LAWRENCE LIVERMORE NATIONAL LABORATORY, LIVERMORE POOL-TYPE REACTOR
(Building 280)
7000 East Avenue
Livermore
Alameda County
California

HAER No. CA-2928

WRITTEN HISTORICAL AND DESCRIPTIVE DATA
PHOTOGRAPHS

HISTORIC AMERICAN ENGINEERING RECORD
Pacific West Region
National Park Service
909 1st Avenue
Seattle, WA 98104

HISTORIC AMERICAN ENGINEERING RECORD

LAWRENCE LIVERMORE NATIONAL LABORATORY
LIVERMORE POOL-TYPE REACTOR
(Building 280)

HAER No. CA-2928

Location: West of the North Outer Loop in the northwestern portion of Lawrence Livermore National Laboratory (LLNL),
7000 East Avenue, Livermore, Alameda County, California

Present Owner: U.S. Government, Department of Energy,
National Nuclear Security Administration

Present Use: Vacant

Significance: The Livermore Pool-Type Reactor (LPTR), located in Building 280, is historically significant for its role in breakthrough neutron experiments and research in support of LLNL nuclear weapons and testing programs. From 1958 to 1980, these experiments provided critical information regarding weapons design and diagnostics for nuclear testing. Originally designed for use in the weapons program, the LPTR also incorporated features that made it useful for nuclear research in many other programs, including physics and biomedicine.

Historian: Alison Garcia Kellar, Architectural Historian
Garavaglia Architecture, Inc. (GA)
San Francisco, California 94104

Date: August 2016

Part I. Historical Information

A. Physical History

1. Date of erection:
Designed: 1955
Construction Begun: 1955
Building Completed: 1956

2. Architect: The Austin Company, an engineering and building company based in Oakland, California, designed Building 280. Headquartered in Cleveland, Ohio, the firm was noted for its industrial and military construction.[1] The international engineering company Foster Wheeler Corporation designed and built the LPTR, which was housed inside of Building 280.[2]

3. Original and subsequent owners, occupants, uses: The building has always been owned by the U.S. Government, as part of 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]).[3]

The original user was the Lawrence Radiation Laboratory, which evolved into Lawrence Livermore National Laboratory. The occupants had continuously been Lawrence Livermore National Laboratory employees, and the building was continuously used through 1980 for nuclear research, supporting the LLNL weapons program, in addition to chemistry, physics, and biomedical research programs at the LLNL and Lawrence Berkeley National Laboratory (LBNL).

5. Original plans and construction: Building 280 and adjacent Increment 1 of Building 281 were originally considered to be one building, designated as Building 193, as together, they accommodated the functions of the LPTR. As originally designed, Building 193 comprised the LPTR facility.

Designed in 1955, and constructed first, the T-shaped one-story Increment 1 of Building 281 was attached to Building 280 by a personnel air-lock entrance. Adjacent Building 281 originally housed the control room for the LPTR and its related chemistry laboratories. The 18,549 gross-square-foot concrete-block structure had windows on the north and south elevations.

Designed concurrently in 1955, Building 280 was created specifically to house the LPTR, as a double-height, round, domed structure. The 5,343 gross-square-foot structure measured 80' in diameter and 52' in height.[4] Construction consisted of a reinforced

---

[1] Michael A. Sullivan and Rebecca A. Ullrich, *Historic Context and Building Assessments for the Lawrence Livermore National Laboratory Built Environment* (Livermore: Lawrence Livermore National Laboratory: 2007), 135.
[2] K. R. Heidecker and R. A. Ullrich, *Five-Year NRHP Re-Evaluation of Historic Building Assessment* (Livermore: Lawrence Livermore National Laboratory: 2012), 213.
[3] "Lawrence Livermore National Laboratory, High Energy Laser Facility," Written Historical and Descriptive Data, Historic American Engineering Record, National Park Service, U.S. Department of the Interior, 2015; page 2. From Prints and Photographs Division, Library of Congress (HAER No. CA-232; https://enviroinfo.llnl.gov/cultural).
[4] Heidecker and Ullrich, 213.

concrete ring wall with a cylindrical shell of welded steel plates topped with a self-supporting roof of steel plates. The building's foundation and all flooring were comprised of reinforced concrete. An insulated steel shell and steel dome encompassed the airtight interior.

Located at the center of Building 280, the construction of the LPTR required a submerged aluminum tank, surrounded by biological shielding, to house the core. The tank measured 6'-7" in diameter and was 3/8" thick. The reinforced board-formed concrete core included a thermal column of graphite and 35 uranium fuel elements, each measuring 3" x 3" x 35", submerged into the floor storage pit.

6. Alterations and additions: In 1967, an LLNL-wide renumbering campaign designated Building 193 as Buildings 280 and 281. In 1958, two years after its construction, the LPTR went critical, meaning it began operating at a steady power level, and closed down in 1960 to modify the containment system and upgrade the power from one to two megawatts. Building 280 was decommissioned in 1980 and has not been in use since.[5]

B. Historical Context:

1. Early LLNL History

The LLNL was the brainchild of E. O. Lawrence and Edward Teller, physicists affiliated with the Manhattan Engineering District. Lawrence and Teller believed that the existing Los Alamos National Laboratory (LANL) was not working aggressively enough to achieve the goal of accelerating advancements in nuclear weaponry. The two physicists advocated for the founding of a second laboratory, determined that the design and production of a thermonuclear weapon in a new facility would be the next advancement in nuclear weaponry. Lawrence and Teller's argument was well received within the AEC, as the Soviet Union had just detonated its first atomic weapon in 1949. American nuclear policymakers felt an urgency to stay ahead of the Soviet Union both technologically and militarily, fearing the potential actions of an enemy armed with nuclear weapons. To deter the use of such weapons by the opposition, policymakers were determined to significantly increase the U.S. stockpile. Convinced that a second laboratory would accelerate the process of building up a nuclear arsenal, the AEC established the LLNL in Livermore, California, in September of 1952 as a second nuclear weapons design facility.[6]

Herbert York, the first director of LLNL, articulated four missions for the new laboratory;; including 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 was in strong pursuit of both weapons and non-weapons related research, as he felt that a diversified research program at LLNL would attract the country's brightest young scientists.[7]

---

[5] Ibid.
[6] Ibid., 247–249.
[7] Herbert York, "Making Weapons, Talking Peace," *Physics Today* (April 1988).

2. LPTR Mission History

The following LPTR mission history is from the *Five-Year NRHP Re-Evaluation of Historic Building Assessment* created in 2012:
In 1955, construction began on the LPTR Facility, Buildings 280 and 281. The LPTR facility was intended to replace the old Water-Boiling Neutron Source Reactor (WBNS) built by CR&D in 1953. The WBNS was considered an old model reactor, not large enough or suitable for weapons research. Building 280 housed the LPTR and Building 281 housed research laboratories for the reactor. The LPTR was designed as a flexible research reactor primarily to support the LLNL weapons program but also intended for use by the chemistry, physics, and biomedical research programs at both LLNL and LBNL.

From 1958, when it first went critical, until 1980, the LPTR was a workhorse for the weapons program. The LPTR was used for a variety of chemistry and physics experiments, including weapon radiochemical analysis, bomb fraction measurements, analysis of samples from nuclear tests, capture-to-fission ratio measurements of uranium 235, cross-section measurements, calibration of instruments for determining fission yield, instrument testing, and radiation damage studies.

The LPTR provided valuable information regarding nuclear processes, nuclear testing, and nuclear weapons design. Without its own research reactor LLNL would have had to contract this work to LANL or ARCO, limiting its ability to come up with new techniques and designs.

From 1958 to 1980, the LPTR also provided support to a variety of non-weapons-related research programs including the biomedical research programs at LBNL and LLNL. The research for biomedical programs included studying the effects of radiation on living things, using tracers to monitor biological processes, and creating isotopes for medical purposes.

In 1980, after more than twenty years of service, the LPTR was decommissioned.[8]

[8] Heidecker and Ullrich, 212.

Part II. Structural/ Design/ Equipment Information

A. General Statement:

1. Architectural character: The LPTR building (Building 280) is a round, domed structure comprised of welded steel plates clad in mastic sprayed material. The building is an unembellished, windowless industrial building, made to serve a specific scientific research purpose. Like other industrial buildings, this building was designed to support and accommodate the machines it housed, in this case the reactor. As identified in the 2007 *Historic Context and Building Assessments for the Lawrence Livermore National Laboratory Built Environment,* Building 280 is characterized as Industrial Vernacular, a style present among LLNL Cold War era buildings.[9]

2. Condition of fabric: The core of the LPTR has been removed, and the containment vessel remains intact. Minimal portions of the flooring have been test bored throughout. The vacant building is in very good condition.

B. Description of Exterior:

1. Overall dimensions: The building measures 80’ in diameter and 52’ in height, and has a working floor area of nearly 4,500 square feet. [10] The building measures 38’ from the ground to the spring point of the dome.

2. Foundations: The foundation is a 6” level concrete slab, with a 4” curb around the entire circumference.[11]

3. Walls: The building is a cylindrical shell of welded ¼” thick steel plates, reinforced with angle rings.[12] The dome and its walls are insulated with a 3/8” layer of cork and mastic sprayed on the outside of the building, covered with reflective paint.[13]

4. Structural system, framing: The structural system is comprised of the welded steel plate walls, and a self-supporting roof of 5/16” steel plates. The base of this structure is welded to large anchor bars which are buried into a reinforced-concrete perimeter ring wall.

5. Porches and loading docks: A contemporary overhang sits over the large, main, truck door. A shallow concrete ramp leads to the main door from the south.

7. Openings:

a. Doorways and doors: There are three metal frame exterior doors at the eastern portion of the building. This included one truck door and two personnel escape doors, all of which opened inward.[14]

---

[9] Sullivan and Ullrich, 144.
[10] Heidecker and Ullrich, 213, and Lawrence Radiation Laboratory, *The Livermore Pool Type Reactor (LPTR),* UCRL-4919 (Livermore: Lawrence Radiation Laboratory: 1967), 15.
[11] Lawrence Radiation Laboratory, 15.
[12] Ibid.,15.
[13] Ibid., 21.
[14] Ibid., 15.

b. Windows and shutters: There are no windows present in this building.

8. Roof:

a. Shape, covering: The roof is a rounded dome of self-supporting steel plates, clad in a mastic spray covering. A stack with a butterfly vent and a dosimeter sit at the apex of the roof. A ladder along the north side of the building runs up onto the domed roof and leads to the vent.

C. Description of Interior:

1. Floor plans: The former LPTR sits in the center of the round floor plan. The space has no interior walls or compartmentalized spaces aside from the LPTR. To the west of the disassembled reactor is an openly submerged equipment pit. Also submerged below are a hold up tank and storage tank. A magnet pit sits to the north of the reactor. Stairs located northeast of the reactor lead from the ground floor up to the reactor. When the LPTR was in operation, work stations with various related computers, equipment, and machinery extended radially from the reactor.

2. Stairways: An open metal stairway leads up to the reactor.

3. Flooring: The concrete flooring was initially surface hardened and covered with five coats of a strippable plastic paint to facilitate decontamination. An equipment pit is located in the floor to the west of the reactor shield, measuring 12’ x 34’ x 16’ deep. Conduits built into the floor run radially from the reactor faces to the building wall and are capped at floor level.[15]

4. Wall and ceiling finish:

a. Wall finish: The interior is comprised of an airtight steel shell and steel dome, which forms a controlled-leakage steel barrier designed to assure containment of radioactive effluents under all conditions. The interior of the building is insulated with a 1” layer of polyurethane on the walls, to provide both acoustic and thermal insulation

b. Ceiling finish: The domed ceiling is insulated with a 1-½ ” layer of polyurethane on the ceiling, to provide both acoustic and thermal insulation.[16]

5. Openings:

a. Doorways and doors: An airlock personnel door sits between Building 280 and Building 281. There is a cave door at the reactor.

7. Hardware: The hardware present in the building includes a 15-ton traveling crane with 2-ton monorail hoist which serviced the reactor.

8. Mechanical equipment:

---

[15] Ibid., 16.
[16] Ibid., 21.

a. Heating, air conditioning, ventilation:
Beam plug storage located to the southeast of the building included air conditioning exhaust vents, a decontamination system, and two butterfly vents, which allowed for air circulation and gas waste exhaustion.[17] The stack located at the top of the dome includes a butterfly vent, which connects to the beam plug storage via an 8” x 16” duct that runs along the ceiling and wall.

There is an air-conditioning duct on north wall, while an in-take duct sits on the south wall. An early air-cleaning system connected to the building assured that internal pressure would remain low in the event of a building seal. Pipes along the western portion of the building would allow for the high-expansion foam fire protection system to deploy in case of an internal fire.[18]

b. Lighting: Lighting in the building is comprised of fluorescent fixtures, both flush in the dropped ceiling and suspended from the gypsum ceiling.

c. Plumbing: The concrete floor has flush drains and covered pits, including one large equipment pit surrounded by narrow drainage gutters. Located in the northwest of the building, the submerged equipment tank housed waste tanks, demineralizers, and several pumps and filters.[19]

d. Electrical: Fourteen 4” conduits were buried in the concrete floor, which ran radially from the reactor to the building wall. These conduits capped at the floor level for use with experimental equipment or for utilities extension.

D. Machines: Two dosimeters, which measured exposure to radiation, were located outside of Building 280: one by the northern escape door, and the other on top of the roof. The 15-ton crane operated with a variable-speed motor.

E. Site Layout: The building is located in the northwest portion of the LLNL Livermore campus. The building is largely isolated, surrounded by paved asphalt. T-shaped Building 281, originally utilized as the LPTR’s laboratory building, is attached to Building 280 just to the west. Building 281 originally housed the control console and many of the mechanical utilities for the reactor.[20]

Presently, an electrical substation and emergency system sit unattached to the south of the air lock chamber. A grouping of trees with a paved walkway extends to the south of the site, while a parking lot sits to the east. A one-story auxiliary gabled structure, housing the emergency scrubber system, sits immediately to the north. Beyond the parking lot to the east sit two other LLNL buildings.

---

[17] Ibid., 15.
[18] Ibid., 22.
[19] Ibid., 16.
[20] Ibid, 19.

Part III. Operations and Process

A. Operations: The building was constructed to house the LPTR, a low-power low-flux reactor, designed for basic research and radioisotope production. The LPTR was completed in 1956, and first operated in 1958.[21] This facility was versatile and suitable for general research by all departments at LLNL.

The reactor neutron-research program of the LPTR had three general experimental programs: precision gamma studies, solid-state studies with neutron diffraction spectrometers and radiation damage experiments, and precision measurements of neutron interactions with matter.[22]

B. Technology: While the LPTR is no longer extant, the support equipment remains. The following is a summation of the reactor core, which was the impetus for the construction of Building 280:

The swimming pool type reactor, or Livermore Pool Type Reactor (LPTR), was a one megawatt solid fuel, light water moderated and cooled reactor.

The reactor core resided in a tank approximately six feet in diameter and three-eights of an inch thick surrounded by biological shielding. The fuel elements of the reactor core were modeled after those in the Materials Test Reactor (MTR) located at the National Reactor Testing Station in Idaho.

The design of a swimming pool type reactor was considered superior to a water boiler because it overcame the problems with escaping gases or loose fission products experienced by water-boiler reactors. In the event of an accidental explosion, the water surrounding the swimming pool type reactor would contain radiation. [23]

The reactor's core was cooled by a closed circulation system using low conductivity water, which was circulated downward through the core, a holdup tank, primary coolant pump, and heat exchanger before returning to a reactor tank.

C. Workers: Workers form a variety of LLNL departments utilized the research conducted with the reactor. This included technicians, engineers, physicists, scientists and office staff from internal divisions including Mechanical Shops, Mechanical Equipment, Health Chemistry, Health Physics, Mechanical Engineering, Electronics Engineering, Plant Engineering, and the Neutronics "N" Division.[24]

D. End Product: By the early 1960s, the LPTR was irradiating over 900 samples. At that time, about one-third of the output samples went to UC Berkeley researchers, and the rest remained at Livermore for use by chemistry and physics groups.[25] The LPTR provided valuable information regarding nuclear processes, nuclear testing, and nuclear weapons design in support of LLNL

---

[21] Heidecker and Ullrich, 82—83.
[22] Ibid., 83.
[23] Ibid., 82.
[24] "LPTR Holds Open House," *The Magnet*, Vol. 2, no. 6 (June 1958): 1.
[25] "Shopping for Isotopes," *The Magnet*, n.d., 4.

programs.[26] From 1958 to 1980 scientists in the biological and medical fields were able to use the LPTR to investigate the effects of radiation on living things and to study life processes in plants and animals by tracer techniques.[27]

Part IV. Sources of Information

A. Architectural drawings: Original building plans were not referenced for the production of this report. An early internal publication, *The Livermore Pool Type Reactor (LPTR)* (UCRL-4919), was published in 1967 and included schematic diagrams, sections, and plans reflecting he building and its operating systems shortly after construction.

B. Early Views: Construction photographs of Building 280, provided by LLNL, were referenced for the production of this report. These photographs depicted site preparation, LPTR core construction, crane and wall construction, and exterior siding treatment. Photographs of Building 280 during the early years of operation depicting various workstations, instrument panels, and auxiliary and support instruments were also reviewed.

Aside from the released, provided images, limited photographs of the complex were accessible and or available in a reproducible format.

D. Selected Sources:

Heidecker, K.R., and R.A. Ullrich. *Five-Year NRHP Re-Evaluation of Historic Building Assessment*. Livermore: Lawrence Livermore National Laboratory, 2012.

"Lawrence Livermore National Laboratory, High Energy Laser Facility," Written Historical and Descriptive Data, Historic American Engineering Record, National Park Service, U.S. Department of the Interior, 2015. From Prints and Photographs Division, Library of Congress (HAER No. CA-232; https://enviroinfo.llnl.gov/cultural).

Lawrence Radiation Laboratory. *The Livermore Pool Type Reactor (LPTR).* UCRL-4919. Livermore: Lawrence Radiation Laboratory, 1967.

Sullivan, Michael A., and Rebecca A. Ullrich. *Historic Context and Building Assessments for the Lawrence Livermore National Laboratory Built Environment*. Livermore: Lawrence Livermore National Laboratory, 2007.

"The Livermore Pool-Type Reactor." *The Magnet*, 2, no. 6 (University of California, Berkeley, June 1958): 4—5.

"LPTR Holds Open House." *The Magnet*, 2, no. 6 (University of California, Berkeley, June 1958): 1.

[26] Sullivan and Ullrich, 212—213.
[27] "The Livermore Pool-Type Reactor," *The Magnet*, no. 6 (June 1958): 4, and Sullivan and Ullrich, 212.

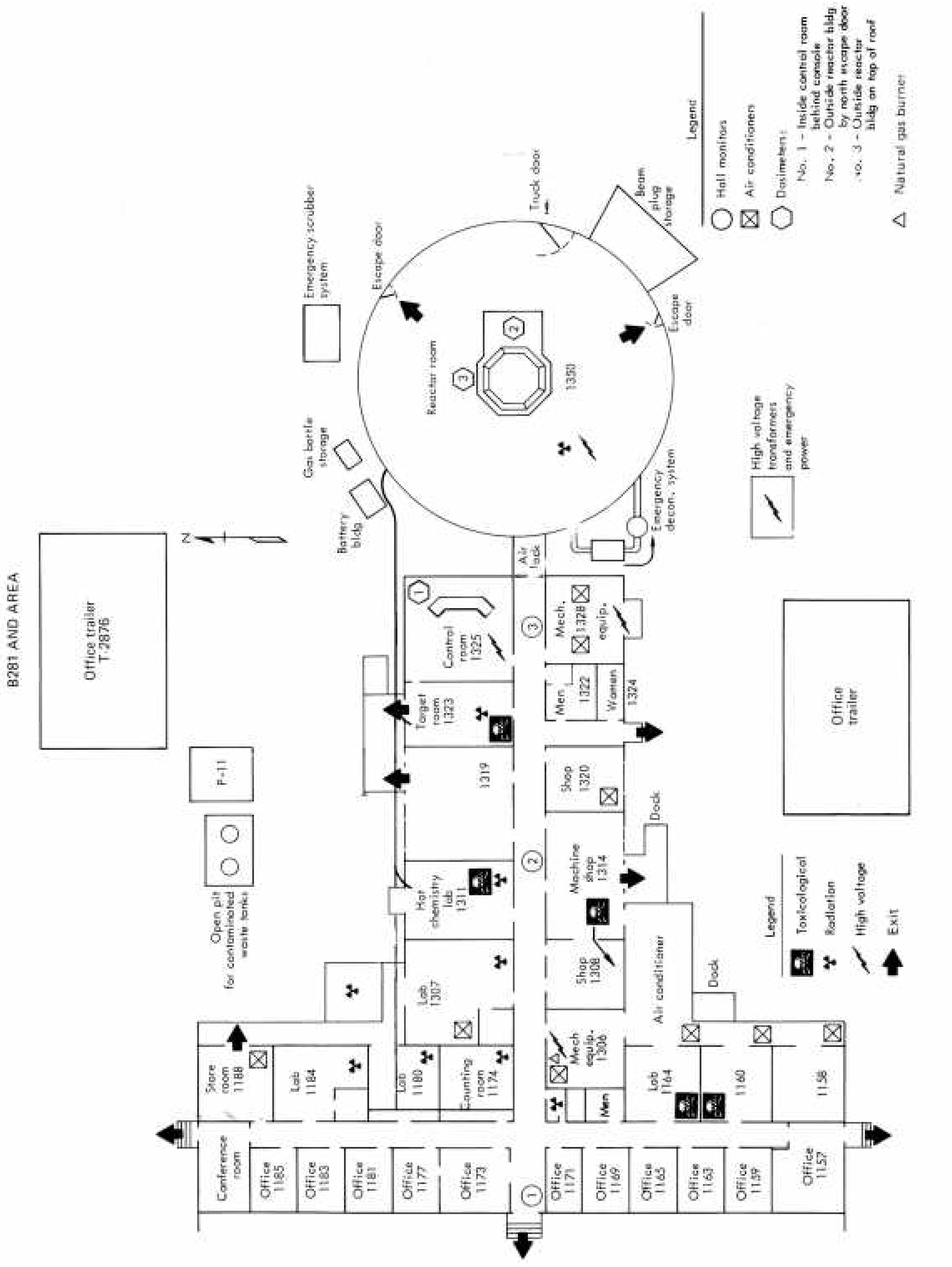


Figure 1. Building 280 and 281 Facility Drawing, c. 1971. LLNL Archives.

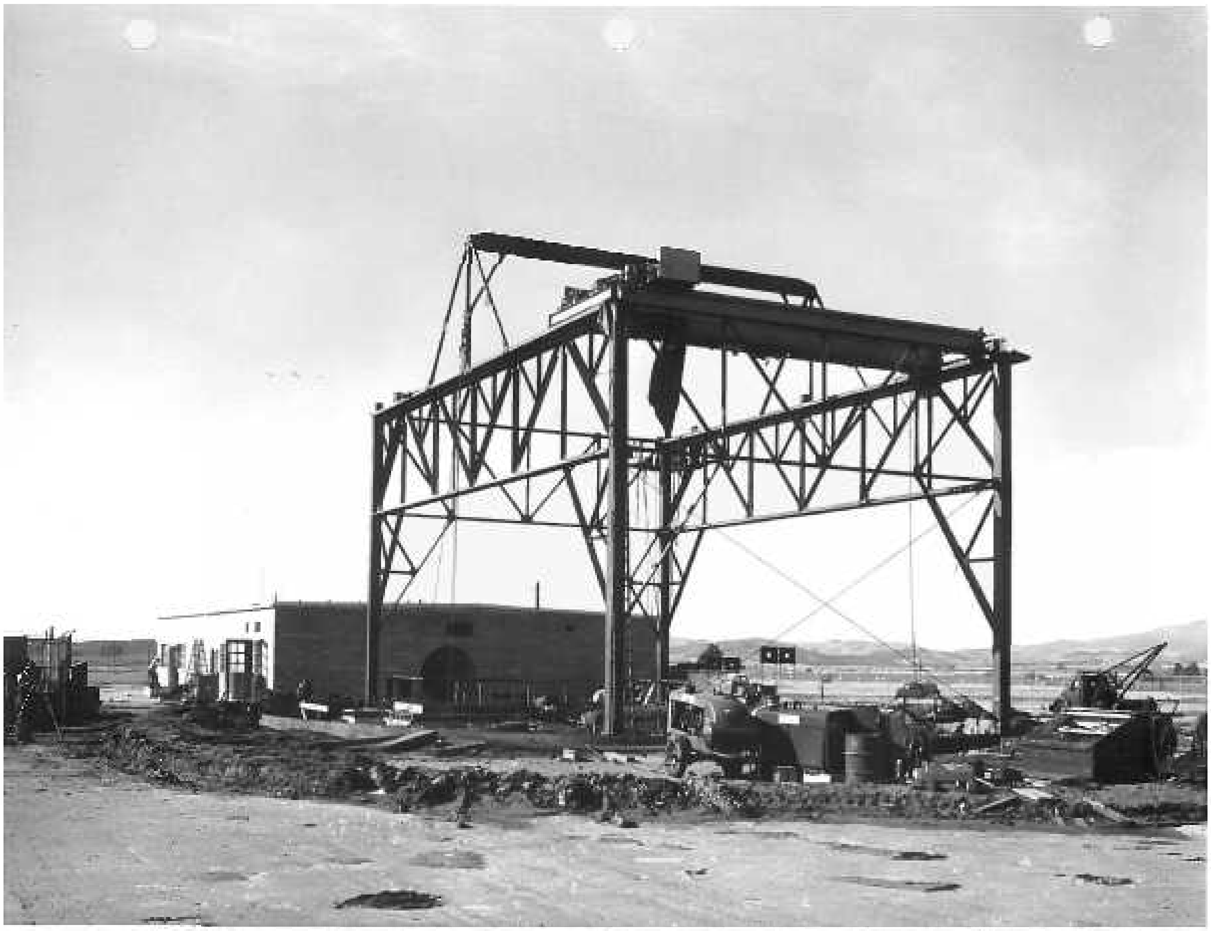


Figure 2. Construction of the 15-ton traveling crane, prior to the construction of Building 280, 1956. LLNL archives.

Figure 3. Construction of the reactor core, 1956. LLNL Archives.

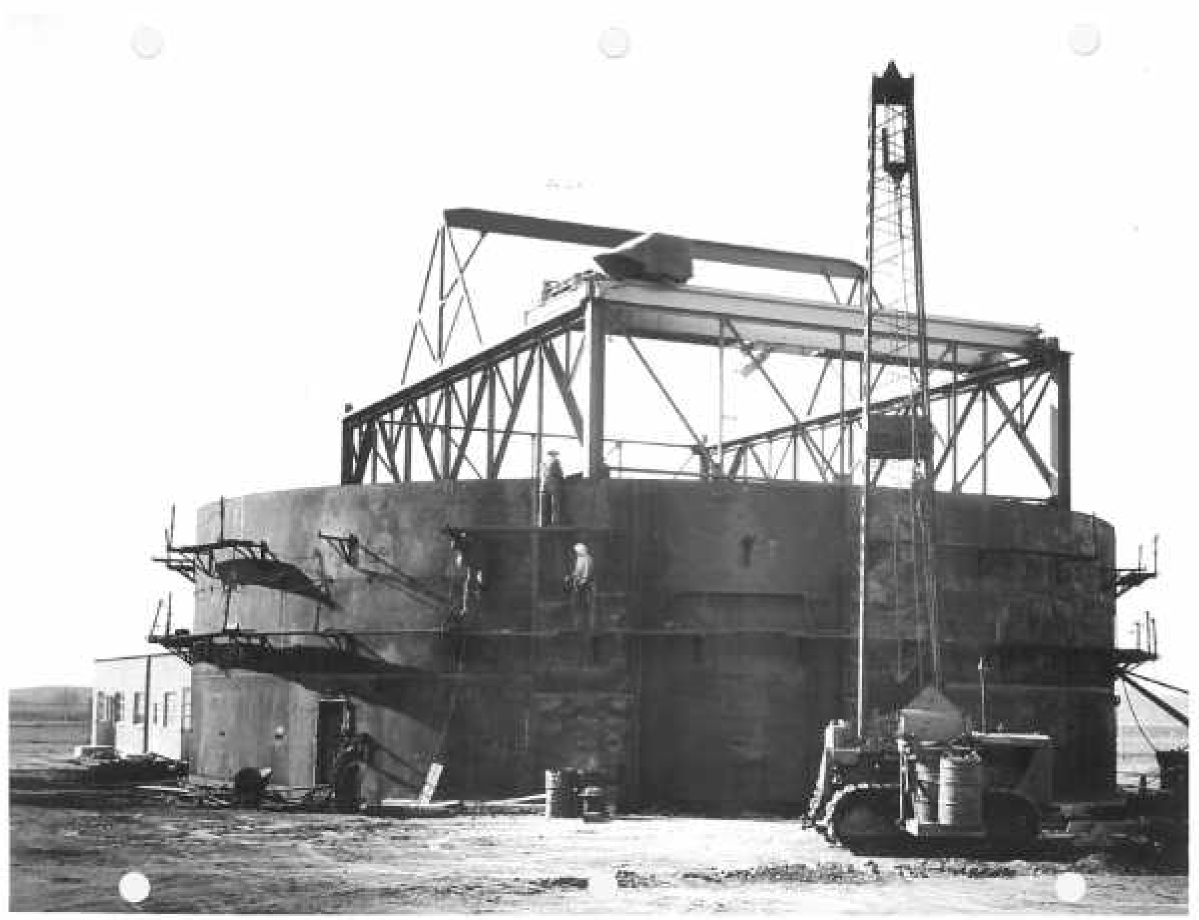


Figure 4. Construction of the steel plate wall structure around the 15-ton traveling crane, 1956. LLNL Archives.

Figure 5. Building 280 construction nearing completion. Note scaffolding and worker spraying on mastic material finish at the exterior, 1956. LLNL Archives.

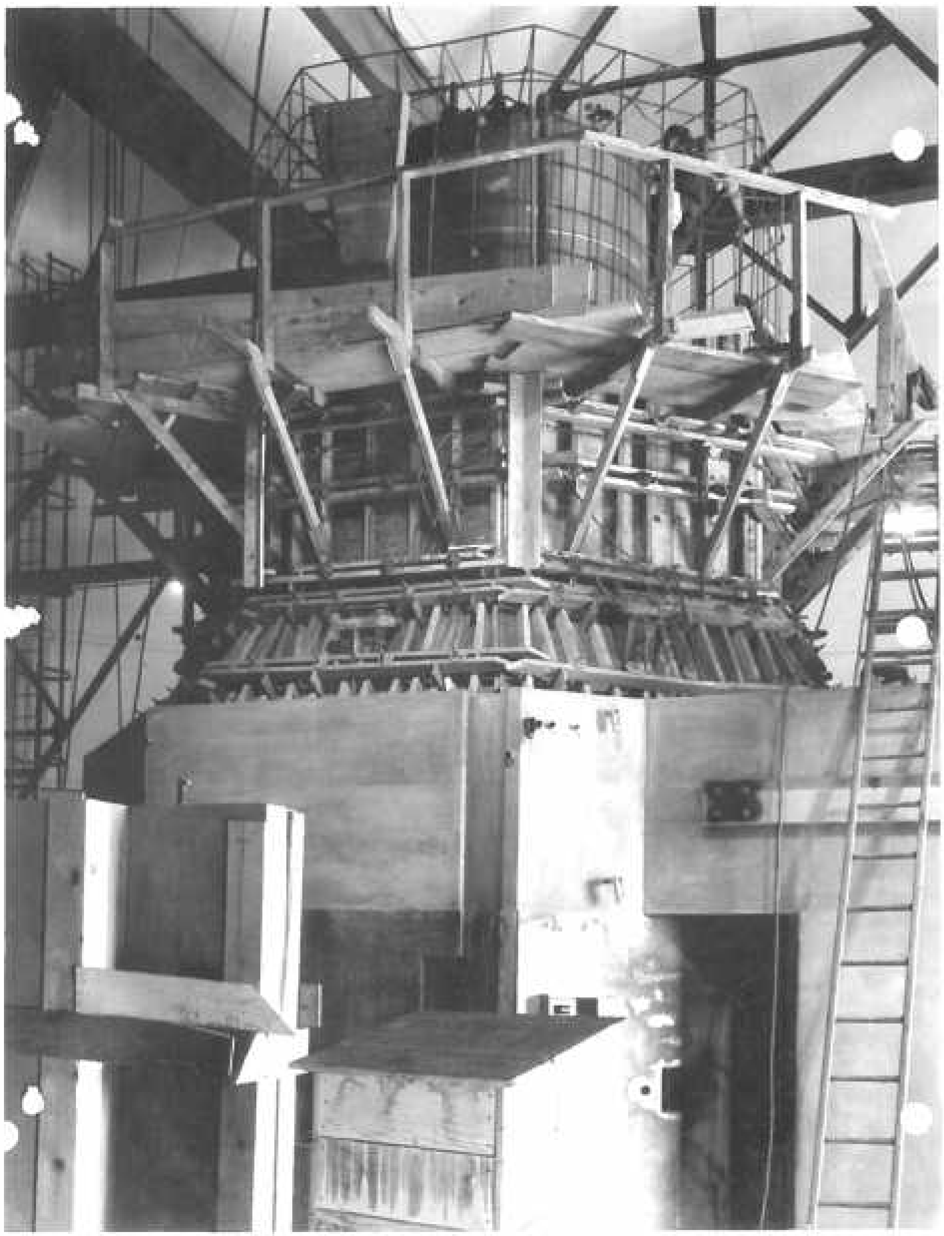


Figure 6. Reinforced, board-formed concrete construction of the LPTR core, 1956. LLNL Archives.

Figure 7. Inside Building 280 with the LPTR, shortly after construction, looking south, 1957.

Figure 8. Inside Building 280 with the LPTR, shortly after construction, looking east, 1957.

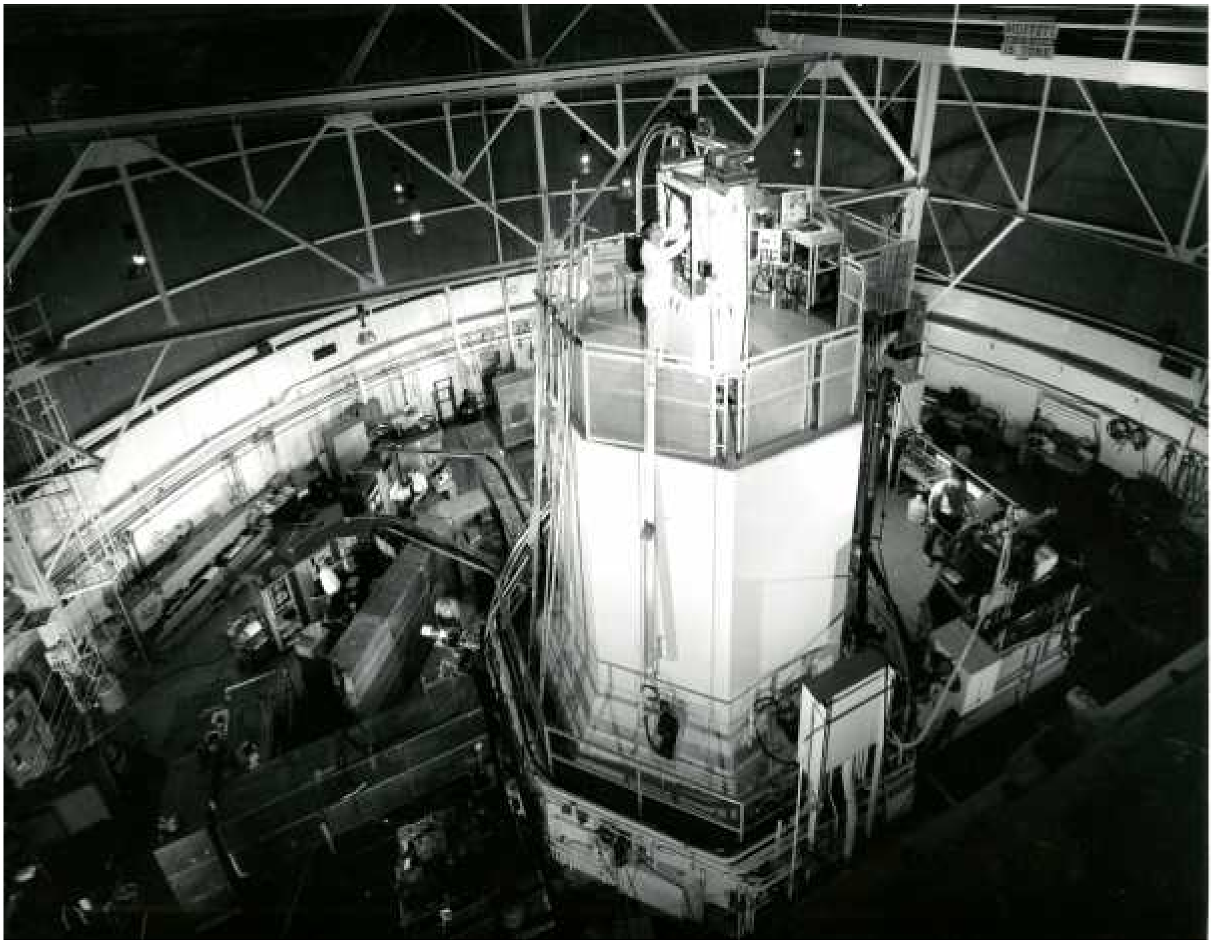


Figure 9. Inside Building 280 with the LPTR, with workspaces and support stations below, 1957. LLNL Archives.

Figure 10. Workspaces, support stations, and equipment leading from the LPTR, 1957. LLNL Archives.

Figure 11. Reactor control panel and reactor 1962. LLNL Archives.

Figure 12. Reactor Experimental Equipment, personnel airlock door leading to Building 281, 1963. LLNL Archives.

Figure 13. Inside the core of the LPTR operating at a power of 2MW, looking through 20 feet of water, 1963. LLNL Archives.

Figure 14. The LPTR facility, with Building 280 to the left and Building 281 to the right, 1964. LLNL Archives.

Figure 15. Escape air lock door at Building 280 at left, with connection to Building 281 at right, 1961. LLNL Archives.

HISTORIC AMERICAN ENGINEERING RECORD
INDEX TO PHOTOGRAPHS

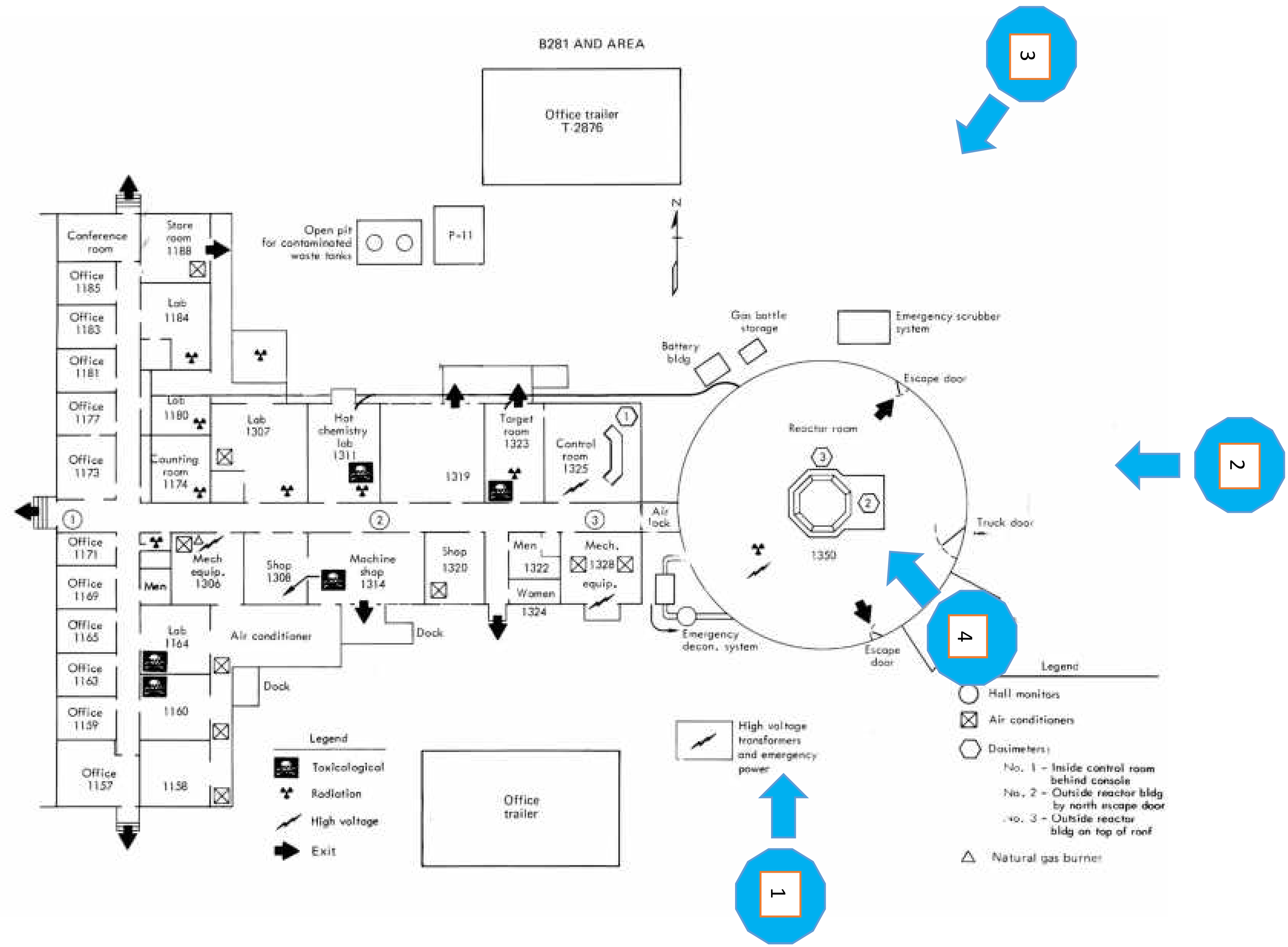
HAER No. CA-2928

LIVERMORE POOL-TYPE REACTOR
(Building 280)
LAWRENCE LIVERMORE NATIONAL LABORATORY
7000 East Avenue, Livermore, Alameda County, California

INDEX TO BLACK AND WHITE PHOTOGRAPHS

Randy Wong, Photographer, June 2018

LPR-001	Exterior South Elevation
LPR-002	Exterior East Elevation
LPR-003	Exterior Northeast Elevation
LPR-004	Interior Southeast Elevation



B281 AND AREA
Office trailer T-2876
3
2
4
1
N
Open pit for contaminated waste tanks
P-11
Conference room
Store room 1188
Office 1185
Lab 1184
Office 1183
Office 1181
Office 1177
Lab 1180
Lab 1307
Hot chemistry lab 1311
1319
Target room 1323
Control room 1325
Office 1173
Counting room 1174
Battery bldg
Gas bottle storage
Emergency scrubber system
Escape door
Reactor room
1350
Truck door
Air lock
Office 1171
Mech equip. 1306
Men
Shop 1308
Machine shop 1314
Shop 1320
Men
1322
Women
1324
Mech. 1328 equip.
Emergency decon. system
Escape door
Office 1169
Office 1165
Lab 1164
Air conditioner
Dock
Office 1163
Dock
1160
Office 1159
Office 1157
1158
Legend
Toxicological
Radiation
High voltage
Exit
Office trailer
High voltage transformers and emergency power
Legend
Hall monitors
Air conditioners
Dosimeters:
No. 1 - Inside control room behind console
No. 2 - Outside reactor bldg by north escape door
No. 3 - Outside reactor bldg on top of roof
Natural gas burner