U.S. NAVAL BASE, PEARL HARBOR, RADIOACTIVE WASTE DISPOSAL FACILITY BUILDING
(Facility 1274)
North of intersection of Ingersoll and Crommelin Avenues
Pearl Harbor
Honolulu County
Hawaii

HABS HI-566
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PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN BUILDINGS SURVEY
PACIFIC WEST REGIONAL OFFICE
National Park Service
U.S. Department of the Interior
333 Bush Street
San Francisco, CA 94104

**HISTORIC AMERICAN BUILDINGS SURVEY**

# U.S. NAVAL BASE, PEARL HARBOR,
# RADIOACTIVE WASTE DISPOSAL FACILITY BUILDING
# (Facility 1274)

**HABS No. HI-566**

**Location:** North of the intersection of Ingersoll and Crommelin Avenues
Pearl Harbor
Honolulu County, Hawaii

U.S.G.S. Pearl Harbor, HI quadrangle 1999
7.5 Minute Series (Topographic) (Scale – 1:24,000) NAD83 datum.
Universal Transverse Mercator Coordinates: 04.607510.2361480.

**Date of Construction**: 1963

**Designer**: Thomas C. H. Lum, P.E. Park Associates, Inc., Honolulu

**Builder**: Unknown

**Owner**: US Navy

**Present Use**: Vacant

**Significance:** Facility 1274 is significant for its role as an important support building for the refueling of nuclear reactors in *Skate*-class submarines including the USS *Sargo* (SSN 583) from 1963 to 1986 during the Cold War. It functioned to remove radioactive particles from the primary coolant water of these submarines while they were undergoing refueling or defueling at Pearl Harbor. It also performed the same function for *Los Angeles*-class nuclear submarines during the post-Cold War period from 1997-2009. Facility 1274 is also significant as a rare example of a Cold War property type, nuclear refueling support unit and radioactive waste disposal facility.

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**Date of Report**: March 2013

**DESCRIPTION:**

Facility 1274 is a single story concrete building with a ½ x 12-slope single pitch roof. It is constructed with a reinforced concrete frame and 8" high concrete block, and sits on a concrete slab foundation. The building has an L-shaped footprint with overall dimensions of 65'-4" x 57'-4". The main section of the building measures 57'-4" x 44'-4" with a 21'-0" x 25'-0" extension forming the base of the L off of the southeast side that contains the decontamination slab.

This extension is 20'-1" high with a flat roof and a low concrete parapet. The height of the extension extends about 5'-6" above the single pitch roof of the main section of the building. A 3'-0" wide concrete walkway surrounds all four sides of the extension at a level 3'-7" below the top of the roof parapet. This walkway is cantilevered out from the walls and has a railing of 1½" metal pipe. It is accessed from grade by a caged metal ladder at the east corner. The flat concrete roof slab of the extension has a 12'-0" x 12'-0" square opening that is covered by corrugated metal panels.

Windows in Facility 1274 are a combination of jalousie and fixed lights with 2'-4" x 2'-10" sashes. The windows are set in a single band about 8'-8" above grade. Some windows are sealed with plywood panels, some have window air conditioning units, and some have exhaust units. Entry doors to the building are single, hinged, flush metal; some doors have vision panels. Two large-scale doorways with flush-mounted double sliding metal doors on interior overhead tracks are found on the southwest side of the building. These doorways lead into the packaging area of the main section of the building and into the decontamination slab in the extension section. These doorways are each 9'-8" wide and about 10' high.

A thin, cantilevered concrete canopy, projecting about 3' from the exterior wall, extends around most of the building at about 10' above grade. This canopy, called an eyebrow on original drawings, is at the level of the top of the band of windows and at the top of the large scale doorways.

At its north corner, Facility 1274 is connected to the adjacent building, Facility 1409, by a short passage with concrete block walls. This passage, about 6' long, is only about 14' wide. Its northwest wall is flush with the northwest wall of Facility 1274. On the opposite side of the passage, a narrow corridor is formed between the two buildings (1274 & 1409) which provides access to the north exterior doorway leading from the packaging area of Facility 1274.

Most of the exterior of Facility 1274 appears to be original, but a large amount of electrical conduit, piping, and numerous fire protection panels have been added, especially on the northwest and southwest sides. On the northwest side a large metal enclosure labeled for fire protection has been added. This is about 7' wide and projects about 4' from the building. Near this enclosure an additional metal cabinet, about 3' wide has also been installed for fire protection. Also on the northwest side is a small plywood shed about 2' x 3'. This shed and the two fire protection cabinets are all about 8' high. Small, wall-mounted fire protection panels have been added at the west end of the southwest side. These panels are labeled to serve both buildings, 1274 and 1409. Added electrical conduit has been run along the northwest and southwest sides of the building, directly below and above the cantilevered (eyebrow) canopy.

Because of radiological controls on the building, the only interior area that could be accessed was the rad con office, storage area, and former locker room in the west portion of the main section of Facility 1274. Interior finishes in this area are vinyl composition floor tiles, painted smooth concrete walls, and the painted underside of the concrete roof slab, which has integral prestressed concrete beams on about 8' spacing. This area has an added fire sprinkler system. Ceiling height in this area is about 13' to the underside of the roof slab. The rad con office, in the west corner of this area, is partitioned off by a 1'-0" thick concrete wall that is about 8' high. This open-top partition leaves the 8'-0" x 11'-2" rad con office open to the underside of the roof slab. At east portion of the wall between the storage area and the former locker room are large fixed light windows. A small built in counter has been added in front of the fixed light windows. The partitioned area labeled "office" on original drawings is no longer extant, the walls enclosing it have been removed or were never constructed. The storage area is open and occupies the space between the rad con office and the locker room.

Although the packaging area and the decontamination slab area were not directly accessed, their exterior doors were opened to allow inspection from the doorway, without entering the rooms. Both areas have painted concrete floor, painted smooth finish walls, painted concrete underside of the roof slab, and added fire sprinkler system. The underside of the roof slab in the packaging area has the typical integral beams, the underside of the roof slab in the decontamination slab area is flat. At the east corner of the packaging area, the room labeled "hot storage" on original drawings is no longer extant. A short section of concrete curb, about 4" high, extends about 8' from the north wall in the area that corresponds to the former location of the wall of the hot storage room.

**HISTORIC CONTEXT:**

During the period from 1963 – 2008, Facility 1274 was the site where used primary coolant water from U.S. Navy nuclear submarines was processed to clean it of its radioactive contaminants while the submarines were undergoing refueling or defueling at Pearl Harbor. Over this period, the facility is known to have processed the coolant water from 2 types of nuclear reactors, the early S3W reactor and the later S6G reactor. The S3W reactor was used in *Skate*–class (4 vessels built) and *Halibut*-class (1 vessel built) submarines, and the S6G reactor was used in *Los Angeles*–class (62 vessels built) submarines. The *Skate*-class submarines were the first production nuclear submarines in the US Navy.[1] The S3W reactor was also known as the Submarine Fleet Reactor (SFR).[2]

<u>Pressurized water reactor operation in a nuclear submarine.</u>

The 2 types of reactors mentioned above, S3W and S6G, are pressurized water reactors (PWR) which circulate high-pressure water over the reactor core to moderate the nuclear reaction and to absorb the heat produced by the reactor and transfer it to a system that generates steam to drive a turbine which propels the vessel. In nuclear reactors, the water that comes in close proximity or flows over the core, called primary coolant, becomes radioactive. Pressurized water-type reactors are the most widely used type for submarines. In PWRs the primary coolant is pumped over the core at very high pressure, to keep the water from boiling into steam. A key factor of pressurized water reactors is that the primary coolant is contained within the reactor compartment in a system that is shielded from the crew and is kept separate from the water/ steam (secondary) system that passes over the turbine. A heat exchanger within the steam generator circulates the primary coolant in pipes that are isolated from the piping of the secondary system. The heat is transferred, but the water of the two systems does not mix. The steam of the secondary system is piped from the steam generator to the turbine,

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[1] David Miller, *An Illustrated Guide to Modern Submarines*, (New York: Prentice Hall Press). 1987. 73.
[2] Norman Friedman, *US Submarines Since 1945, An Illustrated Design History*. (Annapolis: US Naval Institute Press) 1994. 125-128.

which drives the vessel's propeller. This steam is then condensed into water and piped back to the steam generator to repeat the cycle.[3]

Nuclear reactors in submarines typically operate with a core of $U^{235}$ highly enriched uranium (HEU) fuel that has an enrichment level of at least 93 percent.[4] This is in contrast with typical land-based reactors used to generate electrical power that use fuel enriched to 3-5 percent.[5] HEU fuel for submarine reactors was chosen because its greater energy potential allowed the design of a compact reactor system that would produce more power. In addition, a naval reactor designed around HEU fuel carries enough built in reactivity in the fuel for a long period between refueling. Land-based reactors do not have the size restrictions that are imposed on submarines. They are equipped with extra components to allow refueling and they are typically refueled every 18 months with 3-5 percent enriched uranium fuel, a process that takes place with a minimal interruption in service. The refueling of land based reactors is often accomplished by sliding new fuel rods into the core, which push the used rods out.

The refueling of a nuclear submarine is much more complicated and expensive than a land based system; the reactor must be completely shut down. The operational costs of a nuclear submarine between refuelings are relatively low compared to the cost of the actual refueling process, so any design that reduces the number of refuelings over the lifetime of the vessel will lower the cost of owning it. It is generally more economical to supply a submarine with a more expensive reactor core that requires infrequent refueling. The lifetime of a nuclear core is measured in equivalent, full-power hours of the submarine's operation. Submarines will usually accrue over 1,000 full-power equivalent hours per year.[6]

Refueling of *Skate*-class submarines at Pearl Harbor.

The first nuclear submarine refueling undertaken at Pearl Harbor was accomplished in 1962-63 on a *Skate*-class submarine, the USS *Sargo,* SSN 583. *Skate*-class submarines were fitted with a reactor designated as S3W which was rated with a service life between refuelings of 2,500 hours (full-power equivalent). The *Sargo* was commissioned in October 1958, so at the time it entered Pearl Harbor shipyard for refueling on July 28, 1962 it had been in service for 3 years and 9 months on its original reactor core. On the date that *Sargo* entered the shipyard, Facility 1274 was under construction. Construction drawings were submitted to the Navy by architects Park Associates, Inc. on June 12, 1962 and were approved by the Navy on July 9, 1962. The refueling lasted until March 1963 when the *Sargo* was returned to service. Construction drawings for Facility 1274 were certified as "Record Drawing, as built" on April 17, 1963, indicating that the building was complete. Facility 1274 was under construction at the time of the *Sargo's* first refueling at Pearl Harbor, and it is not known if the facility was used to process the coolant water from that refueling. When the coolant water was drained from the submarine's primary cooling system it would have been pumped into a portable tank, either for processing at another location at Pearl Harbor, transportation to a processing facility on the mainland, or to await processing at Facility 1274 when the building was completed.

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[3] Magdi Ragheb, "Nuclear Naval Propulsion," from website intechweb.org/pdfs/19667 accessed January 17, 2013. And "A Brief History, From Squash Court to Submarine," The Economist, March 10, 2012. And Federation Of American Scientists, "Nuclear Propulsion," from website fas.org/man/dod-101/sys/ship/eng/reactor accessed January 17, 2013.
[4] Carey Sublette, "Nuclear Weapons Frequently Asked Questions," from website nuclearweaponarchive.org/Nwfaq/Nfaq6, accessed April 10, 2014. February 1999.
[5] Ragheb, "Nuclear Naval Propulsion," 2011. 1.
[6] Friedman, *US Submarines Since 1945*, 1994. 126.

After the *Sargo* was returned to service in March 1963 following its first refueling at Pearl Harbor, it operated for 3 years and 1 month on the second reactor core until its next refueling, which began in April 1966. This second refueling of the *Sargo* was also done at Pearl Harbor and would have involved Facility 1274 in the processing of the primary coolant. The *Sargo* was in Pearl Harbor for two years during this second refueling process, and returned to service in April 1968. The *Sargo* operated for 5 years and 5 months on its third reactor core and entered Pearl Harbor in September 1973 for another refueling. *Sargo* returned to service in April 1975 and operated for 5 years and 2 months on its fourth reactor core, returning to Pearl Harbor for refueling in June, 1980. *Sargo*'s fifth reactor core was installed and the submarine was returned to service in March 1983. The submarine operated for 3 years and 7 months on its fifth reactor core before returning to Pearl Harbor in October 1986, when it was placed on inactive status in preparation for decommissioning, which occurred at Pearl Harbor in February 1988. Decommissioning involved defueling of the *Sargo*'s reactor, during this procedure the primary coolant from the submarine's reactor would have been processed in Facility 1274, just as with all previous refuelings mentioned above.

Table 1. USS Sargo (SSN 583), schedule of refueling and defueling at Pearl Harbor.

| | Dates of refueling/ defueling at Pearl Harbor | Core | Age of reactor core |
|---|---|---|---|
| *Sargo* commissioned Oct '58 | | | |
| | | 1 | 3years 9 months |
| | July '62 – Mar '63 | | |
| | | 2 | 3 years 1 month |
| | April '66 – April '68 | | |
| | | 3 | 5 years 5 months |
| | Sept '73 – April '75 | | |
| | | 4 | 5 years 2 months |
| | June '80 – Mar '83 | | |
| | | 5 | 3 years 7 months |
| | Oct '86 inactivated(defueled) | | |
| *Sargo* decommission Feb '88 | | | |

Besides the *Sargo*, there were 3 other *Skate*-class submarines; USS *Skate* (SSN 578), USS *Swordfish* (SSN 579), and USS *Seadragon* (SSN 583). These 3 submarines as well as the USS *Halibut* (SSGN 587) were equipped with S3W reactors. None of these are known to have undergone refueling or defueling at Pearl Harbor.

Submarine nuclear reactor design advanced after the S3W reactor of the *Skate*-class vessels. By the late 1950s, new submarines coming off the ways were fitted with what would become the standard U.S. nuclear submarine reactor for the next 10 years, the S5W.[7] In accordance with increasing the economy of nuclear submarine operation, the S5W was initially credited with 5,500 hours of service life between refuelings. This service life of the core was quickly increased to 10,000 hours, which could mean up to 8 years of operation.[8] These S5W reactors were installed in 97 submarines including:

*Skipjack*-class, 5 vessels.

*Permit/Thresher*-class, 13 vessels.

*George Washington*-class, 5 vessels.

*Ethan Allen*-class, 5 vessels.

*Lafayette*-class, 31 vessels.

*Sturgeon*–class, 37 vessels.

*Glenard P. Lipscomb*-class, 1 vessel (built in 1971).

Some of these submarines remained in commission until the 1990s. Submarine nuclear reactors could frequently have their reactor core specifications changed without carrying a new reactor designation. This means that throughout construction history of a certain class of submarines, as well as during subsequent refuelings, it could have a longer-life core installed in its reactor. No record was found of any submarines with S5W reactors being refueled or defueled at Pearl Harbor. As submarine design advanced and reactor core specifications improved, the various reactors in different vessels typically came to be rated with a lifetime of about 24 years with 2 refuelings. Further improvements in hull design resulted in an even longer projected lifetime for the vessel that would require longer-life cores to be fully taken advantage of.

<u>Refueling of *Los Angeles*-class submarines at Pearl Harbor.</u>

*Los Angles*-class submarines, first commissioned in 1976, were fitted with a reactor designated as S6G which would only have 1 refueling in the course of the lifetime of the submarine.[9] There were 62 submarines of this class commissioned. This large number of relatively expensive vessels was partly a result of the long period between refueling, which allowed for a lower overall cost of ownership to the government.

One *Los Angeles*-class submarine with an S6G reactor that underwent a refueling at Pearl Harbor was the USS *Bremerton* SSN 698. This submarine was launched in 1978 and it entered the Pearl Harbor shipyard for refueling in late 2003, with a reactor core age of 25 years. After its refueling, the *Bremerton* re-entered service in March 2007. Although the *Bremerton* and two

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[7] The 3 digit designation of US Naval reactors consists of: First digit = reactor application, S for submarine. Second digit = number of reactors designed for that application by the manufacturer. Third digit = manufacturer W-Westinghouse, G-General Electric, C-Combustion Engineering.

[8] Friedman, *US Submarines Since 1945*, 1994. 126.

[9] Friedman, *US Submarines Since 1945*, 1994. 126.

other *Los Angeles*-class submarines were refueled or defueled at Pearl Harbor with reactor core ages of 25 years, a number of other submarines of this class were decommissioned (defueled) or refueled there with core ages of only 19-21 years. This was the result of the submarines long service life between refueling in combination with the timing of the expensive refueling occurring at a time of cuts in the navy's budget. "When dramatic cost cuts were needed, submarines had to be laid up or discarded instead of being refueled. That is why many relatively modern units were retired from 1989 on: retaining them in service would have entailed the major expense of refueling."[10]

Table 2. Los Angeles – class submarines known to have undergone refueling or defueling at Pearl Harbor.

| Vessel | Refueling/ defueling at Pearl Harbor | Year of refuel/ defuel | Vessel launched | Age of reactor core |
|---|---|---|---|---|
| USS *Birmingham* SSN 695 | Defuel | 1997 | 1977 | 20 yrs |
| USS *Indianapolis* SSN 697 | Defuel | 1998 | 1977 | 21 yrs |
| USS *Boston* SSN 703 | Defuel | 1999 | 1980 | 19 yrs |
| USS *Buffalo* SSN 715 | Refuel | 2001 | 1982 | 19 yrs |
| USS *Bremerton* SSN 698 | Refuel | 2003 | 1978 | 25 yrs |
| USS *Minneapolis St. Paul* SSN 708 | Defuel | 2008 | 1983 | 25 yrs |
| USS *Olympia* SSN 717 | Refuel | 2008 | 1983 | 25 yrs |

Reactor coolant water purification in Facility 1274.

During a refueling or defueling of the nuclear reactor of a submarine, the normally sealed reactor compartment must be opened to access the spent fuel in the reactor core for removal. This sealed reactor compartment includes the primary cooling system surrounding the core that has to have the coolant drained away before the fuel can be reached. In *Skate*-class and *Los Angeles*-class submarines, this primary coolant is water. During operation of the reactor, as this coolant water circulates, it picks up particles of corrosion from the interior of the piping (activated corrosion products) and particles of metal and other materials that have worn off the moving parts, such as pump impellers and seals. These particles are irradiated as the coolant water passes them over the reactor core, and it is these radioactive particles (primarily metals) that are the principle sources of radioactivity in the used coolant.

[10] Friedman, *US Submarines Since 1945*, 1994. 127.

The radioactive metal particles in the water primary coolant (cobalt, tungsten, chromium, iron, nickel and others) typically have half-lives of many years and remain dangerous for a long period. Because of the presence of these radioactive particles, the coolant must be handled with care. During a refueling or defueling, the coolant water is collected and passed through a processing system to remove the radioactive particles and render it safe. After processing, the clean coolant water is typically reused in the reactor cooling system, or it can be evaporated or discarded. Facility 1274 was fitted with equipment such as tanks, piping, pumps, and filters that functioned to process the coolant water from the reactor to remove radioactive particles.

The processing of the reactor coolant water began at the submarine when the sealed reactor compartment is prepared to be opened. All coolant water was drained into portable stainless steel tanks. These tanks were transported to Facility 1274, placed on the concrete pad outside the east end of the building and connected to piping that pumped the coolant into the processing equipment inside. The coolant, then called "raw waste" was pumped into a cylindrical 4,300 gallon raw waste tank, located in the area at the east corner of the building that is labeled as "Hot Storage" on the original 1962 building plans. A second raw waste tank of 1,800 gallons was located west of the larger raw waste tank, in the area labeled "Packaging Area." This smaller raw waste tank was connected by piping to the larger raw waste tank and to the pump that supplied them both.

From the raw waste tanks, the coolant passed through a 3-10 micron filter that was lead-shielded. This presumably functioned as the first step in removing radioactive particles from the coolant. From this filter, the coolant was piped into a 1,800 gallon chemical process tank, which was fitted with a hopper to allow dry chemicals to be added to the tank. This tank was also located in the Hot Storage area. After being dosed with dry chemicals in the chemical process tank, the coolant, then referred to as "concentrated waste" was run through a bag filter in the Hot Storage area and a series of 4 demineralizers that were located in the Packaging Area. The typical demineralizers used in the processing of radioactive coolant water are; carbon bed, ion exchange resins, and colloidal resin. Leaving the demineralizers, the coolant was called "clean effluent" and it was run through another filter and stored in a 4,300 gallon clean holding tank in the Packaging Area. From the clean holding tank, the clean effluent water could be routed back to the previous tanks to flush the system, it could be drawn off from a drain connection to fill portable tanks for re-use as coolant in a reactor, or it could receive a final 3-10 micron filtration and be discharged into Pearl Harbor.[11] Until 1973, this clean effluent was discharged into the harbor. Since then, the water has been re-used in nuclear power plants.[12]

In 1972 a steam-heated evaporation system was installed in the 2 story section of the building. This system included a "Rototherm E" evaporator condenser and a 7'-6" diameter, 7'-8" high evaporator feed tank.[13] Drawings indicate this evaporator condenser system was installed to remove some of the water from the raw waste before in was run through the filtration and demineralizing processing.

[11] NAVFAC Plan files dwg 011833 dated December 8, 1971. And dwg 1325623 dated May 12, 1972.
[12] Nadine W. Scott, "Pearl Harbor Problem with Radioactive Waste." *Honolulu Star Bulletin*, April 4, 1979. P. A18.
[13] NAVFAC Plan files dwgs 7001491, 7001495, 7001499 dated April 20, 1972.

## Sources

A. Architectural Drawings:

Historic drawings are available as electronic scans only, at the NAVFAC Pacific Plan File data base at Building 258, Makalapa, Pearl Harbor. Scans can be viewed and printed on 11" x 17" paper only. These drawings were produced by a Federal agency and are considered in the public domain.

Original drawings July 9, 1962, numbered 974974 -974989.

Plumbing drawings October 21, 1971 and December 8, 1971, numbered 011822 – 011848.

Evaporator, piping, mechanical drawings April 10 & 20, 1972 numbered 7001491 – 7001499, 7001666 – 7001668 and May 12, 1972, numbered 1325619 – 1325627.

B. Early Views:

No early views of Facility 1274 were located for this report.

C. Bibliography:

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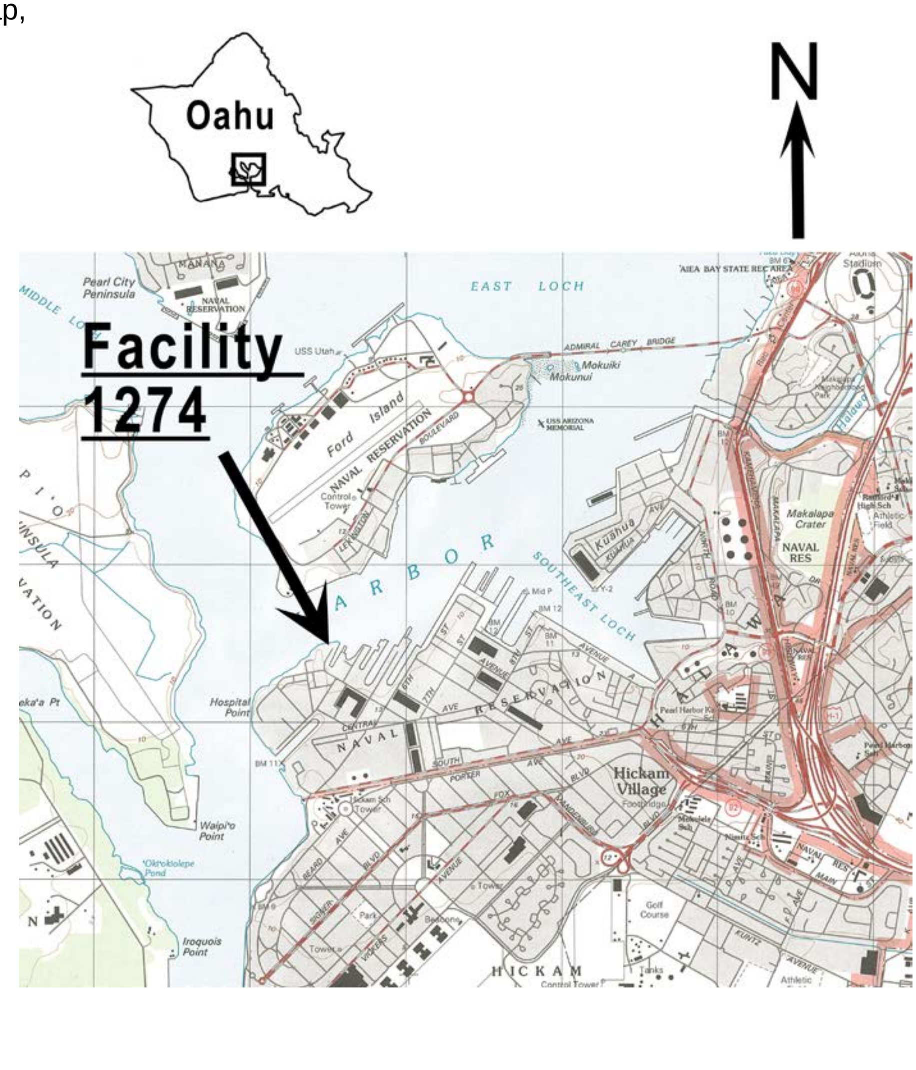
**PROJECT INFORMATION**

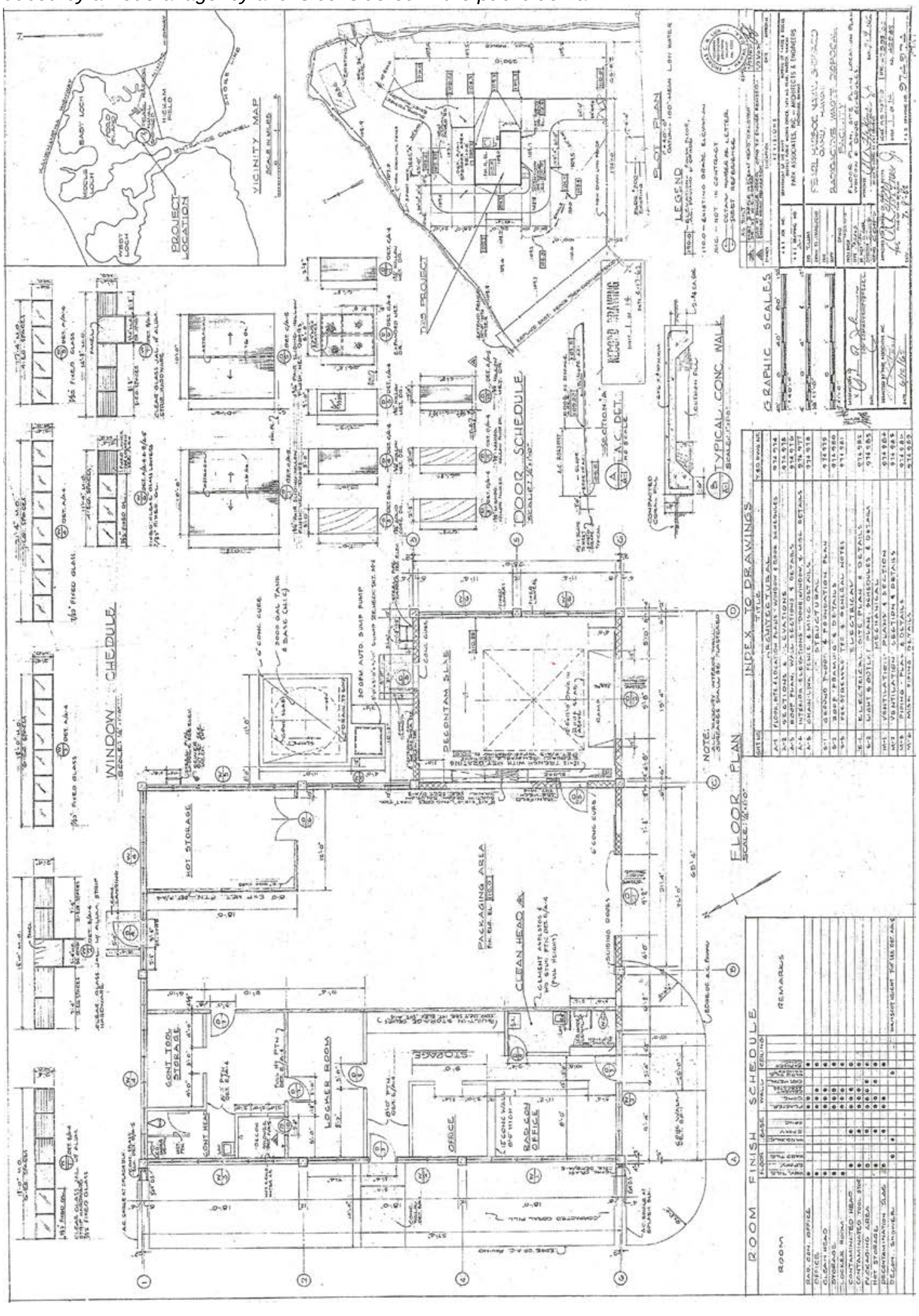
This report is produced in advance of the demolition of Facility 1274. A memorandum of agreement, dated August 2010, among Commander Navy Region Hawaii and the Hawaii State Historic Preservation Officer stipulated the HABS recordation of Facility 1274 prior to its demolition for the construction of a Submarine Production Support Facility for the Pearl Harbor Naval Shipyard under Project MCON P-320.

Archival photographs were taken in January 2014 by David Franzen, Franzen Photography, Kailua, HI. The field work and research was conducted in January 2013, and the initial report was prepared in January, 2013.

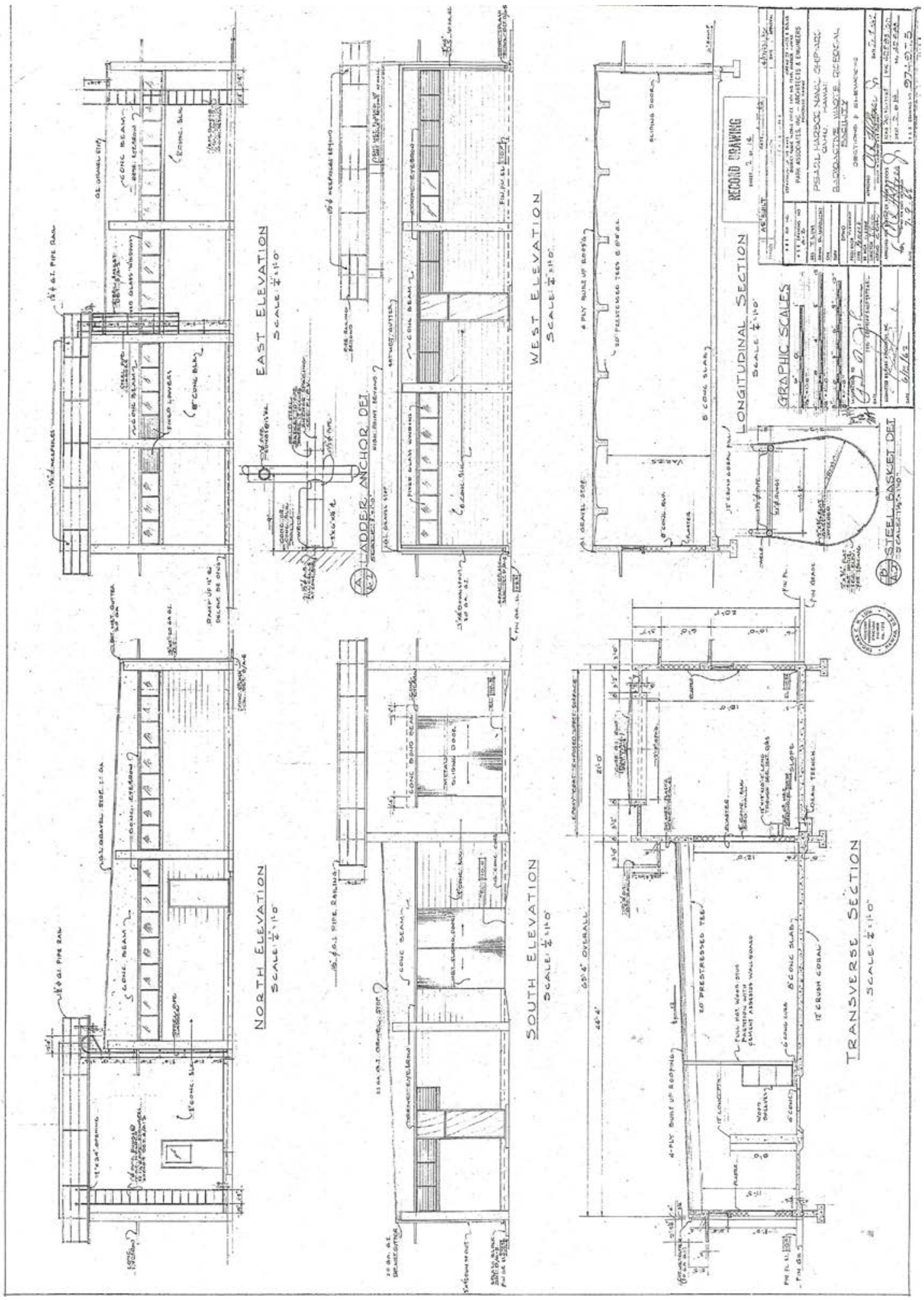
Location map,



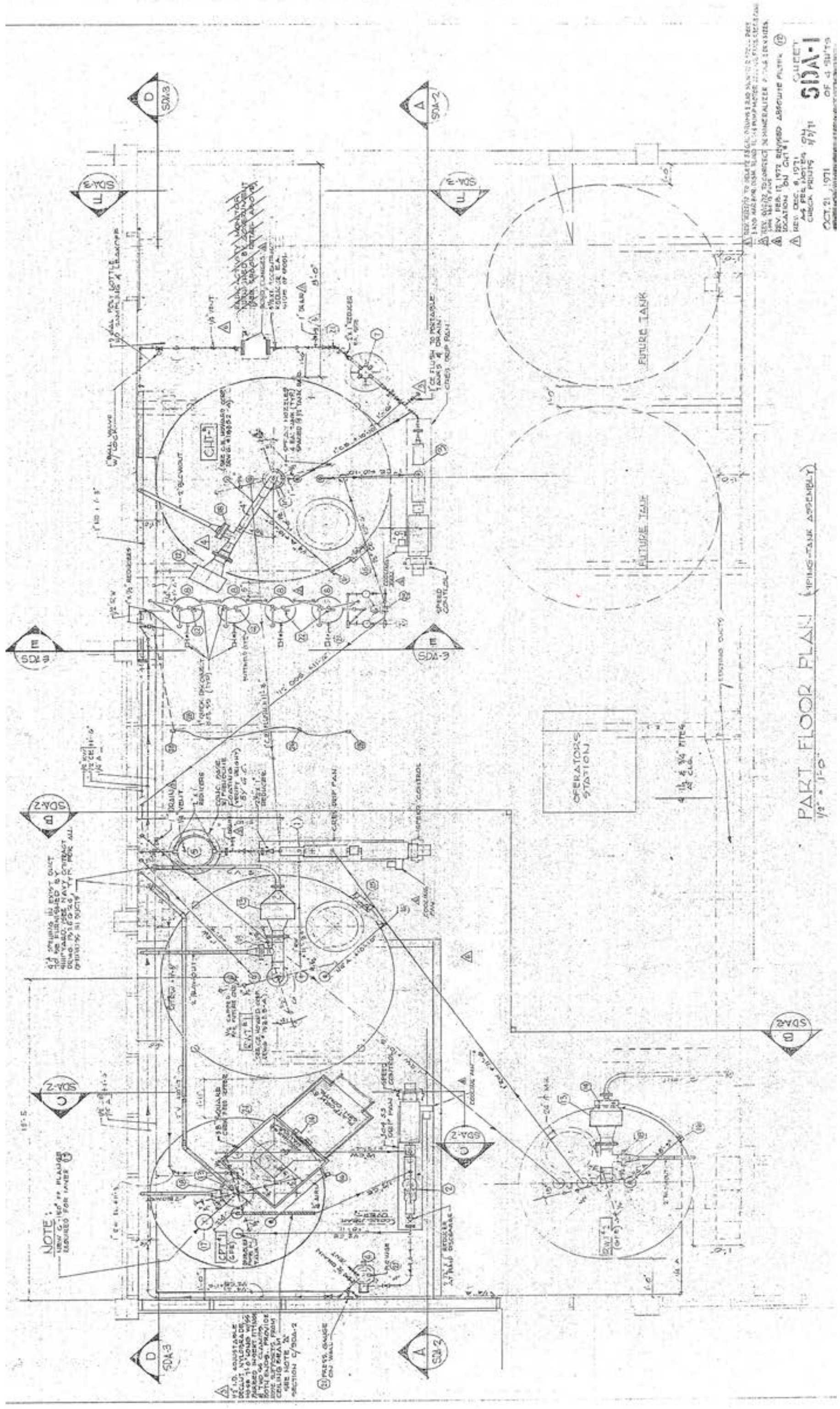
Drawing 974974 dated (approved) July 9, 1962 showing the floor plan and plot plan of Facility 1274, Radioactive Waste Disposal Facility. NAVFAC Pacific Plan File data base. *This drawing was produced by a Federal agency and is considered in the public domain.*



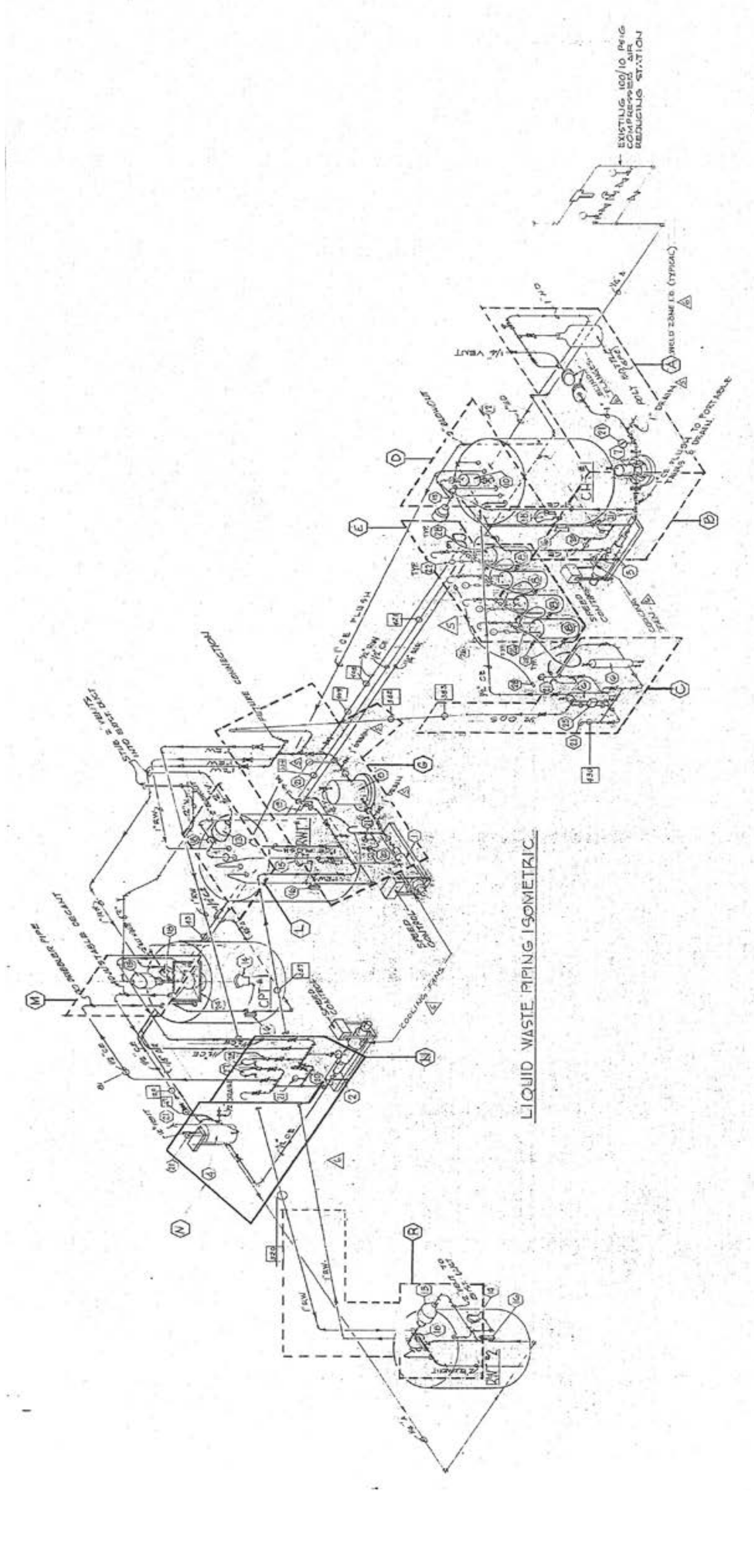
Drawing 974975 dated (approved) July 9, 1962 showing exterior elevations and sections of Facility 1274, Radioactive Waste Disposal Facility. NAVFAC Pacific Plan File data base. *This drawing was produced by a Federal agency and is considered in the public domain.*



Portion of drawing 011822 dated October 21, 1971 showing the layout of piping and tanks in Facility 1274, Radioactive Waste Disposal Facility. NAVFAC Pacific Plan File data base. *This drawing was produced by a Federal agency and is considered in the public domain.*



Portion of drawing 011833 dated December 8, 1971 showing a schematic diagram of the piping and tanks in Facility 1274, Radioactive Waste Disposal Facility. NAVFAC Pacific Plan File data base. *This drawing was produced by a Federal agency and is considered in the public domain.*



Drawing 7001495 dated April 20, 1972 showing the piping plan for the evaporator in Facility 1274, Radioactive Waste Disposal Facility. NAVFAC Pacific Plan File data base. *This drawing was produced by a Federal agency and is considered in the public domain.*