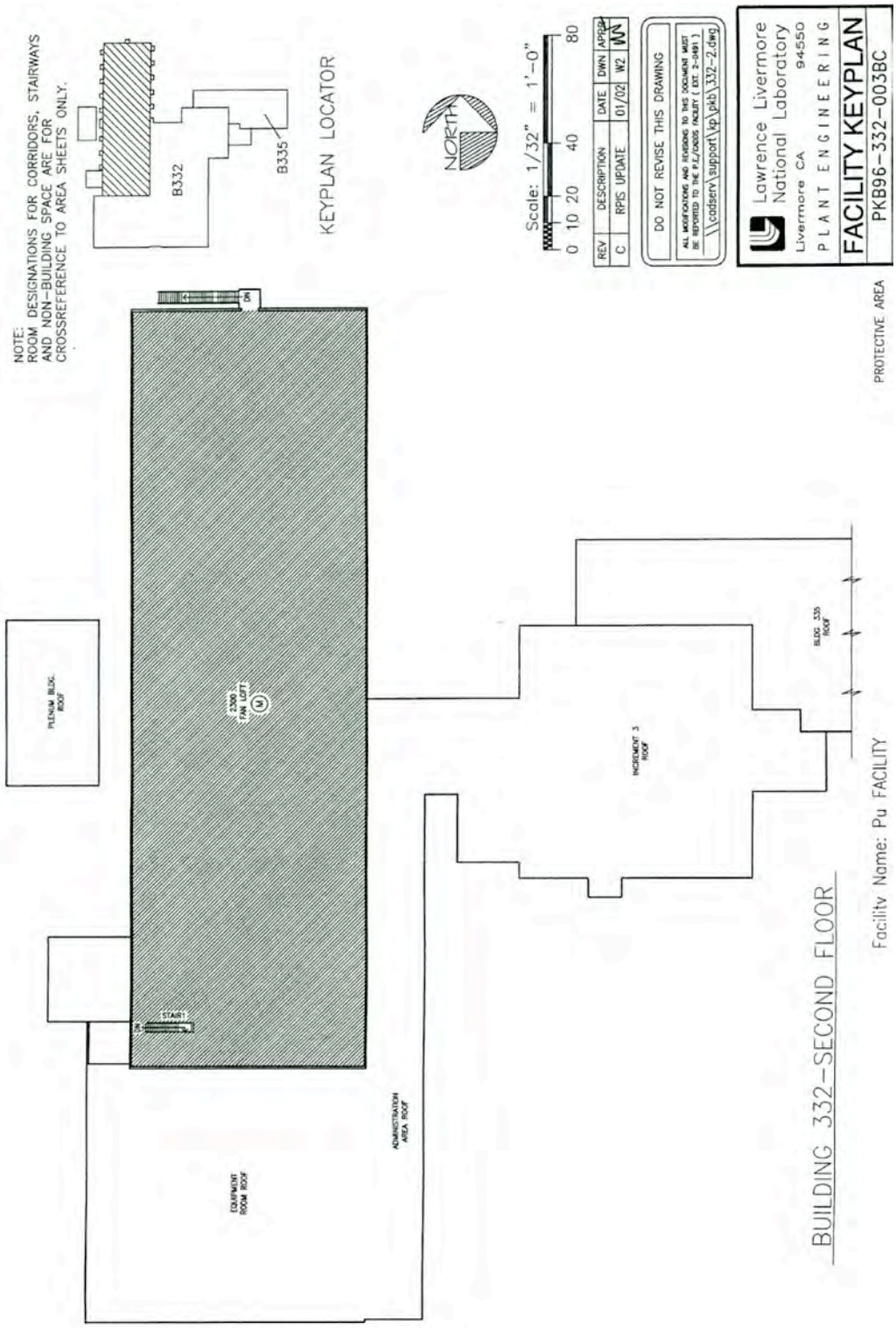
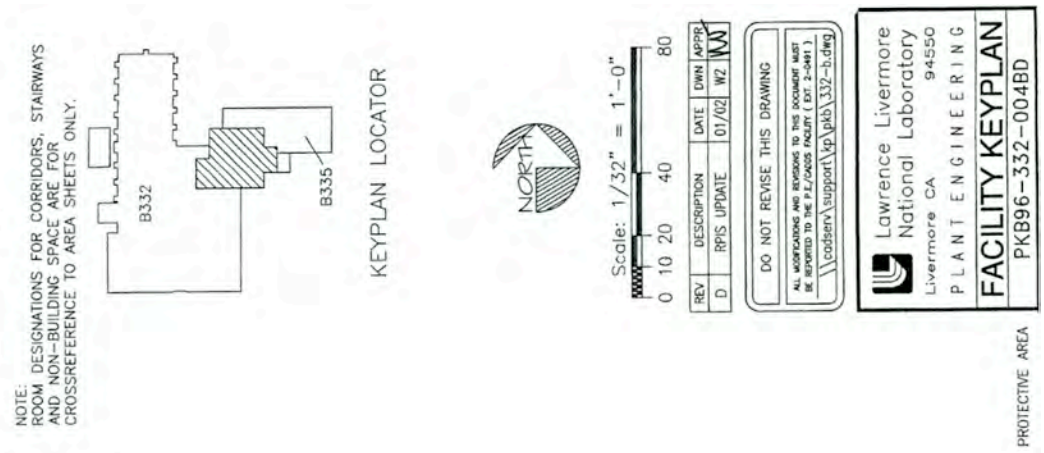
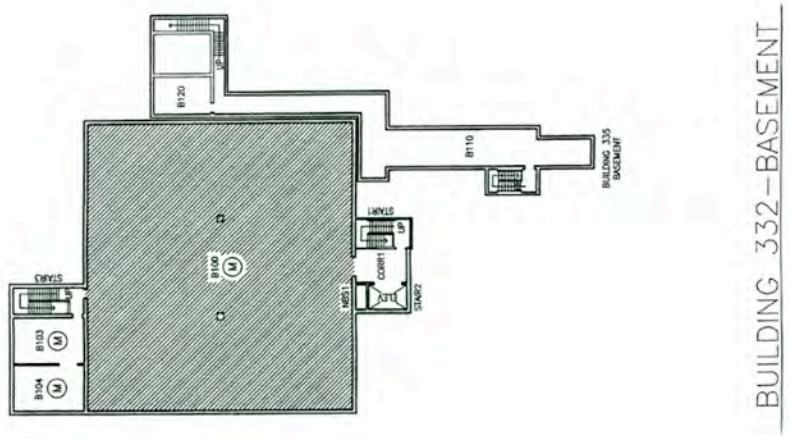


Figure 4 Drawing PKB96-332-004BD, Rev. D, January 2002.
FACILITY KEYPLAN, BUILDING 332, BASEMENT.





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LAWRENCE LIVERMORE NATIONAL LABORATORY,
PLUTONIUM FACILITY
HAER No. CA-2349
(Building 332)
7000 East Avenue
Livermore
Alameda County
California

INDEX TO BLACK AND WHITE PHOTOGRAPHS

Michael P. Anthony, Photographer, April 2009

CA-2349-1	SOUTH AND EAST SIDES OF OFFICE SECTION; NARROW STRIPS OF WINDOWS ON BOTH SIDES; BUILDING 332; VIEW FROM SOUTHEAST.
CA-2349-2	MAIN ENTRANCE TO OFFICE SECTION; DOUBLE DOORS; BLDG. 332 SIGN; SOUTH SIDE OF BUILDING 332; VIEW FROM SOUTHEAST.

Michael P. Anthony, Photographer, April 2008

CA-2349-3	NORTH END OF EAST SIDE OF OFFICE SECTION AND SOUTH SIDE OF INCREMENT III; BUILDING 332; VIEW FROM SOUTHEAST. WITH 10' SCALE.
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CA-2349-5	SOUTH SIDE OF IMCREMENT III; SOUTH SIDE OF BUILDING 335, CONNECTED TO BUILDING 332, IS ON RIGHT THIRD OF PHOTOGRAPH; VIEW FROM SOUTH.

CA-2349-6 EAST SIDE OF NORTH THIRD OF INCREMENT I AND NORTH END OF INCREMENT I; DOORS TO LAB AREAS OF RADIOACTIVE MATERIALS AREA (RMA) ON FIRST STORY OF EAST SIDE; NO WINDOWS OR DOORS ON THESE SIDES OF FAN LOFT (SECOND STORY); BUILDING 332; VIEW FROM NORTHEAST. WITH 10' SCALE.

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CA-2349-8 WEST SIDE AND SOUTH END OF PLENUM EQUIPMENT BUILDING (PEB) LOCATED TO WEST OF BUILDING 332; VIEW FROM SOUTHWEST. WITH 10' SCALE.

CA-2349-9 WEST SIDE OF 1977 EXPANSION (ROOM 1309) OF MACHINE SHOP AND WEST ENTRY TO CORRIDOR 2; BUILDING 332; VIEW FROM WEST. WITH 10' SCALE.

CA-2349-10 SOUTH END OF WEST SIDE AND SOUTH END OF MACHINE ROOM (ROOM 1200); CORRUGATED METAL EXTERIOR; BUILDING 332; VIEW FROM SOUTHWEST.

CA-2349-11 WEST ENTRY TO CORRIDOR 2 AND ACCESS TO RMA; MAIN ENTRANCE TO BUILDING; 1977 MACHINE SHOP EXPANSION ON LEFT; BUILDING 332; VIEW FROM WEST.

CA-2349-12 VIEW OF CORRIDOR 26 FROM INTERSECTION OF CORRIDORS 2 AND 26; OFFICE SECTION; ARCHED CEILING RISING TO LINE OF FLUORESCENT LIGHTS IN CENTER; DOUBLE GLASS DOORS LEAD TO VESTIBULE BEFORE EXIT AT FAR END OF PHOTOGRAPH; BUILDING 332; VIEW FROM NORTH.

Michael P. Anthony, Photographer, October 2007

CA-2349-13 CORRIDOR 2; CAIN BOOTH ENTRY TO RMA IN LEFT FOREGROUND; DOUBLT PORTAL DOOR ON LEFT; SECURITY BOOTH ON LEFT WALL, CENTER OF PHOTO; BUILDING 332; VIEW FROM WEST.

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CA-2349-20	ROOM 1009, ENGINEERING DEMONSTRATION SYSTEM LABORATORY, NO LONGER IN USE; IN INCREMENT III; 26”-DIAMETER SUPPORT PILLAR; 3’X3’ FLOOR TILES; BUILDING 332; VIEW FROM NORTHWEST.
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CA-2349-33	CENTER SECTION OF INCREMENT I LOFT; FLANDERS BAG-OUT HOUSING; BUILDING 332; VIEW FROM NORTHWEST.
CA-2349-34	INCREMENT I LOFT; STEEL BEAMS, MARKED WITH ROOMS THAT ARE BELOW; CONCRETE FLOOR; WATER PIPES ALONG CEILING; BUILDING 332; VIEW FROM NORTHEAST.
CA-2349-35	INCREMENT I LOFT; OLD TELEPHONE SYSTEM FOR ORIGINAL BUILDING INCREMENT I; BUILDING 332; VIEW FROM SOUTH.

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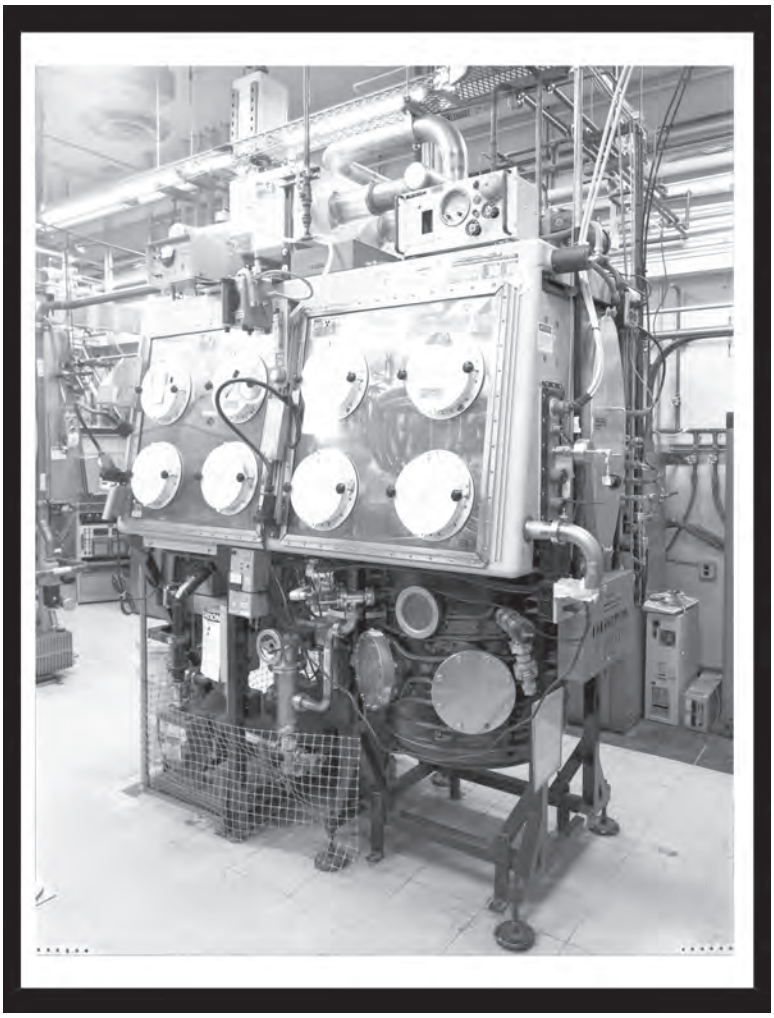

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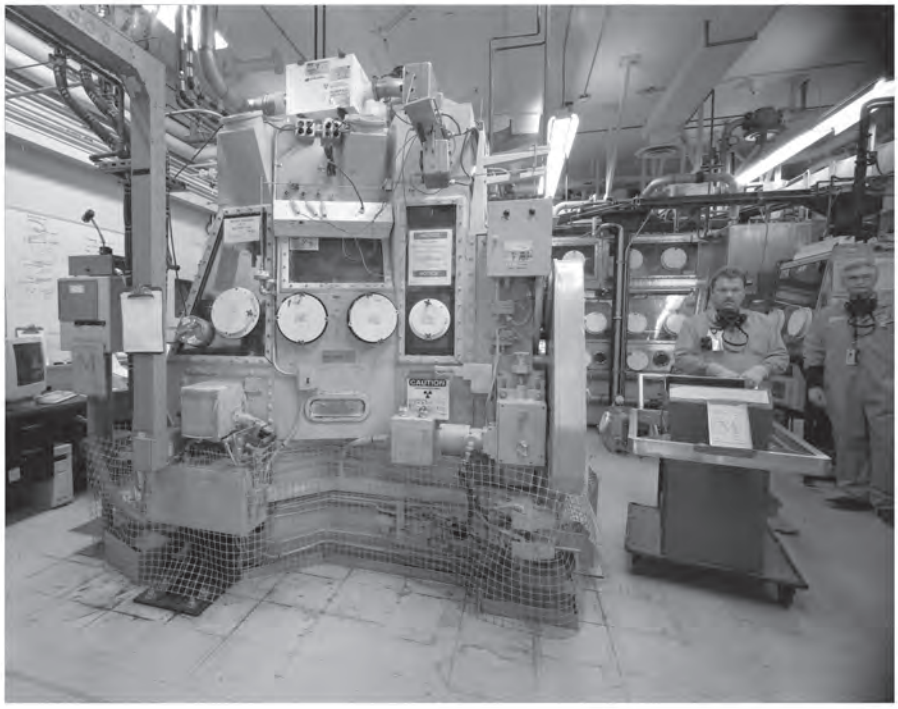

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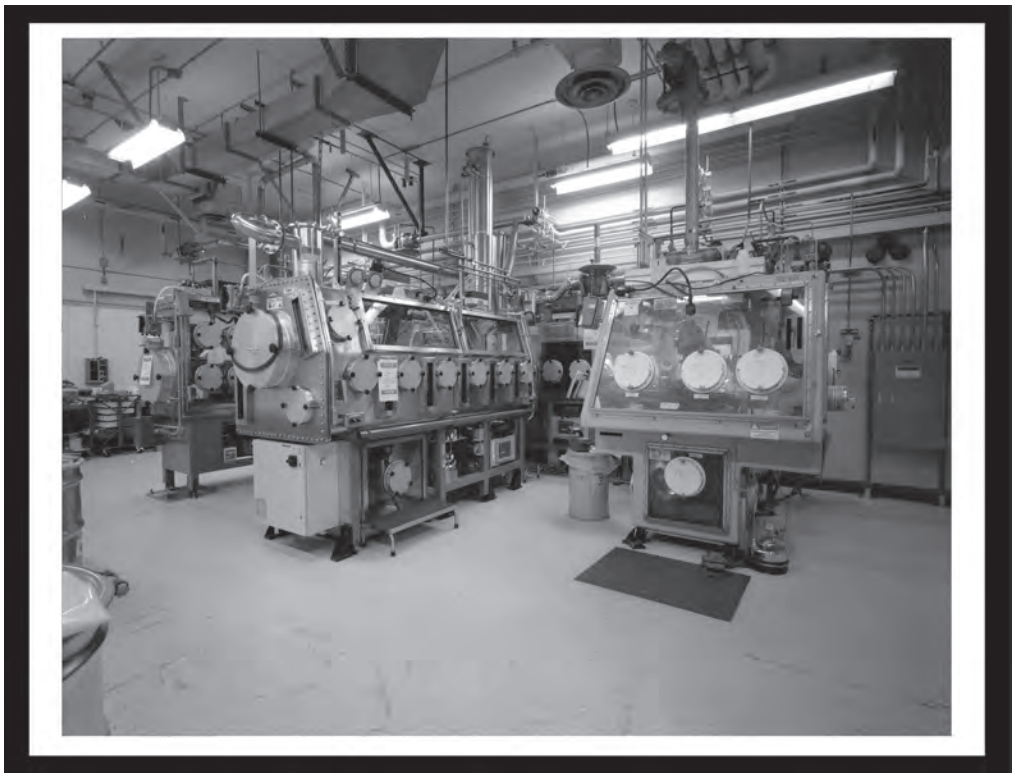

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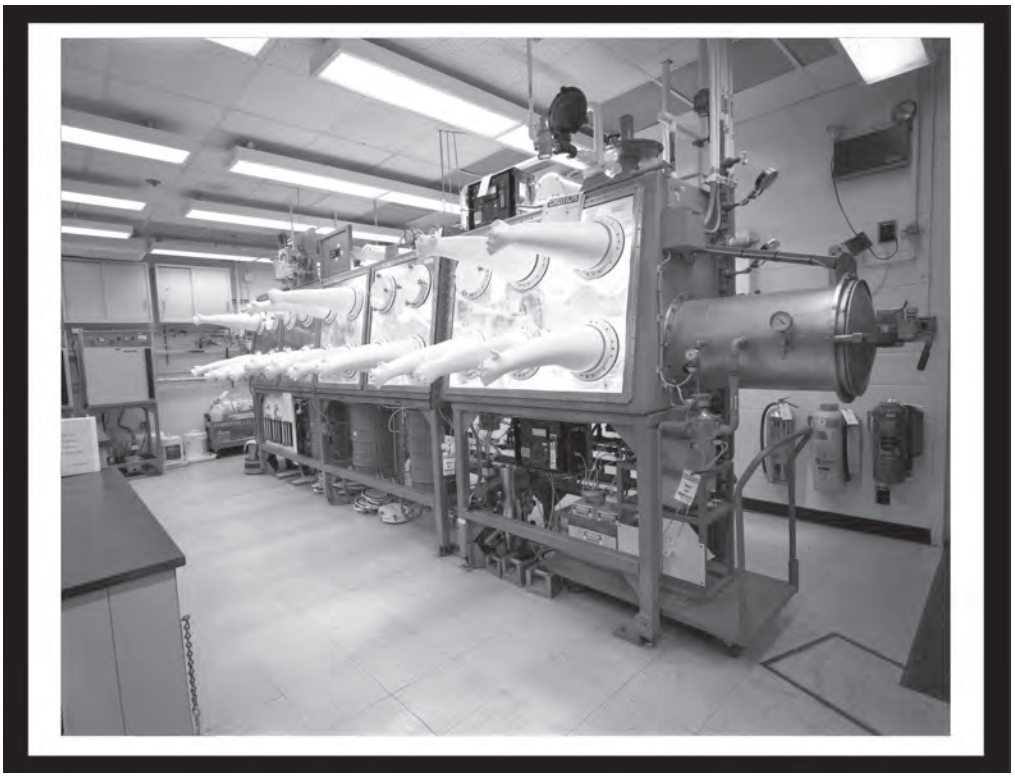

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