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Historical and Architectural Overview of Military Aircraft Hangars

A General History, Thematic Typology, and Inventory of Aircraft Hangars Constructed on Department of Defense Installations

United States Air Force
Air Combat Command

Global Power for America

HISTORICAL AND ARCHITECTURAL OVERVIEW OF MILITARY AIRCRAFT HANGARS

A GENERAL HISTORY, THEMATIC TYPOLOGY, AND INVENTORY OF AIRCRAFT HANGARS CONSTRUCTED ON DEPARTMENT OF DEFENSE INSTALLATIONS

HEADQUARTERS, AIR COMBAT COMMAND
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Introduction

Background

As aviation technology developments and Base Realignment and Closure (BRAC) activities change the missions of Department of Defense (DoD) installations, there is a growing need to adapt military buildings to new uses. Military aircraft hangars are popular buildings to convert because they provide large, adaptable spaces that can serve a variety of purposes. Consequently, inquiries about modifying hangars have been increasing in recent years. Before a hangar can be modified, however, its historical significance must be documented and assessed in accordance with Sections 106 and 110 of the *National Historic Preservation Act* (NHPA).

Section 106 is a specific mandate that requires every Federal agency to take into account how each of its undertakings, such as hangar modifications, could affect historic properties. Section 110 defines broad affirmative agency responsibilities for administration and management of historic properties. A *historic property* is defined as any property listed in or eligible for the National Register of Historic Places. The National Register is the nation's basic inventory of historic resources, and is maintained by the Secretary of the Interior. *It is important to note that protections afforded by Section 106 extend to properties that possess significance whether their significance has been assessed or not.*

To comply with the provisions of NHPA Sections 106 and 110, DoD installations need effective tools to help the base's cultural resource manager determine the significance of any hangars intended for modification or demolition. The U.S. Army Construction Engineering Research Laboratories (USACERL) was tasked to study DoD's inventory of aircraft hangars for criteria relevant to Section 106 and 110 requirements. This study is intended to facilitate DoD's future assessment of any hangar's historical or architectural significance, as required by the NHPA. It was conceived to expand a previous DoD-sponsored study on World War II temporary buildings. That study was intended to be a survey of the approximate numbers and locations of remaining World War II temporary construction in the United States. It concentrated on temporary construction from 1939 to 1946, and addressed many types of buildings — not just aircraft han-

gars. The current study, on the other hand, specifically addresses aircraft hangars and covers most of the 20th century.

Objectives

The objectives of this study were to:

- Identify and describe the principal types of military aircraft hangars built before 1996.
- Document hangar origins, locations, and approximate numbers.
- Provide a context for understanding the aviation and construction history related to major hangar types.

Approach

To provide adequate notice to DoD installations USACERL provided written notification of the project to the appropriate headquarters-level cultural resource management points of contact within the U.S. Army, Air Force, Navy, and Marine Corps. Next, all military installations in the continental United States, Alaska, Hawaii, and Puerto Rico were surveyed via a fax questionnaire to identify which locations had surviving military hangars. Installations that confirmed having hangars were then sent a memorandum requesting the following information:

- a real property inventory for past and present flight lines and air fields
- an installation map that included hangar building numbers and locations
- any available documented installation history
- real property records for each hangar
- drawings of each hangar to include floor plan, front elevation, and structural cross-section
- any hangar-related historic building inventories
- photographs of hangars.

In some cases data were collected through site visits. Specific physical data were collated from the materials provided by the installations surveyed, forming the basis for the hangar database presented in Appendix A. The database was then analyzed to develop the aircraft hangar typology, which comprises one of the major sections of this report (Part II).

Much of the historical information presented in Part I was developed through literature searches and examination of pertinent historical documents obtained from various repositories. Some of the standardized drawings were compiled from the same sources. Specifically, research was conducted at:

- the National Archives and Records Administration (NARA) in Suitland, MD
- the NARA Military Reference Branch in Washington, DC
- the U.S. Army Corps of Engineers Office of History at Fort Belvoir, VA
- the CERL Technical Library, Champaign, IL
- the NARA Cartographic and Architectural Records Branch in College Park, MD
- the University of Illinois at Urbana-Champaign Library and its interlibrary loan system
- the Naval Facilities Engineering Command (NAVFAC) Headquarters in Alexandria, VA.

Installation-level histories and historical building inventories provided site-specific historical narrative and data.

Scope

Data collection for this study excluded most Reserve, National Guard, and overseas installations as well as bases that have been closed and those in former theaters of operation. The report addresses intact military aircraft hangars and associated airfield structures currently owned and operated by DoD. The NHPA's 50-year criterion for assessing historical significance was expanded for this study to include all hangars built through the Cold War era and up to 1996. It is expected that these expanded data will be helpful to installation cultural resource managers as requests are received in the future to modify Cold-War-era hangars.

It also should be noted that, because many types of military hangars were replicated at nonmilitary airfields over the years, this report may serve as a useful resource for civilian agencies required to conduct Section 106 reviews.

While hangars built after World War II are addressed at some length, the reader should note that the emphasis of the history and analysis falls on structures built before 1946. This study offers an overview of hangar construction activity during the Cold War but does not attempt to provide the level of detail or analysis dedicated to the earlier historical periods.

How to Use This Document as a Tool for NHPA Compliance Reviews

Environmental managers ranging from archaeologists to civil engineers may find themselves responsible for Section 106 and 110 compliance. Therefore, to address the widest audience, the information presented here assumes that responsible individuals have little experience in researching historic architecture. This document provides cultural resource managers with historical and architectural information to assist them with Section 106 and 110 reviews. However, use of this document by cultural resource managers must not be considered a substitute for review by trained historic architecture professionals as required by the NHPA.

List 1. Possible indicators of historic or architectural significance.

- Building Name
- Secondary Name
- Present Building Number
- Original/Subsequent Building Numbers
- Location/Street Address
- Present Owner
- Original/Subsequent Owners
- Present Use
- Original/Subsequent Uses
- Date of Construction
- Architects
- Builders/Contractors/Suppliers
- Original Construction Documents
- Alteration/Addition Documents
- Lean-To/Office Module Documents
- Building Condition
- Exterior Description
- Interior Description
- Site Description
- Designed Landscape Features
- Outbuildings/Related Structures
- Early Construction Photographs
- Subsequent Photographs
- Present Condition Photographs

List 1 specifies the categories of information that can best help to determine the significance of an aircraft hangar. Much of this information can be found on the original, subsequent, and current property records for the structure. Property records usually are kept in the installation's real property office. It is important for an installation to retain these documents in some form. If storage space is limited, these records may have been archived on microfilm or microfiche. The installation's record drawing vaults may contain original construction and subsequent modification drawings. Some drawings may be available at the installation's regional Corps of Engineers district or NAVFAC office. Historical photographs and other materials for determining a historical context may be available at the office of the base historian, at base museums, or at local, regional, and national libraries and archives.

Using the Historical Narrative (Chapters 1 – 5)

After physical building information has been collected and analyzed, the historical context of the hangar must be understood. The historical narrative in this document is divided into chapters that discuss five general periods, each corresponding to a major U.S. military conflict or peacetime era.

List 2. Aviation construction themes identified in this report.

Aviation Construction Theme	Duration	Service	Brief Description
Early Aviation Facilities	To 1917	All	Ad hoc construction of aircraft shelters for pioneering aviation efforts.
WWI Mobilization Flying Training Fields	1917-1918	Army	Facilities erected in support of Army air training associated with WWI.
WWI Mobilization Aviation Support Facilities	1917-1918	Army	Air Depots constructed in support of the WWI Mobilization effort.
WWI Continental Naval Air Patrol	1917-1918	Navy	System of naval air patrol facilities from which the U.S. protected its Atlantic approaches from German U-boat attacks during WWI.
WWI Naval Air Training	1917-1918	Navy/ Marine Corps	Expansion of existing facilities and construction of new bases to support naval air training associated with WWI.
WWI Demobilization and the Lean Years	1919-1926	All	Sporadic construction during military downsizing following WWI.
Air Corps Act and the Five-Year Plan – Early Construction	1926-1931	Army	Construction resulting from the Air Corps Act of 1926, which enabled the Air Corps to double in size over 5 years.
Five-Year Program	1926-1931	Navy	Construction of new facilities at existing bases to accommodate expanding aircraft inventory.
Five-Year Plan Expansion	1931-1935	Army	Completion of Five-Year Plan construction and expansion of program to accommodate developing needs.
Vincent-Trammel Navy Bill	1933-1937	Navy	Construction at existing air stations as aircraft compliment expanded with growing fleet.
Wilcox Act Facilities	1935-1939	Army	Facilities constructed in “critical areas” to support concentrations of the GHQAF in defense of American shores.
Prewar Expansion under the Hepburn and Green Slade Boards	1938-1941	Navy	Construction at existing facilities and establishment of new air stations in support of the Naval Expansion Act of 1938 and the 15,000-Plane Program of 1940.
WWII Mobilization Naval Air Stations	1941-1945	Navy	Massive expansion and establishment of new air stations to meet wartime needs.
WWII Mobilization Tactical Flying Fields	1940-1943	Army	Construction during the opening phase of WWII to support expansion of Army Air Forces and provide for continental air defense.
WWII Mobilization Flying Training Fields	1940-1945	Army	Facilities erected in support of Army air training associated with WWII.
WWII Mobilization Aviation Support Facilities	1940-1945	Army	Air Depots constructed in support of the WWII Mobilization effort.
WWII Demobilization and Deactivation	1945-1950	All	Sporadic construction during military downsizing following WWII.

Aviation Construction Theme	Duration	Service	Brief Description
Sustained Forces Doctrine	1950-on	All	Facilities erected to support Eisenhower's "New Look" defense strategy that emphasized constant readiness.
ADC Scramble Facilities	1951-1958	Air Force	Construction of Air Defense Command alert scramble facilities to house fighter-interceptor aircraft.
SAC Bomber Facilities	1952-1958	Air Force	Construction at Strategic Air Command bases to house rapidly increasing numbers of B-36, B-47, and B-52 strategic bomber aircraft.
Aircraft-Specific Facilities	1952-on	Air Force	Construction program to accommodate basing needs generated by the introduction of new aircraft.
Soviet Anti-Submarine Warfare Program	Mid-1950s	Navy	Construction effort supporting naval patrol squadrons concerned with the Soviet submarine threat.
SAC Dispersal Program	1958-1960	Air Force	Construction at Strategic Air Command dispersal bases to house one squadron of B-52 strategic bombers at each site.
Air Mobility Construction Program	Late 1960s	Army	Construction of Army helicopter facilities in the wake of advancements in air mobility for the nuclear battlefield.
Division 86 Facilities	1983-on	Army	Army aviation construction to accommodate increasing air mobility.
Realignment Building Campaign	1980s-1990s	All	Construction resulting from relocation and consolidation of aviation missions at realignment bases.

Each chapter is subdivided according to service (i.e., Army, Air Force, and Navy/Marines). The narrative identifies the major aviation construction themes that should be used in assessing the significance of DoD aircraft hangars. List 2 presents a directory of themes addressed in this study. The themes covered in each chapter are listed at the beginning of each major subsection. The reader should note that some aviation topics (especially local and regional themes) are not well documented in the available source materials and therefore may not be addressed in this report. The emphasis of the narrative is on hangar construction history within a national context, but the national context is provided to illuminate local and regional contexts — not to replace them.

At the end of each history chapter, for each military service, a timeline table is provided that helps the reader to cross-reference events that were happening within different realms of activity during the period. Specifically, these tables track milestone events in the areas of (1) military conflicts and campaigns, (2) aircraft technology and production, (3) military aviation operations, (4) military aviation administration, and (5) military aviation construction.

Using the Hangar Typology (Chapter 6)

In cases where much of the original architectural and construction information is not available, cultural resource managers can use the hangar typology in Chapter 6, in conjunction with the appendices, to help identify possible definitive designs or standard design drawings that may have been used to construct the hangar. In this report the term *typology* means the systematic classification of buildings that share various characteristics. Therefore, if the hangar in question shares enough characteristics with a definitive design or standard drawing, additional information about that hangar — *but not every detail* — may be inferred with some degree of confidence.

The use of definitive designs and standard design drawings by the Army and the Air Force is mandated by Engineer Regulation (ER) 1110-345-100, *Design Policy for Military Construction*. A *definitive design* outlines functional layouts, space allocation, and special features or requirements. It specifies basic horizontal and vertical configuration of elements, and usually recommends basic building systems, materials, construction details, etc. A *standard design drawing*, also called a *standard plan* in this report, is a drawing rendered in sufficient detail about materials and construction methods to serve as project construction drawings after site-specific modifications have been made and inapplicable material has been eliminated. Standard plans generally include alternative wall sections, details, etc., to illustrate variations that may be required due to local climatic or seismic conditions.

Ideally, the typology will demonstrate that a particular standard plan was used to construct the hangar. Some hangars may be similar to a standard design but not an exact match. It is important to understand that standard plans and definitive designs are simply the basis for subsequent construction documents. These subsequent documents often deviate from the standard drawings to accommodate site conditions. It also should be noted that standard drawings are updated occasionally and numbering systems have changed periodically.

Using the Appendices to Determine Historical Context

After the physical makeup (or type) of a hangar is established, cultural resource managers can refer to Appendix A, which comprises the authors' complete database of DoD aircraft hangars. Often, the significance of a hangar may rest on the fact that it is the best or last existing example of a type, or the only known example ever built. The database indicates installations with similar, or dissimilar, hangars to allow cultural resource managers to examine their hangars in a national context in addition to a local context. The accuracy of database entries

depends on the integrity of the installations' records. However, it also should be noted that buildings often are not constructed true to their plans, and consequently they may include built elements not shown in original blueprints or specifications.

The database, when cross-referenced with the text, illustrations, and typology information in the body of the report, should help the cultural resource manager make informed inferences to fill gaps in the local construction records.

Appendix A contains key information about all known DoD aviation hangars that fall within the scope of this study. Its principal benefit will be to help the cultural resource manager determine a hangar's construction date and period of significance. These data appear under the "Year Built" and "Era" captions, respectively.* Each era corresponds to a chapter of the historical narrative. When the correct era or combination of eras is determined, corresponding chapter content can be used to determine a national aviation context for the hangar.

Appendix B is a list of all abbreviations and acronyms used in this report.

* Note that hangars constructed during demobilization years may fall into two eras. The impetus, planning, and funding for the structure may be associated with the previous period, while the actual construction was completed in the latter period.

1 The Early Years: Military Aviation Before 1917

The Origins of Army Aviation Construction

The decades leading up to American involvement in the First World War were a period of relative calm for the U.S. Army. They did, however, witness two developments that will dominate the following discussion of U.S. military aviation and the physical facilities that have been constructed in its support. The first is, of course, the birth of military aviation itself. The second is the use of standard plans and definitive designs by the armed forces' construction organizations, a practice that would play a part in the design and construction of aviation facilities through to the present day. While both of these developments began in this early period, there was initially only a slight connection between the two. Little physical support was provided for the early aviation pioneers, who had to make do with crudely improvised temporary facilities. Construction activity was largely confined to the fabrication and maintenance of frontier posts, coastal defense fortifications, and some semi-industrial facilities, with small-scale buildups accompanying such crises as the Spanish-American War. Only when the development of military aviation accelerated in the years just prior to the outbreak of the Great War were the needs of military aviation integrated with the use of standardized facility designs in a union that would shape the history of the aircraft hangar.

MAJOR THEMES AND CONTEXTS

Early Aviation Facilities

The Origins of Standardized Army Facility Design

As early as the Revolutionary War, Army construction responsibilities were split between two organizations. The U.S. Army Corps of Engineers built engineering structures such as roads, bridges, and fortifications, as well as canals and river and harbor improvements. The U.S. Army Quartermaster Department's Construction and Repair Division was responsible for the construction of Army posts and facilities to house and train the troops. Many structures built by the Quartermaster Department were of temporary construction, including the early avia-

tion facilities.[1] It was under the auspices of the Quartermaster Department that the Army's system of standardized design was first introduced.

The standard plans program appears to have begun with the 1860 publication of an unofficial set of standardized plans representing typical military structures of that time. While never officially adopted, later Army publications made reference to these designs, and it appears that they were followed to some extent. In 1872, the Quartermaster General published an official set of standardized plans that included post layout and building plans. These standardized plans determined the form of newer installations being constructed around the country in an effort to consolidate Army posts as the frontier steadily closed. They did not generally apply to industrial installations such as arsenals and armories. In 1893, the Office of the Quartermaster General again issued hundreds of standardized plans in support of an intensive building program intended to improve the living conditions on Army posts. These plans were contributed by a number of designers, both civilians and officers of the Quartermaster Department. They were then distributed from the Office of the Quartermaster General in Washington, DC, to the local Constructing Quartermasters who supervised onsite modifications and monitored the execution of contracts. The Constructing Quartermaster was expected to follow the standard design as closely as possible, and was required to get approval from Washington for any variation.[2]

A system of standardized design has been in continuous use by the armed forces, in one form or another, up to the present day. The standardization of military construction was born of the necessity to create a streamlined process for large-scale building construction during times of need. The benefits of this streamlining were realized in the reduction of the time necessary for the design, appropriation, and construction phases of the process, combined with reduced expense to the government in each of these stages.

Time could be saved in the design phase because standardized drawings eliminated the redundant effort required at different installations for similar facilities, each of which could take more than a year to design. The use of a standard plan thus eliminated the first step in construction planning and allowed for the immediate commencement of funding approval. It also allowed for a more accurate and reliable cost estimate, precluding the need for planning activities that would otherwise have to precede the design phase. Time could also be saved during the actual construction because the standard plan could be easily executed without spending time experimenting with new construction methods and materials.

The cost to the government could also be reduced at each of the three phases. Expenses were reduced in the design phase by not paying multiple architects and engineers to design repeated versions of the same building type. The use of a standard design also eliminated the need for separate appropriations for planning functions prior to the design phase, as the armed services could confidently state that they already possessed accurate assessments of their basing requirements and the general costs of the buildings. Finally, savings could be realized during the construction phase through the economy of repeated use of predetermined standard materials and methods.[3]

More abstract advantages also could be attributed to the use of standard plans, including the ability to develop the best possible design for a given facility type — although perhaps at greater initial expense — because the design investment would be distributed over a large number of building projects. For this advantage to be realized, however, the standard plan had to be flexible, with specifications broad enough to accommodate a range of building materials and processes, and foreseeable uses of the finished structure. For this reason, simple forms were preferred. Well-proportioned rectangles were used extensively to accommodate a variety of uses, along with modifications that might be introduced to the structure over its life span. Standard design drawings were intended to provide only enough detail on basic materials, methods, and form of construction to function as project layout drawings. They allowed for site-specific adaptation to local seismic and geographic conditions, and the situational availability of labor and materials. These standard drawings would be used to produce the actual working drawings used by the commercial contractor for construction of the facility. Thus, the intent of standard designs was not to supply the actual working drawings for each project, but rather to make the entire building process — from funding to construction — more efficient by eliminating costly and time - consuming preparatory work.[4]

Early Army Aviation

While the use of standardized design was already becoming established in the early 20th century, it was not yet applied to the support of early aviation activities. Support for the development of combat aviation was slight in general, and this was reflected in the lack of physical construction related to aviation activities. Military aviation can trace its roots back several decades before the inception of standardized design programs. The first proposed uses of military aviation in the United States were offers of balloon observation during the Seminole War in 1840, and again during the Mexican-American War in 1845. On both occasions, the local field commanders declined the services of the would-be airmen, and military aviation had to wait until the Civil War for its first practical im-

plementation in this country. After early failures, balloon observation under the direction of three civilian aeronauts — John Wise, John LaMountain, and Thaddeus S. C. Lowe — made a material contribution to the Union war effort. The most tangible support came in the form of spotting from captive balloons for indirect artillery fire, but more daring free balloon missions were also conducted deep into enemy territory for reconnaissance purposes. By 1863, all balloon activities were ceased because they were regarded as too dangerous and not productive enough to warrant further investment of time, money, and lives.[5]

However, in 1891 balloons were finally officially accepted when Chief Signal Officer, Brigadier General Adolphus W. Greely founded a balloon section within the Signal Corps, inaugurating the first official military aeronautical activity in U.S. history. The balloon section saw some limited action in Cuba during the Spanish-American War, but its equipment was in poor repair and its personnel were poorly trained. The unofficial assessment of the section's performance was less than enthusiastic, noting that the balloon drew considerable fire toward rear positions. Subsequently, the Signal Corps' aviation efforts were mostly put on hold until the founding of its Aeronautical Division on 1 August 1907. This division was to be responsible for the development and execution of military aviation equipment and techniques, including operations of both balloons and the new flying machine designed by the Wright Brothers.[6]

Wilbur and Orville Wright had conducted the first controlled, powered flight at Kitty Hawk, NC, on 17 December 1903. Throughout the next four years they lobbied the U.S. military establishment to consider their flying machine for service, but had no luck. They even turned down an offer from the British government to acquire the airplane in order that the United States might be the first to employ air power. Finally, in December 1907, the Signal Corps Aeronautical Division issued its first specification for a proposed aircraft. The Wrights easily won the design competition: of the three proposals accepted, theirs was the only one to be followed by an actual product. They delivered their first airplane — the *Wright Flyer* — on 20 August 1908, and began flight trials at Fort Myer, VA. The first military observer aloft was Lieutenant Frank P. Lahm, who rode with Orville on the early flights as the Wrights set record after record for speed and endurance. A crash on 17 September cost Lt. Thomas E. Selfridge his life and ended trials for the year. Tests were resumed in July 1909, and the Wrights' machine finally passed with flying colors.[7]

The Army's first 'official' airplane, the Wright A, was used when pilot training began on land leased at College Park, MD, in October 1909. By November, the weather had turned too cold and windy for safe operations, so the flight school was moved to Fort Sam Houston, TX. Because both of the qualified pilots had

been reassigned to their parent units, only Lt. Benjamin Foulois remained with the school's Wright A to complete his training. The first flight at Sam Houston was also Foulois' solo, on 2 March 1910.

The first appropriations specifically for military aviation were approved for fiscal year 1912 (FY12), and part of the $125,000 was immediately spent to acquire five new airplanes — three from the Wright brothers and two from Glenn Curtiss, who had begun to design planes for the Navy.[8] These aircraft operated from two wooden hangars at Fort Sam Houston, the Aeronautical Division's first purpose-built aircraft shelters (Figure 1-1).[9]* The first of these hangars was constructed by contractor Otto P. Koerner, measuring 41 x 49 ft, with a packed dirt floor and accordion doors.[10] In the summer of 1911, the training operation returned to College Park, where the Signal Corps had renewed its lease and added a 200-acre expansion. The Quartermaster Department cleared the new land and erected four wooden aircraft hangars. It appears that these four hangars were constructed in accordance with the Quartermaster Department's first standard aircraft hangar design, which was published sometime in 1911. This design depicted a wood-frame, board-and-batten wood-sided structure, with dimensions of 45 x 45 x 11 ft (Figure 1-2).[11] It is here that standardized design was first specifically applied to the requirements of military aviation.†

In December 1911, the school was transferred to Augusta, GA, in search of more benign flying conditions. The worst winter in recent memory greeted them there, and the pilots were more than happy to return to College Park in the spring of 1912. That year brought innovation and experimentation as well as training, with the development of the Burgess H tractor plane, pioneering efforts in the design of a bomb sight, airborne trials with the Lewis gun, and night landings. An official military aviator rating was developed, the first observation missions were run during Army exercises in Connecticut, aerial artillery spotting

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* Technically, perhaps, the balloon house constructed in 1900 at Fort Myer would constitute an earlier aircraft shelter. However, it was essentially just a storehouse for the Signal Corps' balloon equipment left over from the Spanish-American War. It was not necessarily intended to house balloons in an inflated state and, in fact, must not have performed well as a shelter at all. In 1902, the equipment had to be overhauled and rebuilt nearly from scratch, as it had deteriorated in storage beyond the point of utility (Glines, p 41; Mason, ill. 1).

† It is possible that the College Park hangars were constructed from an original, custom plan which was subsequently adopted as the standard by the Quartermaster Corps. The hangars were constructed in 1911, the same year the standard plan was first published, but it is uncertain whether or not the standard plan was established before or after construction began on the College Park hangars. This sort of chicken-and-egg question is probably unresolvable given the available evidence, but it is certain that the plans used for the College Park hangars match the 1911 standard.

was conducted at Fort Riley, KS, and a new aviation presence — complete with a wooden hangar constructed by the Post Quartermaster — was established at Fort Leavenworth.[12] Autumn of 1912 brought the school's traditional relocation to winter quarters, but this year half the Army pilots would be joining Navy and Marine Corps fliers at Glenn Curtiss' school at North Island (San Diego, CA) to train on his aircraft. This marked the beginning of the U.S. Army aviation presence at North Island, which would last until 1935. Neither Curtiss nor the U.S. Government owned North Island, which was leased from a local real estate company. The aviation school's original facilities were confined to two aged wooden barns and temporary canvas tent hangars put up by the pilots themselves.[13]

In the spring of 1913, the lease at College Park was allowed to expire and all flight training was centralized at North Island, where it remained through the rest of this period. Funding for FY14 cleared at about the same time, and work began on a two-year project to establish two principal aviation facilities—a training center at North Island and an aviation center at Fort Sam Houston. Funding delays over the next two years caused the design and construction processes to fall behind schedule. New hangar designs deemed necessary to correct shortcomings in the College Park models were not completed until 1915. Construction at Fort Sam Houston was begun that summer and completed by December. The story at North Island was even more problematic, as the real estate interest that owned the property refused to sell it, and even asked the Army and Navy to vacate the premises. A protracted legal and commercial melee ensued that was still not resolved when the United States entered World War I.[14]

On 18 July 1914, H. R. Bill 5304 established the Aviation Section of the U.S. Army Signal Corps, and for the first time authorized the permanent assignment of personnel to this body. In August 1914 the First Aero Squadron was formed, dropping the term "Provisional" that had preceded its title the previous year. In the summer of 1915, the First Aero Squadron trained in Curtiss JN trainers with artillery observers at Fort Sill, OK, where the aviators had to construct their own camp and flying field. It was decided to retain these facilities after the pilots who built them departed for their permanent duty stations, thus marking the start of a long aviation presence at Fort Sill that continues to the present day.[15]

January 1916 brought the Aviation Section's first foreign deployment as it supported General John J. Pershing's pursuit of the Mexican rebel Pancho Villa. Operating out of tent hangars on temporary fields, the Aviation Section proved itself utterly unfit for the task, as its aging Curtiss JN-3 observation planes simply could not operate in the heat and altitude of the Sierra Madres. While the Aviation Section's experience in Mexico proved very discouraging, it did serve to

demonstrate the woeful condition of Army aviation resulting from a lack of Congressional funding support. Consequently, steps were immediately taken to bring American air power up to speed with that of the European combatants of WWI. In March 1916 the Aviation Section was appropriated $500,000 to remedy the problems, and the National Defense Act of 1916 authorized $13 million for the expansion of the Army's air arm to seven active squadrons and twelve reserves.[16]

Beyond authorizing and funding an expansion of the number of aircraft and pilots, this bill provided for the beginning of a construction campaign that would provide the physical support necessary for expanded aviation operations. A number of important permanent facilities were begun in connection with this program, including:

- Langley Field, VA (Langley Air Force Base [AFB])
- Kelly Field, TX (Kelly AFB)
- Hazelhurst Field, NY
- Luke Field, HI (Naval Base [NB] Pearl Harbor).

Langley was intended to be the new governmental experimental station and flying field, where development of military aviation technology could be centralized and accelerated. Land was purchased in 1916 and Albert Kahn, the noted industrial architect from Detroit, was commissioned to design the facilities — the first permanent construction planned for the Aviation Section. However, money ran out before construction could begin, so work was not begun until April 1917. With the American entry into World War I that same month, plans for permanent construction would temporarily fall by the wayside. Because of these construction delays, then, by April 1917 much work still remained before Langley could accept operational aircraft. Kelly and Hazelhurst Fields joined North Island as secondary training fields, intended to receive pilots who had completed their basic flight training at civilian training schools and would finish their instruction on operational U.S. Army aircraft. Hazelhurst was established using existing facilities of the New York National Guard, including five wood hangars already present. Kelly Field was built from scratch on new land purchased near Fort Sam Houston, and construction began on seven new hangars in March 1917 — just one month before America's entry into WWI.[17]

In April 1917, upon the U.S. entry into the war, the Signal Corps Aviation Section was far from ready for combat in the skies over Europe. Total personnel stood at 53 officers (of which only 35 were flight-qualified), 1,087 enlisted men, and 210 civilian employees. The aircraft inventory stood at about 300, but most were obsolescent trainer types or under-powered, unarmed observation planes

that were utterly unfit for a theater of war. The Aviation Section could claim a total of seven flight-related installations, four of which were just beginning development. North Island and Fort Sam Houston had established aviation activities, and Fort Sill retained its single pilot-built hangar and a willingness to train aerial artillery observers. Hazelhurst Field's established training operation was newly included under the Aviation Section's authority. Meanwhile, Langley and Kelly Fields were still under construction, and the brand new Chandler Field, PA, was scheduled to begin construction in April. Much work remained before the United States could be considered a serious air power.[18]

Early Navy and Marine Corps Aviation Construction

The period before U.S. involvement in World War I was one of significant development in technology and doctrine for the U.S. Navy. In particular, the years just before the Great War witnessed the birth of naval aviation which would, in time, develop into the most decisive naval combat arm. Aviation's future significance was anything but apparent during these early years, however, and like their Army counterparts, the pioneers of naval aviation were generally ill-regarded by naval leadership. In particular, they received little support from the Navy's construction authority, the Bureau of Yards and Docks*, which was the counterpart of the Army Quartermaster Corps Construction Division. Getting a comparatively late start in the field, and suffering from the same technological and administrative limitations, naval aviation advocates labored mightily throughout the period to reach a limited state of readiness comparable to that of the Army's air arm by April 1917.

MAJOR THEMES AND CONTEXTS

Early Aviation Facilities

The Origins of Standardized Navy Facility Design

The Navy also employed a standardized design system in the construction of its aviation facilities. Before 1842, naval construction exhibited little standard-

* The Bureau of Yards and Docks is identified by several different abbreviations and brevity codes throughout this document: *BY&D*, *Y&D*, *BuDocks*, and *Yards and Docks*. These various abbreviations appear in the titles of Navy architectural drawings and construction documents as well as narrative related to such documentation. To preserve the integrity of this nomenclature within its historical context, no attempt has been made to standardize the abbreviations. The abbreviations are redefined throughout the text where required for clarity.

ization, with design work executed locally by civilian contractors for the industrial-type buildings that dominated Navy Yards. In 1842, the Bureau of Yards and Docks was founded and given responsibility for construction and maintenance of most structures on naval installations, while its Office of Civil Engineering took over most building design duties. Special function facilities continued to be designed and constructed by the Navy bureau in charge of them. By 1853, each Navy Yard had a Civil Engineering office, and in 1867 the Civil Engineer Corps was established within the Bureau of Yards and Docks and its personnel were given commissions. Civil Engineer Corps officers designed buildings locally and submitted their proposals to the Bureau's headquarters in Washington for approval. As the 20th century opened, the Bureau was tasked with the construction of new facilities necessary for the maintenance of a modern steel Navy, such as improved and expanded dry docks, ordnance development and storage facilities, coaling stations and fuel oil depots, educational facilities, and living quarters. Its control over Navy and Marine Corps construction activities was made complete in 1911 when the construction of special function facilities — including aviation facilities — was centralized under the Bureau of Yards and Docks with the rest of the Navy's civil engineering operations.[19] At this point, naval aviation had just begun to take its first tentative steps.

Early Naval Aviation and Aviation Camps

On 14 November 1910 Eugene Ely, a civilian associate of aircraft designer Glenn Curtiss, flew a Curtiss biplane off the deck of the cruiser USS Birmingham at anchor at Hampton Roads, VA, demonstrating the potential for aircraft to cooperate with fleet elements. On 18 January 1911 Ely landed a Curtiss pusher on the modified deck of the USS Pennsylvania at anchor in San Diego Bay, turned it around, and flew it two miles back to shore. Tests in February of that year demonstrated the sea- and airworthiness of Curtiss' new tractor-type seaplane,* and confirmed its ability to operate with the fleet when one of these water-borne aircraft was flown to the USS Pennsylvania, lifted onto her afterdeck with a crane, then lowered back into the water where it took off again. Convinced that the potential for naval aviation must be explored, the Navy ordered Lieutenant T. G. Ellyson to the Curtiss flying school at North Island. Ellyson became the first U.S. Naval Aviator when he qualified for his pilot's license on 6 July 1911, flying an A-1 Triad seaplane that became the Navy's first aircraft. In September, Lieutenants John H. Tower and John Rodgers were ordered with Ellyson to Annapolis, MD, to occupy the Navy's new Engineering Experiment Station on Greenbury Point. Flight training, testing, and experimentation continued there throughout the autumn.[20]

The aviation camp on Greenbury Point was indicative of the lack of physical support afforded these early naval aviation pioneers. It was assumed at this time that naval aviation activities would be limited to those that could be carried out from the fleet at sea, so there was initially little perceived need for fixed land facilities. At Greenbury Point, a small clearing was cut into the woods, some swampy land filled in, and a number of tent hangars erected to shelter the three seaplanes. The site was soon discovered to be poorly suited to flight operations, and the camp was moved the next year. Not least of the problems was the location of the site directly down range from the Naval Academy rifle range.

Greenbury Point was the first in a series of aviation camps that would constitute the Navy's aviation shore facilities. A second camp in a form more representative of Navy aviation shore facilities was constructed in December 1911 at North Island to house aviation operations during the winter months. This type of camp had slightly better but still meager facilities, generally consisting of nothing more than a beach on a sheltered body of water, a number of portable tent hangars, perhaps a temporary machine shop, a single naval vessel and a few seaplanes (Figure 1-3).[21]

Concentrating on the ability of aircraft to operate with the fleet at sea, Naval authorities continued to look for a way in which the faster and more fuel-efficient conventional aircraft could take off and land from a ship under way. Tests were conducted with a compressed-air catapult that finally succeeded in November 1912, although its first successful ship-board use would not occur until 1915. Other testing conducted in 1912 involved the development of a primitive autopilot, aerial torpedoes, airborne radios, and the more efficient "flying boat" hull form. Pilot training also continued apace, with seven new aviators reporting for training.[22]

Naval aviation's first deployment with the fleet came in January 1913 during maneuvers in the Caribbean. Operating out of an aviation camp on Fisherman's Point at Guantanamo Bay, Cuba, the aviation element demonstrated its utility for airborne observation, spotting, and reconnaissance, and sparked increased interest among high-level fleet officers. Continued experimentation brought advances in aerial bombardment, wireless communications, and instrument flying. October also saw the commissioning of the Chambers Board, which advocated continued expansion of the Navy's air operations, and in particular, called for the establishment of a permanent Naval Aeronautic Station (NAS) at Pensacola, FL.[23]

Growth of Naval Aviation at NAS Pensacola

On 21 January 1914, NAS Pensacola was established on the site of the former Navy Yard. Upon the arrival of the aviation unit, the canvas tent hangars from Annapolis were erected to house the seven aircraft currently in service while the *USS Mississippi* sheltered non-flight activities (Figure 1-4). Thirty existing structures which had survived the Civil War and the subsequent hurricane and tidal wave of 1906 were rehabilitated and put to use in support of the new aviation mission. A brick storehouse, Building 27, was retrofitted as a hangar. Commander Henry C. Mustin suggested that existing erecting shops should be converted for the same purpose. A brick two-story structure, Building 1, was used as a Joiner and Woodworking Shop in which wooden parts for the seaplanes were built. Though poorly suited to their new function, these existing structures were less expensive than new construction.[24]

No sooner had Naval aviation found its new home than, in April and May 1914, its members were mobilized for their first combat deployment, which was prompted by heightened military tensions related to the Mexican Revolution. The two aviation detachments supported Navy and Marine Corps operations at Tampico and Veracruz throughout these months, conducting primarily reconnaissance and spotting missions. The bullet holes sustained by Lieutenant N. L. Bellinger's plane during a reconnaissance of the Veracruz anchorage for mines constituted the first combat damage to a Navy aircraft. Following their return to Pensacola, a number of fliers were sent as liaisons to London, Paris, and Berlin to observe aviation developments among the combatants of the Great War. The importance of naval aviation was officially recognized with the creation of the position of Director of Naval Aeronautics in July 1914, and the naming of Captain Mark A. Bristol as the first director in November. At the same time, technological developments at NAS Pensacola enabled the emergence of the swept wing in the Burgess-Dunn AH-7 and AH-10.[25]

Steady progress marked the next three years at Pensacola, prior to American entry into WWI, as naval aviation expanded in size, scope, and technology, including the Navy's first steps in lighter-than-air (LTA) aviation. The Navy's air arm grew from 48 officer pilots in 1915 to 150 officer and enlisted pilots in 1916. Funding support in these years could consistently be measured in the millions of dollars. Constant advances were made in aircraft size, performance, and reliability, as well as in more complex and reliable instrumentation. The Aeronautical Engine Laboratory was established in 1915 at the Washington Navy Yard, where much of the developmental work was undertaken, but operational testing of the new developments was conducted largely at NAS Pensacola. The Naval Appropriations Act of 1916 provided for a Naval Flying Corps, backed by a Naval

Reserve Flying Corps, the first officially recognized aviation units in the U.S. Navy. It also appropriated more than $3 million for naval aviation, a portion of which was immediately spent to acquire new trainer aircraft. Thirty of the sixty new planes were Curtiss N-9 seaplanes, the first tractor types that the Navy owned in numbers.[26]

These advances in Naval aviation were matched by physical development of NAS Pensacola itself. In August of 1915, Commander Mustin was given authorization to build new hangars for thirty planes at a cost of $110,000. In addition, a new steel barge hangar was constructed for the Navy's first LTA craft, which arrived on 16 December 1915. This unique floating hangar contained an enclosed shop on one end and was open on the other end (Figure 1-5). In 1916, the Navy's first three permanent hangars of steel and asbestos were completed at Pensacola. Each structure measured 102 ft x 72 ft, but was expanded to 102 ft x 148 ft in 1917. Despite all of its progress, Naval aviation would have much work yet to complete before it would be ready for its involvement in the Great War.[27]

Implications of the New Marine Corps Aviation Mission

The opening decades of the 20th century were years of significant change and development for the U.S. Marine Corps. Central to these changes was a profound doctrinal evolution, with debate raging in naval circles as to whether or not the Marine Corps was even necessary anymore, and if so, what its mission was to be. The final resolution of this controversy called for the Marines to shed their old ship-board security and gunnery duties and accept the mission of acquiring and securing advanced bases for the growing steel fleet. To support this new mission, the Marine Corps established its new Advanced Base School at the Marine Corps Depot in Philadelphia, PA, in 1911. There it developed a new doctrine for its increasingly independent mission and trained its personnel to execute it.

One very important part of this developing doctrine was defining the role to be played by Marine Corps aviation, which was then taking its first steps in conjunction with the Navy's air arm. The close connection between the Navy and Marine Corps was quite evident in these pioneering years, and has continued to the present day. In particular, the Navy's Bureau of Yards and Docks was and still is responsible for the Marine Corps' aviation shore facilities, and in their early years the sister services operated in conjunction from the same facilities.

Marine Corps aviation was officially born on 22 May 1912, when First Lieutenant Alfred A. Cunningham reported to the Navy's aviation camp at Annapolis "for duty in connection with aviation." Cunningham was a member of the Corps'

Advanced Base School and an avowed aviation enthusiast. He had been conducting privately funded tests of a privately owned aircraft in conjunction with the Aero Club of Philadelphia, and was convinced that the airplane would be of great utility to the Corps' advanced base operations. Apparently, he was able to convince his superiors of this, and was temporarily detached from the school to enroll in the Navy's new flight program. Cunningham joined the Navy's flying school at Annapolis, but quickly obtained orders to visit the Curtiss factory at Marblehead, MA. He soloed there on 20 August 1912, after less than three hours of ground instruction. Later Marine Corps aviators who followed Cunningham — including First Lieutenant Bernard L. Smith, who arrived at Annapolis in September — trained with the Navy either at the Annapolis aviation camp or at Pensacola.[28]

Slow steps forward in conjunction with naval aviation followed for the Marine Corps pilots. Cunningham withdrew from flight duty in 1913, as his fiancée refused to marry him as long as he continued the hazardous duty. He was replaced by Second Lieutenant William M. McIlvain. The first practical test of Marine aviation took place in January and February 1914, when Smith and McIlvain deployed with the fleet to Culebra, Puerto Rico, for maneuvers. This exercise was a test of the Marine Corps ability to seize and hold advanced bases for the fleet, and the two pilots conducted daily reconnaissance flights in support of the ground forces throughout the maneuvers. They also availed themselves of the opportunity to take aloft the higher Marine Corps commanders in order to demonstrate the value of aerial reconnaissance, and they apparently made quite an impression.[29]

In 1915, Smith deployed to Europe to observe aviation developments in WWI. McIlvain remained as the Corps' entire aviation strength. In April, McIlvain was joined by Cunningham, who must have convinced his new wife of his importance to the program. In the summer, Second Lieutenant Francis T. Evans became the Corps' fourth qualified pilot. McIlvain was then sent to train with the Army Signal Corps Air Division at North Island. The Marines had decided that the superior combat performance of land planes would be crucial to the effective aerial support of the Advanced Base Force, and forged an agreement with the Army so that Marine aviators would be trained in both sea and land planes.[30]

By the end of 1916, the Corps' air strength stood at five officers and 18 enlisted men in the "Marine Section" of the Naval Flying School at NAS Pensacola. On 26 February 1917, Cunningham received orders to organize the Corps' first independent aviation unit, and the Marine Corps Aviation Company was established at the Philadelphia Navy Yard as a component of the Advanced Base Force. Its authorized strength was ten officers and forty enlisted men, and it was planned

to be equipped with both land- and seaplanes. It had only just begun to receive its own aircraft when the United States entered WWI.[31] While the Marine Corps' air arm was far from being ready to play a telling role in the coming conflict, these early years were crucial to the development of its philosophy for air power, emphasizing air support of the Corps' ground forces and close cooperation with the U.S. Navy. To this point in time, the Marine Corps had no independent aviation shore facilities of its own, having always shared Navy facilities — an arrangement that was soon to change.

Table 1-1. The Early Years, U.S. Army aviation.

	1907	1908	1909	1910	1911	1912	1913	1914	1915	1916
Military Conflicts										January: Pursuit of Pancho Villa
Army Aircraft		Wright Flyer tested at Fort Myer, VA	Wright A: 1st Army airplane			Burgess H: First tractor-type airplane		Curtiss JN: Trainer produced in large numbers		Curtiss JN-3 Trainer serves in Mexico
Army Aviation Operations		20 Aug: Flight trials at Fort Myer, VA 17 Sept: Selfridge crash brings first fatality	July: Wright Flyer passes trials Oct: Pilot training starts at College Park	March: Flight training begins at Fort Sam Houston		Summer: First exercises with Ground Forces at maneuvers in Connecticut Autumn: Flight training begins at North Island				
Army Aviation Administration	1 Aug: Founding of Signal Corps Aeronautical Division				March: First appropriations for aviation of $125,000			July: Founding of Signal Corps Aviation Section & assignment of first permanent personnel Aug: Formation of First Aero Squadron		March: National Defense Act appropriates $13 million for aviation
Construction Support of Army Aviation				First 2 wood hangars built at Fort Sam Houston	Summer: Quartermaster Dept builds 4 wood hangars at College Park IAW first standard hangar plan	Two existing barns and tent hangars are sole aircraft shelters at North Island			Quartermaster Dept completes new standard hangar plans; replaces 1911 series Dec: New construction finished, Ft. Sam Houston	First permanent aviation facilities planned at Langley Field Begin expansion & construction under National Defense Act of 1916

Table 1-2. The Early Years, U.S. Navy and Marine Corps aviation.

	1911	1912	1913	1914	1915	1916
Military Conflicts				April: Mexican crisis at Tampico & Veracruz		
Navy/Marine Corps Aircraft	A-1 Triad becomes Navy's first aircraft Curtiss seaplane: First Navy tractor type			Burgess-Dunn AH-7 & AH-10: First swept wing craft	Navy acquires its first lighter-than-air craft (dirigible)	Curtiss N-9 seaplane: First tractor type acquired in numbers
Navy/Marine Corps Aviation Operations			Jan: First naval aviation deployment; maneuvers in Caribbean	Jan: First Marine Corps aviation deployment; Culebra, Puerto Rico	First Marine Corps landplane training with Army at North Island	
Navy/Marine Corps Aviation Administration			Oct: Chambers Board commissioned. Report endorses naval aviation and advocates establishing a permanent naval air station.	July: Naval aviation officially recognized with creation of Director of Naval Aeronautics position		Naval Appropriations Act of 1916 creates Naval Flying Corps & Naval Reserve Flying Corps, the first officially recognized aviation units
Construction Support of Navy/Marine Corps Aviation	Construction of special-function facilities is centralized under the Bureau of Yards & Docks		First mobile aviation camp set up at Greenbury Point, near Annapolis Canvas tent hangars used as mobile aircraft shelters	January: First permanent Naval Air Station founded at Pensacola Canvas tent hangars used at Pensacola	Steel barge hangar built at Pensacola for the Navy's first lighter-than-air craft	Navy's first permanent hangars built at Pensacola

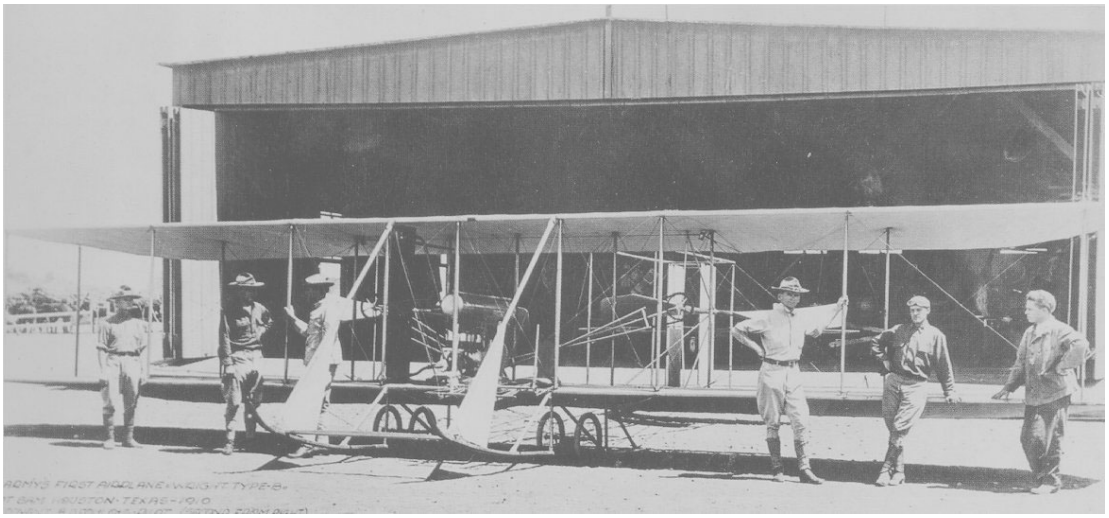

Figure 1-1. Aeronautical Division's first purpose-built aircraft shelter, Fort Sam Houston, TX, ca. 1910.

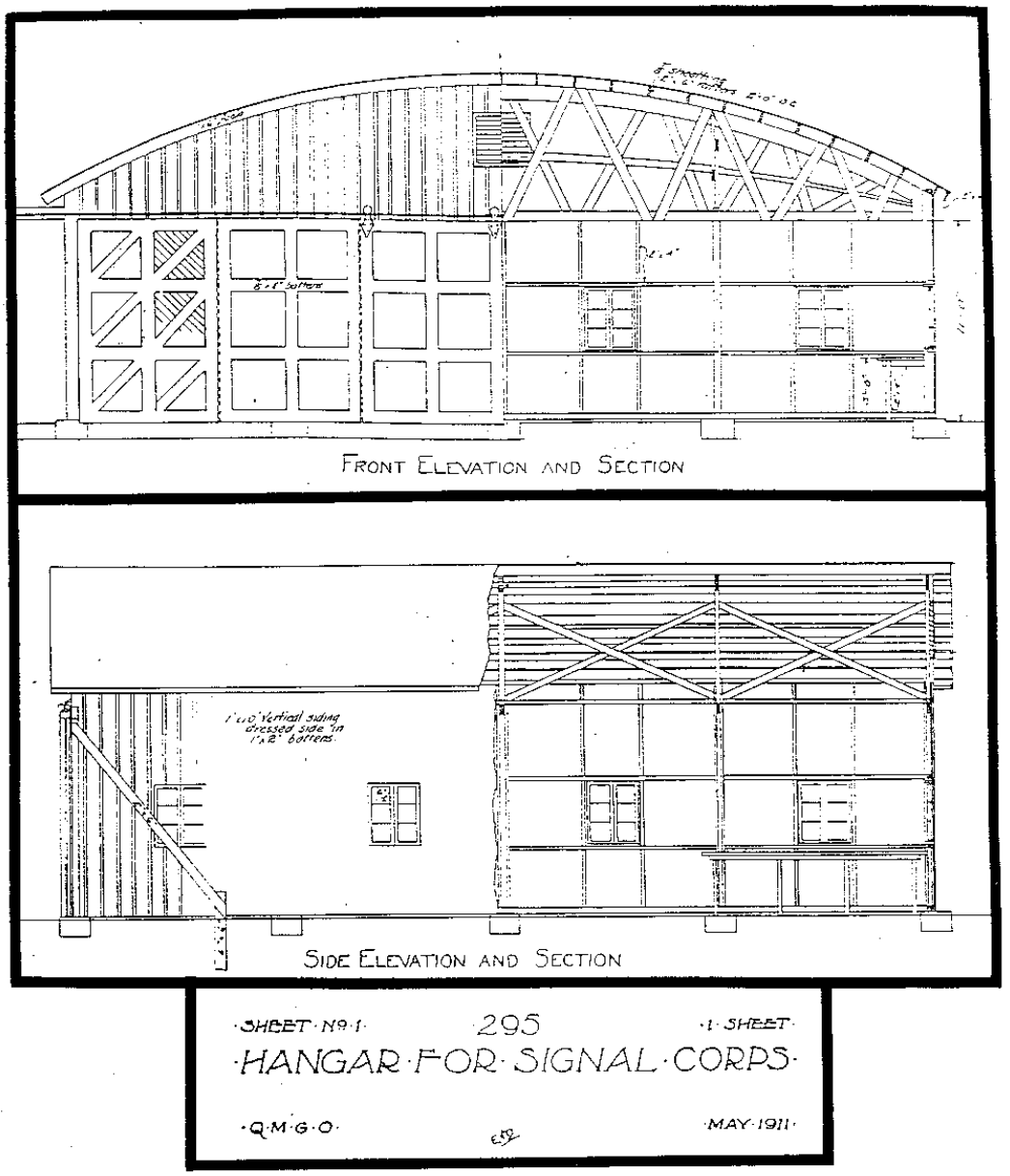

Figure 1-2. First known standard hangar plan, Quartermaster Plan No. 295 for a Signal Corps Hangar, ca. 1911.

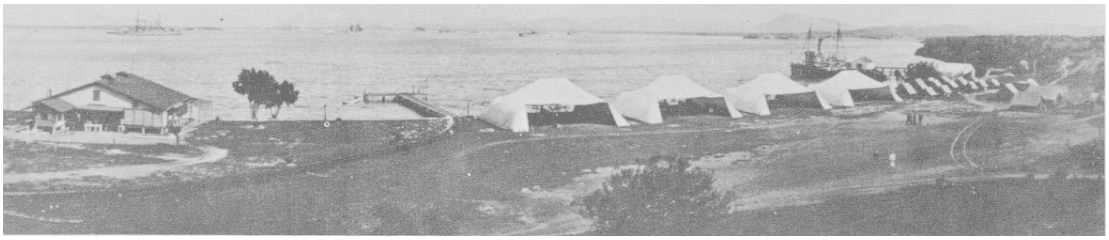

Figure 1-3. Typical Naval Aviation Camp at Fisherman's Point, Guantanamo Bay, Cuba, ca. January 1913.

Figure 1-4. Tent hangars at NAS Pensacola, FL, ca. 1914.

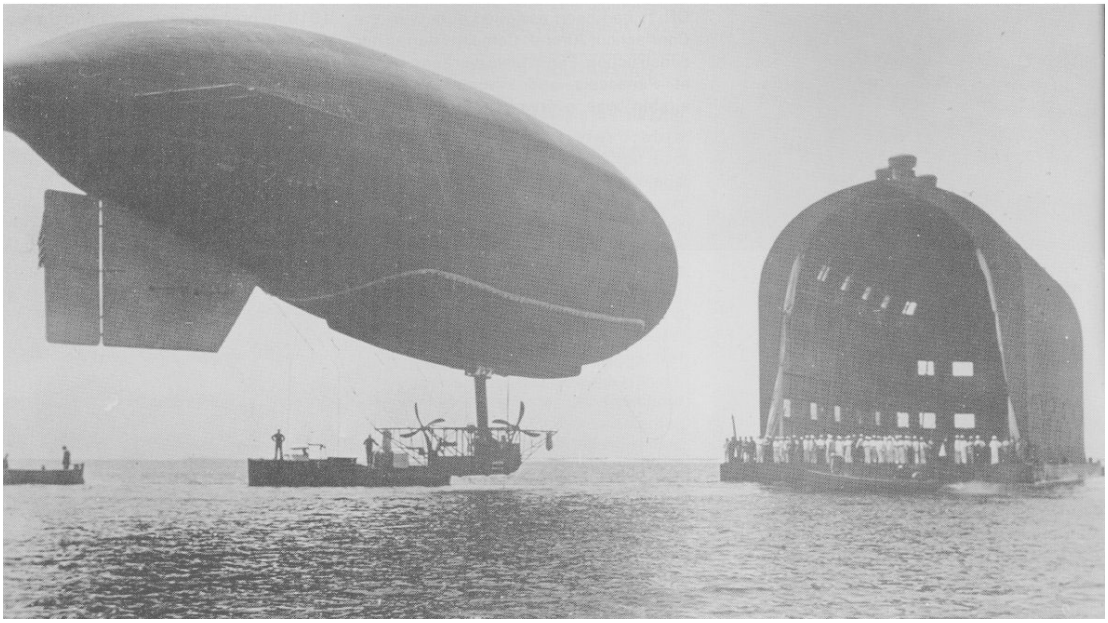

Figure 1-5. Floating LTA hangar at NAS Pensacola, FL, ca. 1916.

Endnotes for Chapter 1

1 Lenore Fine and Jesse A. Remington, *The Corps of Engineers: Construction in the United States* (Office of the Chief of Military History, U.S. Army, 1972), pp 4-8; Erna Risch, *Quartermaster Support of the Army: A History of the Corps, 1775-1939* (Office of the Quartermaster General, Quartermaster Historian's Office, 1962), p 210.

2 R. C. Goodwin & Associates, *National Historic Context for Department of Defense Installations, 1790-1940*, Vols. I & II (U. S. Army Corps of Engineers, Baltimore District, 1995), pp 47, 154, 176, 181.

3 Engineer Regulation (ER) 1110-345-710, Engineering and Design Drawings, (Department of the Army, 17 April 1981); *Hearings, Military Public Works Appropriations, 1953, Part 3—Department of the Air Force*, before the Subcommittee of the House Committee on Appropriations, 82nd Congress, 2nd Session, 1952, pp 44-47.

4 ER 1110-345-710, *Engineering and Design Drawings* (Department of the Army, 17 April 1981).

5 W. J. Boyne, *Silver Wings: A History of the United States Air Force* (Simon & Schuster, 1993), pp 14-16; C. V. Glines, The Compact History of the United States Air Force: New and Revised Edition (Hawthorn Books, Inc., 1973), pp 21-37.

6 D. A. Anderton, *History of the U. S. Air Force* (Hamlyn Publishing Group, 1981), pp 13-15.

7 H. M. Mason, *The United States Air Force: A Turbulent History* (Mason/Charter, 1976), pp 1-11; Boyne, pp 16-24.

8 Anderton, pp 16-17; Boyne, pp 14-31.

9 J. Brown, *Where Eagles Land: Planning and Development of U. S. Army Airfields*, 1910-1941 (Greenwood Press, 1990), pp 17-18.

10 M. D. Freeman, *Fort Sam Houston: An American Depot*, Headquarters, and Training Facility, 1876-1946 (U. S. Army Corps of Engineers, Fort Worth District, 1994), p 79.

11 Brown, p 18; Goodwin & Assoc., pp 441, 447.

12 Anderton, pp 17-18; Brown, p 19; Glines, pp 55-63.

13 Brown, p 19; Goodwin & Assoc., p 442.

14 Brown, pp 20-25.

15 Anderton, p 18; Brown, p 26.

16 Boyne, pp 32-35; Glines, pp 68-72; Mason, pp 23-34.

17 Robert I. Curtiss, et al., *Langley Field: The Early Years: 1916-1946* (Langley AFB, VA: Office of History, 4500th Air Base Wing, 1977), pp 11-17; Brown, pp 26-30.

18 Anderton, p 20; Brown, p 30; Glines, p 72.

19 Goodwin & Associates, pp 163-172, 189.

20 NAVAIR 00-80P-1, *United States Naval Aviation, 1910–1970* (Deputy Chief of Naval Operations [Air], 1970), pp 3–5; Captain Archibald D. Turnbull, USNR, and Lieutenant Commander Clifford L. Lord, USNR, *History of United States Naval Aviation* (Yale University Press, 1949), pp 1–17.

21 *Activities of the Bureau of Yards and Docks, Navy Department: World War, 1917-1918* (Government Printing Office, 1921), p 395; Archibald D. Turnbull, Captain, USNR & Clifford L. Lord, Lieutenant Commander, USNR, *History of United States Naval Aviation*, (Yale University Press, 1949), p 17.

22 NAVAIR 00-80P-1, pp 6-7; Turnbull & Lord, pp 17-28.

23 NAVAIR 00-80P-1, pp 7-9; Turnbull & Lord, pp 33–35.

24 The Cradle (Pensacola Engraving Company, Inc., 1989), pp 18-26.

25 NAVAIR 00-80P-1, pp 9-11.

26 Lieutenant Colonel Edward C. Johnson, USMC, *Marine Corps Aviation: The Early Years, 1912-1940* (History and Museums Division: Headquarters, U. S. Marine Corps, 1977), pp 11-15; Turnbull & Lord, pp 45-95; Johnson, p 9.

27 The Cradle, pp 26-49.

28 Major General John p Condon, USMC (Ret.), *U. S. Marine Corps Aviation* (Deputy Chief of Naval Operations (Air Warfare), 1987), p 3; Lieutenant Colonel Edward C. Johnson, USMC, *Marine Corps Aviation: The Early Years, 1912-1940* (History and Museums Division: Headquarters, U. S. Marine Corps, 1977), pp 1-4; NAVAIR 00-80P-1, p 6.

29 Johnson, pp 4-8.

30 *Ibid.*, pp 8-9.

31 Condon, pp 3-4; Johnson, pp 9-10.