SCHOFIELD BARRACKS MILITARY RESERVATION, ORDINANCE STOREHOUSES
South of the Intersection of Kolekole Avenue and Cadet Sheradin Road
Wahiawa vicinity
Honolulu County
Hawaii

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

FIELD RECORDS

HISTORIC AMERICAN BUILDINGS SURVEY
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HISTORIC AMERICAN BUILDINGS SURVEY

SCHOFIELD BARRACKS MILITARY RESERVATION,
ORDNANCE STOREHOUSES

Location: Wahiawa vicinity
City and County of Honolulu, Hawaii
South of intersection of Kolekole Avenue and Cadet Sheridan Road

Present Owner: United States Army
Present Occupant: United States Army
Present Use: Various uses, see each individual building report.

Significance: These buildings are significant under National Register Criterion A for their association with the early development of Schofield Barracks in the post-World War I era. Directly following World War I, the United States Army had large amounts of surplus ordnance in Army stocks that were leftover from the war. These buildings are part of a group of nine that were built ca. 1922 to serve as an ordnance storehouse area for the post, containing ammunition for the field guns and howitzers used by the artillery units at Schofield. These buildings are also significant under Criterion C as examples of an early ordnance storage facility: the above ground ordnance storehouse. This design was used across the United States for the storage of ordnance until the well-known 1926 Lake Denmark Naval Ammunition Depot explosion. This catastrophic event spurred the development of new safety guidelines and design parameters, and rendered the above ground ordnance storehouse design obsolete. (Since then, the preferred design is an earth covered igloo which is more resistant to accidental detonation.)

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Date: April 2010
PART I. DESCRIPTION
For descriptions of each of the warehouses covered by this overview report, see each building's dedicated HABS report:

Building 2101    HABS HI-544-A
Building 2102    HABS HI-544-B
Building 2104    HABS HI-544-C
Building 2105    HABS HI-544-D
Building 2106    HABS HI-544-E
Building 2107    HABS HI-544-F
Building 2108    HABS HI-544-G
Building 2109    HABS HI-544-H

The warehouse area is generally level and grassy, with paved roadways and parking areas. Numerous large trees provide shade in the open terrain between the buildings. A notable tree is located about 50' southwest of Building 2105. This is a specimen of *capparis mollicella* about 15' tall with a spread of about 15' and a trunk diameter of about 10" to 12". This tree is listed on the City and County of Honolulu, Register of Exceptional Trees. In Schofield Barracks' property records this tree is cataloged as Schofield Barracks Tree Inventory number 4331. No identification tag was observed in this tree during the field work.

The remaining large trees in the area between and surrounding the warehouses enhance the park-like setting of the warehouse compound. These large trees date from the 1930s to the mid-20th century. There were no large trees in this area during the period when the railroad serviced the warehouses.

PART II. HISTORICAL CONTEXT
This report provides overview information for the entire group of eight 1922 ordnance storehouses at Schofield Barracks, Buildings 2101, 2102, 2104, 2105, 2106, 2107, 2108, & 2109.

For information and photos of the individual storehouses see each building's dedicated HABS report:

Building 2101    HABS HI-544-A
Building 2102    HABS HI-544-B
Building 2104    HABS HI-544-C
Building 2105    HABS HI-544-D
Building 2106    HABS HI-544-E
Building 2107    HABS HI-544-F
Building 2108    HABS HI-544-G
Building 2109    HABS HI-544-H

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2 Ibid., 46.
Schofield Barracks in the 1920s and 1930s

The construction of the nine original ordnance storehouses coincided with the expansion of troops at Schofield Barracks during the years following World War I. During the war, the post was emptied of soldiers and the deserted post's upkeep was undertaken by men from the Hawaiian National Guard and later, in 1919, by a cavalry unit. In 1921 Schofield Barracks became home to the 21st Infantry Brigade, consisting of the 19th and 21st Infantry Regiments, and the 11th Field Artillery which included the 8th, 11th, 13th Field Artilleries and the 11th Ammunition Train. This complement, along with engineers, a medical regiment, and staff personnel became the Hawaiian Division. Schofield Barracks eventually became the Army's largest single garrison by the mid 1930s with a motorized regiment of 155mm howitzers.

By the 1950s these storehouses were no longer used for ordnance. Several of the storehouses were converted to .22 caliber rifle and pistol ranges during the 1950s. Later modifications included converting some buildings to offices, others for training and to be used for the post's musical band. Building 2103 was demolished sometime between 1955 and 1971.

Ordnance Storehouses at Schofield Barracks

The group of nine ordnance storehouse buildings at Schofield Barracks was built ca. 1922. These buildings, which would come to be numbered Building 2101 through Building 2109 (Building 2103 is no longer extant), were constructed from standardized plans for ordnance storage buildings that were issued by the Quartermaster General prior to 1926. These standardized designs featured a 51'-4" wide single story building of varying length up to about 218' with concrete frame and structural clay (terra cotta) tile construction, vented gable roof, and typically utilizing above-grade concrete slab floors with loading platforms along the long sides of the building that were at railroad car floor level. Another term for an ordnance storehouse of this type is a magazine. The ordnance storehouses originally contained "ammunition for the field guns and the howitzers" used by the artillery units at Schofield. In the early 1920s this would have been 75mm and 155mm ammunition for the artillery guns at Schofield Barracks. The group of storehouses was known as the "ammunition dump" at the time of construction and was exclusively "for the storage of explosives." Although the ordnance storehouses were completed in 1922, additional money was needed to complete the area so that the explosive material stored there was secure and could be easily issued when it was needed. Roads, fencing and other protection for the structures, as well as facilities for personnel were the items

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4 Alvarez, Schofield Barracks, 46.
5 Alvarez, Schofield Barracks, 51.
6 Alvarez, Schofield Barracks, 53.
12 National Archives and Records Administration (NARA), photograph HHD 372 in box RG-165-HDD, March 27, 1922.
required to complete the ordnance area. These were requested to be funded in the 1923 budget.\textsuperscript{13}

Some of the more common artillery weapons deployed at Schofield Barracks during the 1920s and 1930s were:

- 75mm gun M1916
- 75mm gun M1917
- 155mm gun M1918M1
- 155mm howitzer M1917

Ammunition for these weapons would have been stored in the ordnance storehouses.

The 75mm ammunition was manufactured as fixed rounds. This means that the metal case containing the propellant charge is attached to the projectile. This complete round of ammunition was loaded into the weapon and fired. The rounds of 75mm ammunition for these guns were each about 3" to 4" in diameter and about 20" to 24" in length. Commonly used rounds had either shrapnel or high explosive projectiles. Shrapnel rounds were issued with the projectiles filled and fused. High explosive rounds were issued with the projectiles unfused; they would have been fused at Schofield Barracks or in the field. The complete shrapnel round weighed about sixteen pounds and the high explosive round weighed twelve pounds four ounces.\textsuperscript{14}

The 155mm ammunition stored in the warehouses was manufactured as separate ammunition. This means that the projectile and the propellant charge were issued as separate components. When loading the weapon the projectile was inserted into the breech followed by the separate propellant charge. The projectile for the 155mm weapon weighs about ninety five pounds. The propellant charge for the 155mm gun M1918M1 weighs about twenty five pounds\textsuperscript{15} with an overall length of about 36".\textsuperscript{16} The propellant charge for the 155mm howitzer weighs about eight pounds with an overall length of about 13".\textsuperscript{17} Shrapnel and high explosive projectiles were commonly used at this time. Gas shells for the 155mm weapons were also manufactured. Any gas shells that were available at Schofield would not have been stored at the ordnance storehouses 2101-2109. In the early 1920s a remote section of the post about 1½ miles west of the storehouses is shown on a historic map with numerous "Gas Storage Magazines" in an area designated "Chemical Warfare Magazines."\textsuperscript{18}

**Ordnance Storehouses and Explosives Storage Before 1926**

During the years of World War I and the early 1920s, there were three types of ammunition and explosive storage facilities used by the U.S. military; 1) open storage (principally used in wartime) was an open area for stacking ammunition, 2) casemated magazine (used only at coastal artillery sites) was a protected masonry structure often set into a hill, 3) above ground magazines with floors at grade or raised to the level of a railroad car. Buildings 2101-2109 were of this last type.

\textsuperscript{13} U.S. Congress, War Dept. Appropriations Bill, 587.
\textsuperscript{15} Ordnance Department, *Handbook of Artillery*, 207-245.
\textsuperscript{16} Hawaii State Archives Photo Collection, photo in folder PP-54-5, ca. 1935.
\textsuperscript{18} Fourth Construction District, "Schofield Barracks, H.T." map.
For the design and construction of different magazines during World War I and the years shortly after, the military used six different classes, one for each varying type of ammunition and components, based on the volatility and explosive potential of the material stored. Each class had its own specifications for the aboveground magazine.

Class one: Finished ammunition and loaded components. These were stored in standard constructed magazines, typically about 20' x 50' and spaced 300' - 400' apart. This class of ammunition has a moderate level of sensitivity (the likelihood of a mass detonation of shells larger than 6" diameter is low) but can be extremely heavy, so concrete floors needed to be rated at 1,000 pounds per square foot.

Class two: Smokeless powder. This class of ammunition is not explosive unless it is contained; it is however easily ignited and burns intensely. Aboveground magazines for this class were built with fireproof exteriors of asbestos siding. They were typically about 32' x 96' with a 300' spacing to minimize the chances of fire spreading from one to another.

Class three: Fuses and primers. This class of ammunition is extremely sensitive and very expensive to produce. These were also stored in 32' x 96' magazines spaced 300' with exteriors that were impervious to sparks. Destruction of a small amount of fuses and primers would render a much larger volume of other components unusable.

Class four: High explosives. This class of ammunition was very susceptible to mass detonation, ensuring that the entire quantity of material stored in one magazine building would be destroyed if initiated. This meant storing high explosives in smaller volume magazines which were standard construction of hollow tile to prevent ejected heavy debris from threatening nearby magazines. Typically this class was kept in magazines measuring about 26' x 42' and spaced 800' apart.

Class five: Sodium nitrate and inert components. These components are very stable and do not require a specialized magazine. Sodium nitrate is not explosive, merely an oxidizing compound that needs to be combined with a combustible substance in order to burn.

Class six: Small arms ammunition. This type of ammunition is also very stable, and does not call for a specialized magazine. Standard warehouse facilities with added brick firewalls which sectioned off the spaces into 100' x 160' areas were used.19

1926 Lake Denmark explosion
The standard design of hollow terra cotta tile construction for magazine buildings survived well into the 1920s, and some standard-plan terra cotta tile magazine buildings were still being constructed by the Army as late as 1934.20 The event that propelled the switch from standard terra cotta construction was an explosion that occurred on July 10, 1926 when lightning struck a 150' x 200' terra cotta-constructed ammunition storage building (Magazine Number 8) at the Naval Ammunition Depot at Lake Denmark, New Jersey. A fire erupted and within minutes the building exploded, leaving a crater and sending burning debris over a mile, resulting in two more horrific explosions at Magazine Number 9 and Shell House Number 22. The blasts resulted in the destruction of structures within a radius of 2,700'. Damage to buildings was experienced out to a radius of 8,700' (1.65 miles) from the blasts. Nineteen people were killed.21

19 Murphy et. al., Army Ammunition and Explosives Storage, 20-22.
21 Murphy et. al., Army Ammunition and Explosives Storage, 22.
The most visible improvement in high explosive storage to result from the study of the Lake Denmark explosion was the development of a new type of standard magazine building. This was a structure with barrel-arched construction (typically concrete), banked with earth and commonly called the igloo magazine. Although the Navy had utilized flat-roofed, earth-covered magazines as early as 1918, the arched form of the igloo offered the advantage of its thick sides and relatively thin top surface channeling any explosion straight upward and reducing the horizontal radius within which subsequent detonations could be triggered. The earth covering moderated temperature extremes and protected the magazine contents from detonation by debris from an adjacent explosion. These igloo magazines became the model for virtually all future ammunition storage facilities for all branches of the military.

Another result of the Lake Denmark explosion was the establishment of a table which specified safe distances for human activity to be separated from explosives storage facilities. Before 1910 there were no standards established for safe distances from explosives and ammunition storage areas, and large quantities of these materials were often stored near population centers. In 1910 a group of explosives industry representatives, the Institute of Makers of Explosives (IME) formulated the American Table of Distances (ATD), a guide to calculating safe distances between explosive storage sites and their surroundings in order to minimize property damage in the event of an explosion. The ATD was developed by examining the results of over 100 previous explosions of storage sites. When the ATD was established, a number of states, including New Jersey, codified it into state law. The ATD was not adopted by the military at this time. After the 1926 Lake Denmark explosion a Joint Army-Navy Board on Ammunition (JBA) was convened to look into the disaster. The JBA recommended that the military adopt New Jersey's explosives regulations which used the ATD as its safety guidelines. This was done, and until the middle of World War II explosives safety standards in the military closely followed the ATD. By the early 1940s, in view of advancements in military explosives, it was recognized that the early accident data the ATD was based on was quite limited. Information from subsequent testing, and also data from accidents which occurred after 1910, notably the 1944 Port Chicago Naval Magazine (California) explosion, were incorporated into a new version of the safety standards. These were adopted on February 1, 1955 and came to be known as the Explosive Safety Quantity Distance (ESQD) standards.

From the layout and spacing of Buildings 2101, 2102, 2104-2109 it appears that the recommended (1920-era) distances between structures designated to store the more powerful classes of explosives were not followed at Schofield Barracks at the time of their construction. Class one ammunition was specified to be stored in structures with 300' to 400' distance between them. The ordnance storehouses at Schofield are laid out on a grid pattern with about 200' minimum distance between them.

Another important component of ordnance storehouse design that became mandatory after the Lake Denmark explosion was the installation of lightning protection. Typically, the structures had multiple lightning rods joined by a heavy cable that extended down the outside of the building into the ground. Often the buried end of the cable was separated into strands that were each fixed to copper plates. There is no evidence of any lightning protection system at the Schofield ordnance storehouses.

Ventilation of the ordnance storehouses is another feature of standard designs for magazines that was incorporated in Buildings 2101-2109. Especially in warm temperate or tropical climates it was important that the ordnance materiel inside the structure be protected as much as possible from the heat of the sun. Induction ventilators were used in the roof to help exhaust hot air. A historic photograph taken shortly after the ordnance storehouses were built shows
that they were equipped with two ventilators per building.\textsuperscript{22} Also frequently used inside the buildings in conjunction with the ventilators was a ceiling suspended from the lower chords of the roof trusses that had vent openings into the air space between the ceiling and the roof. This had the effect of significantly lowering the internal temperature of the buildings. Most of the ordnance storehouses retain two historic round ventilators at the ridge.

**Railway lines at Schofield Barracks**

The nine ordnance storage buildings were serviced by two railroads when they were built. The Oahu Railway & Land Co. (OR&L) line ran along an east-west axis just south of the buildings. Its western end terminated about one mile west of the ordnance storage buildings and its east end extended off post and eventually to Honolulu. This was a 3' gauge rail line. Three spurs extended northeast from this line to the ordnance storehouses, each spur running along the northwest side of a row of three of the storehouses and terminating just beyond the last storehouse in each row. All the storehouses have loading platforms along their northwest long sides that provided building access from the spurs adjacent to the buildings. These railroad loading platforms are about 2'-0" to 2'-6" above grade. A fourth spur off the OR&L line paralleled the three spurs that serviced the storehouses to the east. This fourth spur serviced two of the ammunition sheds east of the ordnance storage buildings.

Another rail line extended to the storehouse group from the north. This was the 60cm gauge rail line of Schofield Barracks, operated by the Army Third Engineers and servicing areas within Schofield with about ten miles of track. This line was installed at Schofield about 1920 and employed ten engines, both gasoline and steam, that were surplus rolling stock at the end of World War I, when both the Allies and the German army had 60cm rail lines in trenches at the front.\textsuperscript{23} This 60cm gauge track measured 23.65 inches. It was also referred to as 24" gauge and was used on some plantation railroads in Hawaii.\textsuperscript{24} The 60cm rail line ran in an east/west orientation just to the north of the ordnance storehouses. A single spur extended south to the western row of storehouses (2107, 2108, 2109). It ran along the west side of the 3' gauge OR&L track that served these buildings. In 1933 the 60cm track was removed from Schofield and most of the engines were sent to Fort Benning.\textsuperscript{25}

**PART III. SOURCES OF INFORMATION**

**A. Architectural Drawings:**

Historic drawings dating from 1955 to 1971 produced by the office of the Schofield Barracks Post Engineer for the ordnance storehouses are filed as scanned documents at Schofield Barracks, Directorate of Public Works Archival Database, under the purview of the Environmental Section of the Schofield Department of Public Works.

Drawings numbered:

- 55004001, 55004402, 55004403 (3 drawings)
- 57017001, 57017002, 57017003, 57017004 (4 drawings)
- 57027001, 57027002, 57027003 (3 drawings)
- 57044001, 57044002, 57044003 (3 drawings)
- 66034004 (1 drawing)

\textsuperscript{22} NARA, photograph HIID 372


\textsuperscript{25} Chiddix and Simpson, *Next Stop Honolulu*, 218.
B. Early Views:
Early photos of the ordnance storehouses and Schofield Barracks are available at the National Archives in RG-165-HDD. Schofield Barracks historic photos (including photos of the artillery weapons deployed there) are available at Hawaii State Archives (HSA) file PP54 folders 5 through 11, file PP55 folder 6, and in photo albums 56 and 96. These HSA photos are considered in the public domain.

C. Bibliography:


Hawaii State Archives. Historic photos in file PP54 folders 5 through 11, file PP55 folder 6, and in photo albums 56 and 96. Various dates.


National Archives and Records Administration (NARA). Photograph HHD 372 in box RG-165-HDD. March 27, 1922.


PART IV. PROJECT INFORMATION
This report was produced to provide mitigation for the possible demolition of Buildings 2101, 2102, 2104-2109 at Schofield Barracks Military Reservation. These buildings may be brought into the Army's Residential Communities Initiative (RCI) program which transfers structures and leases land to private development partners in order to improve the Army's family housing inventory.

This report is intended to satisfy requirements under Section 110 of the National Historic Preservation Act of 1966 (NHPA) as amended, to make appropriate records of historic properties that would be substantially altered or demolished as a result of Army action. Mitigation for demolition of extensive alteration under Section 106 sometimes requires HABS reports according to National Park Service (NPS) guidance. Section 101(a) of the NHPA requires that these records be deposited in the Library of Congress for future use and reference. The RCI program could result in demolition of Buildings 2101, 2102, 2104-2109 at Schofield Barracks Military Reservation.
Location map. North at top.

Eight ordnance storehouses
Buildings 2101-2109
Portion of map dated November 1921 showing the nine ordnance storehouses under construction in the arrow-indicated square highlighted area (highlighting and arrows added). This area is enlarged on the following page to better show the storehouses, their map location number: 55, and the two railroad lines servicing the storehouses. The lower arrow points to the description of map location number 55 which reads "Ordnance Storehouses." North at top of map. Fourth Construction District map, November 1921.
Detail portion of map dated November 1921 showing the nine ordnance storehouses. Note their map location number, 55, which is described as "Ordnance Storehouses" on the accompanying list. Also note the two rail lines leading to the ordnance area. The rail line at the top (north) with one access spur is symbolized with double dashes which the map key describes as corresponding to the Army's 60cm gauge line. The rail line at the bottom (south), with three access spurs leading to the storehouses, is symbolized with single dashes which correspond to 3' gauge of the OR&L line. North at top. Fourth Construction District map, November 1921.
Portion of photo dated March 27, 1923 showing the ordnance storehouses at Schofield Barracks. NARA photograph HHD 372 in box RG-165-HDD.
Portion of map dated June 20, 1941 showing the nine ordnance storehouses at Schofield Barracks. Note that the 60cm gauge rail line is no longer present. North at top. Third Engineers, Topographical Section, Map 400A7ER, November 16, 1939 (corrected to June 20, 1941).
Drawing of ordnance storehouse building dated June 28, 2010 showing the exterior southeast elevation, typical of ordnance storehouse buildings. Note that some of the original large door openings are now in-filled but the location of original window and door openings are evident. These drawings were prepared by Mason Architects. Not to scale.
Drawing of ordnance storehouse building dated June 28, 2010 showing the exterior northwest elevation, typical of ordnance storehouse buildings. Note that some of the original large door openings are now in-filled but the location of original window and door openings are evident. These drawings were prepared by Mason Architects. Not to scale.
Drawing of ordnance storehouse building dated June 28, 2010 showing the exterior southwest elevation, typical of ordnance storehouse buildings. Note that some of the original large door openings are now in-filled but the location of original window and door openings are evident. These drawings were prepared by Mason Architects. Not to scale.
Drawing of ordnance storehouse building dated June 28, 2010 showing the exterior northeast elevation, typical of ordnance storehouse buildings. Note that some of the original large door openings are now in-filled but the location of original window and door openings are evident. These drawings were prepared by Mason Architects. Not to scale.
Drawing of ordnance storehouse building dated June 28, 2010 showing the exterior roof plan, typical of ordnance storehouse buildings. Note that some of the original large door openings are now in-filled but the location of original window and door openings are evident. These drawings were prepared by Mason Architects. Not to scale.