3 The Interwar Years (1919 – 1938)

Army Air Corps Aviation Construction After WWI

The Interwar Years constituted a crucial stage in the growth of U.S. air power from its infant days in the First World War to the rapid buildup for the Second World War, in which it would reach maturity. The period was characterized by significant technological and doctrinal development, intensive political maneuvering over the question of an independent Air Force, and constant budgetary struggles to maintain necessary funding levels in a time when the American people had little interest in or sympathy for military matters. The Interwar Years were a difficult time for all of the armed services, but through various means and to various degrees they survived the lean years of the early 1920s and the Great Depression, to grow and develop in the late 1930s in preparation for the coming World War. This was the experience of the Army's air arm in its efforts to maintain and expand its network of aviation facilities. The Air Service weathered a sharp demobilization and lean funding years, followed by a resurgence in the mid-1920s and steady growth throughout the 1930s, despite the Depression. This growth accelerated into an explosion of activity in preparation for the conflicts looming just over the horizon.

MAJOR THEMES AND CONTEXTS

- WWI Demobilization and the Lean Years
- The Five-Year Plan — Early Construction
- The Five-Year Plan — Expansion
- The Wilcox Act — Early Expansion in the West

WWI Demobilization and the Lean Years

Downsizing and Finishing WWI Projects

Immediately following the Armistice in November 1918, the United States commenced a rapid demobilization that cut across all services. The Army Air Service could not avoid these cutbacks, and by 1920 fewer than 10,000 men remained in active service — a mere 5 percent of the wartime force level. Massive contract cancellations threatened the aircraft industry, as cuts in funding for new equipment forced the Air Service to make do with planes left over from WWI. Appropriations were slashed as well, not only plummeting below wartime levels, but falling substantially short of requested sums. Limited by the lack of funding, the

Air Service struggled to establish a system of airfields that would support its broad range of missions, including fields for training, engineering and experimentation, reserve flying, southern border patrol stations, aerial coastal defense stations, and civil airway stations.[1,2]

With the close of hostilities, the majority of the outstanding construction contracts and all of the $485 million in uncommitted wartime funds yet to be executed were unceremoniously canceled. However, a number of projects were quickly completed under the continuing supervision of the Construction Division in the opening months of 1919, amounting to over $42 million on 38 installations for the Air Service alone. A good deal of this construction consisted of the erection of U.S. All-Steel Hangars already in the Army's possession, primarily for use as emergency storage facilities. Hundreds of these hangars were erected at Air Service fields all over the country — almost every active installation received a few of them. Rockwell Field erected over 20, and Langley appears to have had about the same number. These hangars were even erected by other agencies. The Army's Motor Transport Corps also took advantage of them, constructing dozens to shelter the great number of war surplus cars, trucks, and trailers at Camps McPherson, Jesup, Holabird, Normoyle, and Boyd, in Georgia, Maryland, and Texas.[3] At the same time, the Real Estate Service began to purchase land at fields where the lease was soon to expire. Fifteen such facilities were purchased in this way. This acquisition process came to an end in July 1919, when Congress forbade the purchase of any further real estate by the Army without explicit permission.[4]

The 1919 Air Field Plan and Amendments

In the summer of 1919, the Air Service Director of Operations, Major General Henry Jervey, laid out a plan for Congress delineating which fields the Air Service considered crucial to its operations, and which could be disposed of. This accounted for 12 single- and 2 double-squadron flying fields, and one observation training field. This 1919 plan was the Air Service's first attempt to establish a comprehensive system for its flying fields throughout the country. Most of the fields identified in the plan did indeed remain active, though some modifications were necessary. Over the next 3 years, 2 flying fields, 2 coastal patrol stations, 1 depot, and 3 lighter-than-air (LTA) fields were also added to accommodate new missions and unforeseen operational demands.[5] But lack of Congressional funding support and diminishing manpower levels were the prime motivators of subsequent modifications of the general plan. When Congress cut Air Service funding and reduced force levels, a considerable amount of consolidation in flying operations was necessary to effect economies.

In 1922, the Chief of the Air Service, Major General Mason Patrick, proposed a plan that called for the abandonment of a number of facilities in order to consolidate flying operations on the better established installations, projecting significant savings in maintenance that could then be used for other purposes. He singled out eight flying fields and three depots for abandonment or inactivation. Fifteen flying fields — including three LTA fields — and two depots were selected for retention on active status.[6] This system of fields was retained through 1926 with only minimal changes, though some of Patrick's original recommendations were disregarded for political reasons,* and some fields proved to be unnecessary due to later developments. In 1926, Patrick supplied a detailed inventory of the Air Service's ground facilities that included 13 flying fields (2 LTA), 16 auxiliary fields and airway stations, five border patrol fields, five air depots, and five inactive flying fields. In addition there were nine minor fields associated with permanent Army posts where aviation was only a subsidiary activity, intended to act as staging fields for joint maneuvers, and to allow permanent Army personnel the opportunity to learn how to fly. The auxiliary fields and airway stations provided training grounds for the increasing number of National Guard and Army Reserve fliers. The active fields, where the bulk of the Air Service's flying and testing activities operated, and which constituted the core of the Air Service's ground facilities throughout the Interwar Years, included:

- Bolling Field (Bolling AFB)
- Brooks Field (Brooks AFB)
- Chanute Field (Chanute AFB)
- Crissy Field (Presidio of San Francisco)
- Kelly Field (Kelly AFB)
- Langley Field (Langley AFB)
- Maxwell Field, AL (Maxwell AFB)
- McCook Field
- Mitchel Field, Long Island, NY
- Rockwell Field (NAS North Island)
- Selfridge Field (Selfridge ANGB)
- Ross Field, IL (LTA) (Great Lakes Naval Training Center)
- Scott Field (LTA) (Scott AFB).[7]

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* Selfridge Field and the Fairfield Air Depot, for example, were both retained despite the objections of Air Service leadership. Patrick regarded both facilities as inferior and overly expensive to maintain. He was forced to keep the installations active anyway, as Congress exercised final oversight of base closure issues and both fields were evidently well represented in that body.

Postwar Ground Facility Deterioration

Throughout the early 1920s, Air Service leadership proved increasingly reluctant to spend what little funding they received from Congress on maintenance and repair (M&R) of ground facilities. Given the relatively unsettled status of long-range base utilization plans, perhaps this is not surprising. It was more attractive to Air Service leadership to concentrate resources on the development and acquisition of advanced aircraft than it was to spend — and potentially waste — money on the maintenance of temporary structures at installations with uncertain futures. This preference was all the more pronounced in cases where Air Service leadership had actually requested that the installation be abandoned. As early as 1919, for example, Air Service officers noted that the temporary hangars constructed at Mather Field had not been painted with oil-based paints, and that the water-based paints had already washed off, exposing the cladding to corrosion. They called for a decision on the future of the base so the buildings could either be repaired and maintained, or disposed of. In the meantime, the structures continued to deteriorate, their usefulness declining while the cost to maintain them rose.[8] In 1922, Major General Patrick reported that the Air Service owned 320 hangars, whose proper maintenance and repair would cost $250,000. He then noted that the Air Service was able to allot only $106,000 for that purpose, a meager figure representing approximately 3 percent of their original construction cost. This appropriation was entirely insufficient, and the buildings were rapidly falling into disrepair, their cladding of ungalvanized corrugated iron rusting and giving way.[9] In 1925, the repair budget for all buildings at 10 major installations amounted to $500,000 — just 2 percent of the original cost of construction — and 80 percent of that sum came from the Army's own Quartermaster Corps.[10] The Air Service was in the unenviable position of having to invest increasing amounts of money in the maintenance of buildings that were losing their value and usefulness faster than they could be restored and maintained.

To complicate matters, steady improvements in aviation technology throughout the 1920s resulted in heavier and more powerful aircraft. This sometimes made it necessary to upgrade existing facilities, especially to lengthen and strengthen runways and aprons, further sapping the Air Service's limited construction appropriations. The relocation of the Air Service engineering and testing plant from McCook Field presents a worst-case example of the changes required to adapt to the new aircraft. McCook was situated on the outskirts of Dayton, OH, and as that city grew up around it, expansion became impossible. As developmental aircraft grew heavier and more powerful, they required landing strips of greater length, with longer glide paths, and stronger surfaces to withstand greater wheel-loading. As the size of the landing field at McCook was effectively

limited to its existing state, it was determined in 1922 that the experimental facility had to be moved to another site with more space. Two years of investigation and debate followed, during which questions were raised regarding the reasons for McCook's initial foundation, Langley Field's failure as an experimental facility, and possible cooperation with the Navy's developmental program. In the end, the site chosen was adjacent to nearby Wright Field on land that had been donated by Dayton businessmen, led by Frederick M. Patterson. The land was accepted in 1924 and ground was broken in 1926, but the new technical facilities would not be completed until 1928.[11]

While the Air Service allocated sizeable sums to the development of Wright Field as the home of the new Air Service Materiel Division, the expenditure of large amounts of Air Service funds for new construction was certainly not the norm. In fact, with maintenance requirements regularly left unmet throughout the early 1920s, the Air Service conducted very little new construction. There were, however, a few exceptions. Some World War I construction had been finished in 1919, and a great number of temporary U.S. All-Steel Hangars were erected for emergency storage purposes, as noted previously. In 1920, Langley Field received some permanent improvements that began to address the elements missing from Kahn's original design. Two large, permanent seaplane hangars were erected there to support seaplane testing. Each measured 190 x 205 ft and featured steel and reinforced concrete construction with gypsum slab roofs.[12] A single Bombing Plane Hangar was completed in September 1920, to support the *Ostfriesland* tests being conducted off Hampton Roads (see below). This temporary structure featured steel framing and metal cladding on its walls and roof, and measured 110 x 140 ft.[13] In 1921, two permanent steel-and-brick landplane hangars were constructed on the northeast end of the Langley flight line. An immense steel-and-asbestos LTA hangar was also constructed on the base which, after a 1922 expansion, measured 420 x 125 x 116 ft and cost over $425,000. This hangar was intended to establish Langley Field as the Air Service's East Coast LTA station.[14] A corresponding LTA hangar was also constructed at Brooks Field in 1920, measuring 270 x 134 x 113 ft.[15] Thus Langley and Brooks fields, together with stations already established at Scott and Ross Fields, constituted the Air Service's continental LTA airway network.[16] Two Coastal Patrol stations — Miller Field, at Staten Island, NY, and Crissy Field, at the Presidio of San Francisco, CA — had also been established in 1920. Each included two permanent seaplane hangars, each 160 x 200 ft, and constructed of steel frame, cement plaster walls, and gypsum slab roofing.[17] In 1923, both Langley and Rockwell Fields received a small amount of new construction. Two steel hangars were erected at Langley and one at Rockwell, each measuring 110 x 200 ft in accord with a standard design used during the early post-war construction campaigns.[18]

These notable examples aside, the vast majority of the Air Service's construction activities in the early 1920s consisted mostly of minor modifications and M&R activities. As the decade progressed, the budgets for FY23 – 27 each allocated between $265,000 and $300,000 for construction and repair activities, but all emphasized the fact that none of it was for new construction. The lone exception to this rule came in 1922, when $201,000 of the $265,000 allotted went to the erection of hangars on Reserve and National Guard fields, the materials for which were already in the possession of the Air Service. Just $64,000 went to the modification of existing hangars. In 1924, all $300,000 went to modifications and repairs as needed, with the single exception of a storage hangar being constructed at Kelly Field. The same was true in 1926, when the bulk of the Air Service's $285,000 went to minor modifications and repairs, while $52,000 was allotted for the erection of three of the standard 110 x 200 Foot Hangars (see below) at Middleton Depot. The pattern is persistent throughout the early- to mid-1920s. Insufficient construction appropriations were doled out in small parcels for maintenance and repair at a number of fields. This maintenance program was augmented by a small number of minor construction projects, consisting primarily of the erection of pre-owned hangars to fill emergency needs.[19] Throughout the period, new construction was supervised through the Construction Division and repairs and modifications were conducted by the Air Service's Building and Grounds Division.

Progress In Aeronautics

While little was being accomplished in the way of new construction at its installations, the Air Service made great strides in other areas. Important technological advances followed one after another in the field of aeronautics, and Air Service pilots and engineers played a key role in these developments. In an effort to drum up popular support for air power, and perhaps some Congressional budgetary support as well, Air Service personnel embarked on a series of record-breaking flights and other publicity ventures such as air races. World aviation records were repeatedly set and broken as aviators tested the limits of themselves and their rapidly developing aircraft before the public. Air Service Captain Charles Lindbergh's pioneering trans-Atlantic flight in May 1927 is the classic example of this sort of well-publicized landmark exploit.[20]

Strategic Air Power and the Autonomy Issue

More than any other activity, however, air power advocates expended their energies in sustained political battles over the Air Service's strategic roles and missions, and its status as a subsidiary arm of the U.S. Army. Air Service leadership was very vocal in support of the expansion and development of their

organization. As early as 1916, some argued that an independent air arm should be established as an equal to the Army and Navy, along the lines that the British had followed in creating the Royal Air Force. Perhaps the most vocal of these men was General Billy Mitchell. As Assistant Chief of the Air Service and a highly decorated World War I commander, Mitchell was a popular public figure who never missed an opportunity to speak in favor of an independent Air Force. He saw the future of air power in the strategic bomber, and advocated its adoption in large numbers for the defense of America's shores and to enable deep strategic strikes against the nation's enemies. Disagreements with the Navy over the bomber's ability to defend America by sinking enemy ships would seem to have been resolved by tests conducted in the Chesapeake Bay in 1921. Here, the *Ostfriesland*, a captured German heavy battleship, was sunk by Martin MB-2 bombers under Mitchell's command. Other naval vessels of various sizes and types were destroyed in this and subsequent testing, but little came of it. The Navy still insisted that its battleships constituted the nation's first line of defense, and most of the Army leadership still believed that the proper role for military aviation lay in observation and tactical support, not strategic bombing. Years of frustration for Mitchell and his adherents culminated in 1925, when the fiery General attacked Army and Navy leadership in the press following the *Shenandoah* disaster.* His subsequent court-martial removed Mitchell from a position to affect the fate of the Air Service, although his highly publicized passing from service may have served to illuminate the issue at hand and garner some popular support.[21]

The Air Service's battle for autonomy and for recognition of what it believed to be its full strategic potential would play a central role in the development of its ground facilities. As a relatively minor branch of an Army in financial crisis, the Air Service had to deal with chronic funding deficiencies. One result was the sorry condition of its flying fields by the middle 1920s. While the struggle for autonomy as an equal service branch was far from over, a significant step was about to be taken in that area, and the Air Service's ground facilities would feel the results immediately.

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* The *Shenandoah* was the first rigid airship constructed in the United States. After its maiden flight in September 1923, it operated as the Navy's flagship dirigible for the next 2 years. On 3 September 1925, the *Shenandoah* flew into a storm over eastern Ohio, broke in half ahead of the forward engines, and crashed about 25 miles east of Zanesville. Fourteen crew members perished in the incident, including the commanding officer, Lieutenant Commander Zachary Lansdowne. Mitchell called a press conference and issued a lengthy, indelicate broadside charging the Navy and the War Department with incompetence, criminal negligence, and almost treasonable administration. The result of Mitchell's court-martial was less than surprising.

Creation of the Army Air Corps and Expansion Under the Five-Year Plan

While Mitchell was out of official channels, others worked within the system to modernize the Air Service. The passage of the Air Corps Act of 1926 marked a definite improvement in the funding support and status of the Army's air arm. This act created the U.S. Army Air Corps and advocated significantly increased budgetary appropriations to allow this organization to double in size over a five-year period. Improvements in the Air Corps' ground facilities were explicitly included in this program, and this marked the genesis of the Five-Year Plan that would bring the first permanent and significant improvements to flying fields since their establishment in WWI. While appropriations, growth, and construction all fell somewhat short of expectations, the Air Corps Act and the Five-Year Plan that resulted from it did indicate some early official recognition of the growing importance of air power.

The Air Corps Act of 1926

In 1925, two administrative studies were conducted to address the future organization of the nation's military establishment, and the role that air power would play in that organization. The President's Aircraft Board, better known as the Morrow Board, recommended that the Air Service remain a part of the Army, but that it be upgraded to Corps status and be drastically expanded. Congress's Lampert Committee made a counter-recommendation that advocated a more substantial reorganization, with a single Department of Defense and three equal service branches — Army, Navy, and Air Force. The Air Corps Act of 1926 generally adopted the recommendations of the Morrow Board, perpetuating the status quo in the War Department, but taking some steps to remedy deficiencies in funding, equipment, and manpower. This act created the U.S. Army Air Corps and called for greatly increased funding levels to support a substantial expansion program over a five-year period. By 1932, the Air Corps was expected to meet planned force levels of 1,800 planes, 1,500 pilots, 2,500 flying cadets, and 16,000 enlisted men.[22]

The Five-Year Plan for Ground Facility Expansion

In addition to providing for this impressive expansion in aircraft and manpower, the Air Corps Act specifically called for the expansion and improvement of the Air Corps' ground facilities. It was quite clear to Air Corps leaders that a

concentrated technical construction campaign had to accompany the other facets of the Five-Year Plan.*[23] At its inception, the Five-Year Plan for technical construction advocated the establishment of one new flying training field with all permanent construction, and major permanent construction efforts at essentially all established fields across the country — 32 in total. This program called for over $18 million in technical construction over the five years, including 125 hangars and hundreds of other related structures and landing field improvements. Funding for the program was anticipated at about $500,000 for FY28, $2.2 million for FY29, $5.4 million for FY30, and $5 million each for FY31 and FY32. The program was administered in conjunction with the Army Housing Program, through which excess properties were disposed of and the proceeds committed to the improvement of remaining facilities. In reality, this arrangement merely overlaid another bureaucratic level onto the process, since no proceeds from these sales were ever appropriated for Air Corps construction.[24]

Use of Standard Hangar Designs

The vast majority of the technical construction for the Five-Year Plan employed standardized hangar plans provided by the Construction Division. The first half of the program was dominated by the use of a single design for the 110 x 200 Foot Hangar. This hangar featured gabled steel truss-work and corrugated metal siding, with exposed steel-frame door-track extensions (Figure 3-1). For later, more substantial building efforts, a series of related standardized hangar designs were employed that all measured about 110 x 120 or 240 ft, and featured steel truss-work and terra-cotta or stucco cladding. The 1929-A and -B, and 1930-A, -B, -D, and -E designs all had a gabled roof with substantial piers at all four corners, and were often constructed in pairs with a connecting shop or office annex. Detailing on the piers and cladding distinguished these types from each other, particularly in the number and placement of windows (Figure 3-2). The 1929-B design featured double piers at all four corners. Another related design of the period was the Type A-A Hangar, which featured arched roofs with corner piers, but otherwise resembled the 1929 and 1930 hangars (Figure 3-3). A new standardized layout was also provided by the Building and Grounds Office to replace the older WWI standard. This design grouped all the buildings in one

* This concern on the part of the Air Corps leadership for the technical construction campaign was indicated during the Senate hearing on the Air Corps Act, in May 1926. General Patrick expressed concern that the word “hangars” be inserted into Section 7 of the Act, in order that funds would be provided for their construction in conjunction with appropriations for aircraft and men. The word was accordingly inserted, and served as the general justification for the subsequent construction of scores of hangars over the following years.

corner of the mile-square section, leaving the long diagonal axis available for the actual flying field. This field layout was employed on bases that received substantial new construction as a result of the Five-Year Plan, including March and Barksdale Fields (Figure 3-4).

Scattered Early Construction

The first 3 years of the Five-Year Plan, covering the construction projects of 1928 – 1930 that were planned and funded in FY27 – 29, consisted primarily of small but significant improvements to a large number of bases. As funding was not yet of the scope to support large-scale projects, technical construction was spread over a number of active bases in an attempt to alleviate the worst of the hangar space shortages. The appropriations hearings for these years are filled with a number of modest requests for the erection of a single hangar at various flying fields. Some larger projects of as many as six or eight structures were periodically proposed at individual bases but they appear not to have been funded. Almost all of the hangar construction of this early period of the Five-Year Plan involved the erection of standard 110 x 200 Foot Hangars, for which the materials appear to have already been on hand (possibly even left over from World War I). Dozens of these hangars were requested for essentially every active field in the United States, although not all were actually approved and funded for construction.*[25] Nevertheless, a great many of these hangars were constructed at flying fields across the country, including one at Patterson Field in 1928 and two at Langley Field in 1929 that still remain today (Figure 3-5).†[26] A very interesting table included in the FY30 Appropriations Hearing provides a comprehensive listing of the Air Corps' hangar inventory, as of November 1928 (Figure 3-6).

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* This is evident from the fact that the same appropriation requests were made in multiple years. If the Air Service failed to receive the appropriation in one year, it routinely included the same request in the next year's budget. Sometimes, the same project was proposed and rejected three or more times.

† The two standard 110 x 200 Foot Hangars at Langley Field present a particularly interesting case. They were constructed according to an odd Construction Division standard plan that called for twin 110 x 200-footers to be joined at the waist by a single U.S. All-Steel Hangar, which acted as an administrative annex (see Plan No. 695-219 in Standard Plans Section). It is clear that the Air Corps took full advantage of standardization of design and construction, not only in terms of streamlining the design process, but also by repeating construction elements that could be erected quickly and cheaply from stock materials. Moreover, it is abundantly clear from the relevant Congressional Hearings that the Air Corps also took advantage of its standard design system to simplify the appropriations process as well. Every Air Corps funding request for technical construction for FY28 – 30 included a standard hangar construction cost of $39,500 for the erection of each 110 x 200 Foot Hangar. A single hangar at a given field would call for $39,500, two would call for $79,000, and so on in multiples of the standard amount.

Substantial Second-Half Construction

A number of more substantial technical construction projects occupied the latter half of the Five-Year Plan, featuring the activation of two new bases and extensive improvements to three existing bases. In 1929, construction was completed on the new expansion program at March Field. This project included the erection of eight of the standard 110 x 200 Foot Hangars on a new flight line (Figure 3-7) laid out in accordance with the Building and Grounds Division's standard design. March Field was intended as a showcase flying field that could serve as a model for future projects. For years, however, it featured a sort of hybrid layout in that the old 1917 flight line remained along one edge of the section while the new diagonal flight line cut across the section and joined the old one at one corner. The Albert Kahn 120 ft wooden hangars along the old flight line remained for a number of years, producing a distinctive landscape that was not planned as part of the standard. March was to be used as a primary training base in the short run, until the new primary training facility at Randolph Field could be activated. At that point, it was intended to accept a new bombardment group, and its construction program was designed with this later function in mind.[27]

One of the primary aims of the Five-Year Plan was the establishment of a new primary flying training base. This, in fact, was the only new base identified by the original plan for establishment inside the United States. Given the greatly increased number of aircraft authorized for the new Air Corps, it was clear to that organization's leadership that there was an immediate need for a substantially enlarged pilot force. They knew they would have to expand the pilot training programs and facilities in order to accommodate the increased training loads that would be required to churn out record numbers of pilots. Neither Brooks nor Kelly Fields could be efficiently expanded or combined to accommodate the increased load, so it was decided to establish a new primary training school at San Antonio to work in conjunction with the existing training fields in the area. After a difficult search process that occupied the years between 1926 and 1928, the Air Corps finally took possession of the designated land and began construction in October 1928. The design of the new field — designated Randolph Field, after a Texas aviator who had died in a crash earlier that year — was unique in both form and agency. Unlike the World War I and Five-Year Plan standard layouts, the design for Randolph Field originated in the Headquarters of the Chief of the Air Corps. Assistant Chief of Air Corps, General Frank P. Lahm, with the help of Lieutenant Harold Clark, a young engineer from his office, produced an innovative circular design for the primary training field. This design featured a circular central housing and administrative section with radial traffic lines, flanked by squared-off flight lines on two sides. Pilot trainees

would progress in a clockwise manner around the circumference of the field as their training progressed through primary, basic, and advanced stages. The base included 18 large, permanent hangars, designed by the Construction Division in accordance with Air Corps specifications. These hangars were based on the standard 110 x 240 ft 1929-B design, but were slightly widened and shortened to feature main bays measuring 113.5 x 220 ft. Fourteen of the eighteen hangars featured maintenance and administrative annexes of 20 x 60 ft, while the other four included annexes measuring 20 x 173 ft. Both types featured the steel truss structural elements, massive decorative piers on both ends, galvanized metal roofs, and tile and stucco cladding typical of the 1929-B design. Each could house 30 training aircraft and cost slightly more than $31,000 or $34,000 (with the larger annex) to construct. All 18 hangars were completed by August 1931, when the first cadre units started to arrive.[28] They still constitute the bulk of the Randolph flight line today.

Maxwell Field also completed large-scale improvements in 1931 in order to make room for the Air Corps Tactical School. This function was to be transferred there in 1932 from Langley Field, which had become overcrowded. Four 1929-B Hangars, very similar to those at Randolph, were erected at Maxwell to support the new operation (Figure 3-8). Further expansion came in 1934 with the completion of a standard Type A-A Double Hangar (Figure 3-9).[29] Langley Field itself received a good deal of new technical construction the following year, apparently in an effort to relieve the over-crowding problem. Five pairs of standard 1930-D Hangars were erected to form a second flight line in front of the original. These were joined by two additional 1930-D Hangar bays as stand-alone units (Figure 3-10).[30]

Also in 1931, another new flying field was established in Shreveport, LA. Barksdale Field was founded to take the place of a field that had been slated for improvement at Fort Crockett. When this project was abandoned, Barksdale was established to house the new Third Attack Wing that was supposed to have occupied the Crockett facility. Barksdale opened in 1932, having received four pairs of standard 1930-B Hangars with shops annexes, two standard 1930-A Hangars, and one single operations hangar similar in architectural style to the other structures. The new standard layout was employed here, with all the buildings situated in one half of the section, and the flight line running diagonally across the longest part of the field. In 1934, five new hangars were added, with four standard Type A-A Hangars and one 1930-A Hangar reaching completion in that year (Figure 3-11).[31]

Setbacks in the Five-Year Plan

The projects at March and Randolph Fields had been anticipated in the Five-Year Plan. In fact, Air Corps leadership had expected these to be the most involved projects of the entire program. As with earlier long-term programs, the Five-Year Plan underwent some notable modification over time — but unlike the 1919 plan, this program actually expanded. Some new construction was made necessary by a series of conflicts with the Navy's air arm over issues of joint occupancy and redundancy of facilities. The best example of this was the intense political melee fought between the services for control of the Rockwell Field-NAS North Island joint facility. In the end, the Navy won this battle, and the Air Corps was ordered to vacate the facility in 1930, finally closing operations there in 1935. Two new fields were established on the west coast to take Rockwell's place — Benton Field in Alameda County accepted the depot function, while Hamilton Field in Marin County took on the pursuit group. The technical construction that was necessary at these new fields set back the completion of the Five-Year Plan on the West Coast by at least two years.[32]

None of the technical construction programs at Maxwell, Langley, Barksdale, Benton, and Hamilton Fields had been a part of the original Five-Year Plan either, but all had become necessary due to unforeseen circumstances. Taken together, they put the program considerably behind schedule and required greatly increased funding appropriations to bring the Air Corps' technical construction campaign to completion. One key factor that necessitated unexpected construction at bases across the country was the surprisingly rapid dilapidation of the many World War I-era temporary steel hangars. Much of this temporary construction had to be replaced ahead of anticipated schedules, requiring significant amounts of permanent construction that had not been included in the original program.[33] Another factor that caused setbacks and necessitated changes in the Five-Year Plan was delayed funding, as Congress fell behind scheduled requests. This may have been due to the economic pressures of the Great Depression, which dominated fiscal policy in the early 1930s.[34] But probably the greatest source of unforeseen demands for technical construction and increased funding was simple inaccuracy in the original plan itself. Air Corps planners had grossly underestimated the cost of the new construction that would be necessary to support the expanded force levels.[35] Although the unanticipated demands from various other sources eventually set the plan back beyond recovery, it is likely that this single initial miscalculation predisposed the program to failure from the very beginning.

The original Five-Year Plan called for about $20 million in technical construction to be completed by 1932. When that deadline arrived, a great deal of work

remained unfinished, and some had not yet even begun — some 17 fields had requirements for hangars yet to be constructed. Air Corps leaders estimated that over $16 million would still be needed to complete the proposed construction.[36] This funding was awarded in 1933 and 1934, and the bulk of the construction was finished over the next 2 years. By that time, new factors were influencing the Air Corps' technical construction program, enabling it to expand despite difficult financial times.

While the Five-Year Plan had run extensively late and over budget, it had succeeded in bringing substantial improvements and permanent construction to essentially every Air Corps base. Almost all flight lines now featured a number of new, permanent hangars, most of them of the standard Air Corps 110 x 200 Foot design or one of the 1929, 1930, or A-A designs. While it was not an unqualified success, the Five-Year Plan had established the foundation of the airfield system on which the rapid mobilization for World War II would be based.

Advances in Aviation Technology

General Advances

Significant advances were made throughout the Interwar Years in aviation technology. The aircraft that fought WWI were but the distant predecessors of those that would duel in the skies of WWII. The introduction of a great number and variety of technological developments contributed to the growing efficiency and effectiveness of the modernizing Air Corps.* These included:

- the all-metal airplane
- the variable-pitch propeller
- the slotted wing
- armor plating
- wheel covers and brakes
- water-cooled engines with the new "prestone" coolant
- poor-weather flying instrumentation, such as the electric altimeter
- long-distance and night aerial photography equipment.

* The Congressional hearings are full of accounts of new aircraft developments, and committee members appear to have taken great interest, as indicated by page after page of testimony. See, for example, the House War Department Appropriations Hearings for FY31, pp 685-704.

These developments also created the need for ever-increasing amounts of technical support for each aircraft, which, in turn, has been credited with driving up requirements for hangar space. Each new advanced component might require new technicians, with new demands for working space and equipment.[37]

The Impact of Metal Aircraft on Hangar Construction

One very significant new technology — the all-metal plane — actually reduced the Air Corps' demand for hangars. The all-metal plane promised to render obsolete the need to house every aircraft all the time. The new metal airframes could withstand weathering far better than their fabric- and wood-covered predecessors, and Air Corps leadership moved to a system of maintenance-only sheltering as soon as they thought it was practical. Under this system, each squadron would require only a single hangar, in which all of the maintenance work for the unit would be executed, while functional planes remained outside on the tarmac. Discussion of the feasibility of the single squadron hangar began as early as 1936, and by 1939 the Air Corps was actually advocating a shift to a policy of one maintenance hangar per squadron, with the bulk of the aircraft left out in the open, like the automobiles of the day.[38]

The Strategic Bomber

Perhaps the most profound technological advance of the period — both in terms of organizational and doctrinal impact on the Air Corps, and in terms of its specific impact on technical construction — was the development of the strategic bomber. In 1921, the active inventory of the Air Service had included over 1,100 DH-4 observation planes, 179 SE-5 pursuits, and only 12 MB-2 bombers.[39] This list makes it clear what role the Army leadership envisioned for its air arm. This bias persisted until the advent of the Air Corps, whose leadership supported the strategic bombing doctrines of Mitchell and others. Numbers of B-2 and B-3 twin-engine biplane bombers were acquired through the late 1920s. In 1930, the Air Corps issued a design request for a new long-range bomber, and the two aircraft submitted by Boeing and Martin revolutionized the strategic bomber concept. Each design was a sleek, low-winged, dual-engine monoplane capable of outrunning contemporary pursuit planes, even with a heavy bomb load. The Martin B-10 first flew in 1932 and its operational arrival in 1933 immediately enhanced the Air Corps' strategic capabilities. The request for a successor multi-engine bomber was placed in 1934, and Boeing responded with its Model 299 — a four-engine, high-speed, high-altitude heavy bomber. This aircraft first flew in 1935 as the B-17, and would go on to earn glory in the skies over Europe during World War II.[40]

These new heavy bombers posed problems for the Air Corps' technical construction program, due to their size, weight, and technological complexity. Aircraft size actually posed less of a problem than has been surmised.* The problem was not so much that the larger planes would not fit into existing hangars, but rather that fewer planes would fit into any given space. Older hangars were still normally used to house newer planes. Most often, when new aircraft were left out in the open it was due to a general lack of hanger space, because a growing number of bombardment planes were being stationed at bases where none had been before. The B-10 was actually smaller than its B-2 predecessor, sporting a wingspan of 70 ft, compared to the B-2's 90 ft. Even the B-17 was only marginally larger, with a wingspan of 104 ft, although its length was some 30 ft greater than its predecessor's.[41]

More significant than size were speed and weight, which was a difficult combination for the men in charge of airfield construction. The B-10 was 80 mph faster than the B-2 and substantially outweighed it, despite carrying a smaller bomb load. The B-17 featured vastly increased speed and weight in comparison even to the B-10. It outweighed the Martin aircraft by a factor of three — 54,000 lb to 16,400 lb — and was 100 mph faster.[42] New all-metal, high-speed aircraft required longer runways, shallower glide paths, and much stronger pavement surfaces, all of which added to the cost of airfield construction and maintenance. Increasingly complex components also required additional shop space, also adding to the housing loads in aircraft hangars.[43] All of these factors contributed to the Air Corps' technical construction requirements at a time when funding could be hard to acquire from a Depression-minded government.

Expansion Throughout the 1930s

The end of the Five-Year Plan had not brought an end to developments in the Air Corps. Significant advances were made in aeronautical technology, in Air Corps organization and strategy, and in the status of Air Corps ground facilities. That the Air Corps was able to make these strides in the difficult political and financial environment of pacifist, isolationist, Depression-era America speaks volumes for the increasingly vital role that military leadership envisioned for the nation's air arm.

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* See Brown and Goodwin & Associates, for example, who both directly relate increasing aircraft size to increasing hangar size. The relationship between aircraft and hangar size is much more complex, and only in a very few instances is there evidence of a direct connection.

Formation of General Headquarters Air Force

Air Corps leadership was quick to find a mission for its new bomber force. In January 1931, Army Chief of Staff General Douglas MacArthur had reached an agreement with Chief of Naval Operations Admiral William Pratt that tasked the Army Air Corps with the land-based air defense of the United States and its overseas possessions. Now the Air Corps had a mission that did not involve the Army's ground forces, and Air Corps leadership immediately employed it as justification of separate status. Once again, their request was denied, but in 1933 the Air Corps was granted the authority to form the General Headquarters Air Force (GHQAF) on a provisional basis. GHQAF was to be given command authority over all combat aviation forces in order to organize pursuit, attack, and bombardment squadrons for the defense of America's shores. The concept was tested on the Pacific coast in the summer of 1933 when the B-10 made its operational debut. In March 1935, the GHQAF dropped its "Provisional" title and became a permanent unit with its headquarters at Langley Field and three operational wings at Langley, Barksdale, and March Fields. It still had very few planes and fewer heavy bombers, as the B-17 was not to enter operational service until 1937, but it was a beginning. The Air Corps now had a body of command that was dedicated to developing air power in all its forms, but particularly to developing its strategic capabilities.[44]

The Drum Board

Closely related to the development of the GHQAF was a new airfield and technical construction campaign intended to provide bases for its operations. U.S. leaders were coming to the realization that the advent of the strategic bomber could seriously compromise the traditional advantages of the nation's geographical isolation. Questions of the strategic positioning of the nation's air bases had to be considered in order to provide the best possible air defense of its borders. A special committee of the Army General Council — referred to as the Drum Board — was convened in 1933 to consider these questions. Basing its deliberations on a series of previous reports, this board identified seven critical areas along the nation's borders, and called for the construction of ground facilities there to enhance national defense. The seven areas were:

- New England
- Chesapeake Bay area
- Caribbean or Florida area
- Puget Sound area
- San Francisco Bay area

- Los Angeles-San Diego area
- Great Lakes area.

The Drum Board rejected the idea of permanently basing tactical units at fields in each of the areas, preferring a more flexible system based on the GHQAF. The board advocated establishing sufficient base facilities in each area to accommodate the entire GHQAF, which would then be concentrated wherever necessary to meet a crisis. Obviously, these "concentration facilities" could not be elaborate, but it was expected that each area would have one main field — a "regional aerodrome" — supported by a network of lesser fields and a large number of primitive dispersal fields. In all, some $24 million in new technical construction was advocated for the next three years.[45]

Standardization and Expansion Under the Wilcox Act of 1935

While the board's recommendations were not legally binding, Congress followed them to a great extent in August 1935, when it passed the Wilcox Act. This act empowered the Secretary of War to identify the sites for new Air Corps ground facilities and expansion, cutting Congress out of the loop in order to streamline the process. Moreover, while it included no specific appropriation authorization, it did authorize the Secretary of War to appropriate "such funds as proved necessary" for the proposed expansion program. This open-ended authorization was almost the equivalent of a blank check for the expansion of Air Corps ground facilities. While Air Corps leaders would still have to defend appropriations, the spending authorization was already in place for any construction they could justify. The establishment of all new ground facilities up to World War II and most new construction projects on established fields were authorized under this act, which was informally referred to as the "Mother Hubbard Act." [46]

An impressive record of expansion was achieved over the next few years under the authority of the Wilcox Act. Under its direct authorization, five major new airfields were established as regional aerodromes for the concentration of the GHQAF. Four air depots were also founded — one on each coast, one in the Rocky Mountains, one in Hawaii — and the technical training program received a new field in Denver and substantial improvements at two existing facilities. Much of the new construction was conducted according to standard plans, and an easily identifiable standard field layout was also implemented. Both the field layout and the standard hangar designs were later widely imitated during the construction boom associated with World War II.

Infrastructure Expansion in the West

The Drum Board had determined that of the War Department's Color Plans, the Red-Orange Plan was the most critical.* This was the strategic plan prepared to counter a dual threat by Great Britain and Japan. The board thus advised that special attention be paid to the Pacific and West Coast regions to prepare them in case of a possible conflict with Japan. In accordance with this recommendation, the first new facilities established under the Wilcox Act were located in Hawaii, Washington, and California. Hickam Field, HI, was immediately established in 1935, and represents a sort of intermediate step between the construction efforts of the Five-Year Plan and those of the Wilcox Act. Its strategic necessity was indicated by the Drum Board, but its original field layout and standard hangars were more indicative of Five-Year Program construction. Hickam was laid out with the standard diagonal flight line and well-ordered street plan of Barksdale Field. Five standard Air Corps Double Hangars (Type H) were completed in 1937, similar in design to the Type A-A Hangars at Barksdale but featuring a gabled profile instead of an arched one (Figure 3-12). Later construction at Hickam Field would conform more to standards of other Wilcox Act construction efforts.[47]

The Northwest air base and the West Coast air depot were established in 1936 and 1937 at Tacoma, WA, and Sacramento, CA, respectively. Each featured elements representative of Wilcox Act construction that would later become highly standardized. McClellan Field — the Sacramento Air Depot — featured a distinctive airplane repair building with three large, connected, arched hangar bays backed by a very large shops annex (Figure 3-13). This structure was completed in 1938, and its design appears to have formed the basis of the standard Air Depot Aircraft Maintenance Hangars, of which dozens of examples were later constructed over the course of the World War II expansion programs. McChord Field — the Northwest Airfield — received two double hangars with the same bay type as those constructed at McClellan, without the attached shops annex (Figure 3-14). Although construction at McChord was begun before that at McClellan, the hangars were not completed until 1940, at which time the base began full-scale activity. McChord was the first installation to feature the Air

* The War Department's Color Plans were strategic plans prepared by a Joint Army-Navy Board in preparation for any possible conflict with another global power. Each potential enemy country had its own color designation—Germany was Black, Great Britain was Red, Japan was Orange, etc. The Red-Orange Plan was considered the most dangerous strategic threat to the United States, as it involved cooperative attacks by Great Britain and Japan, two of the world's great naval powers, who enjoyed a loose alliance in the early 1930s.

Corps' new standard field layout, which situated buildings along one side of the section, extending in towards the center in a flattened triangle. The isolation of the buildings in one triangular quarter of the section left the bulk of the field open for long diagonal runways that would cross near the center. The ends of these runways were joined by another that ran the length of the field opposite the building area. This allowed for two maximum-length runways in opposite directions and a third runway on an entirely different axis, providing as much safety as possible for adverse weather flying (Figures 3-15 and 3-16).[48]

The other major bases authorized under the Wilcox Act had not yet been established by early 1939. The Northeast, Southeast, and Alaska air bases, and the Rocky Mountain, Southeast, and Hawaiian depots had to wait until Roosevelt's January 1939 request for increased defense appropriations before construction could commence. When that work did begin, it took full advantage of the standardized design developments that first appeared in the earlier Wilcox Act bases. The improvements to the technical training facilities did get under way in 1938, however. Lowry Field was established in Denver, CO, that year, and its technical construction was completed by 1940. Improvements to Scott and Chanute Fields were also completed by 1940. All the new hangars at these three fields were the standard Air Depot Aircraft Maintenance Hangars — Lowry received two single-bay units, Scott received one, and Chanute received two with attached shops annexes.[49]

Civil Aeronautics Administration (CAA) Fields

The establishment of new Air Corps fields under the authority of the Wilcox Act was crucial to the success of the GHQAF system. Just as important were the many civilian flying fields that would operate as dispersal fields in the event that the GHQAF had to concentrate in any one area to meet a foreign threat. Permanent facilities at key Air Corps installations would form the nucleus of the GHQAF efforts in any given area, but ideally, 52 dispersal fields would also be available to support the concentration of units from across the country. These fields were established by the Air Corps working in conjunction with the Civil Aeronautics Administration (CAA). The total number of flying fields of all types in the United States increased from about 1,000 in 1927 to over 2,300 in 1936, and by 1939 the GHQAF had the requisite 52 fields per area of concentration.[50]

Emergency Relief Funding

The Air Corps funded and executed millions of dollars worth of improvements to its air fields under the authority of the Wilcox Act, appropriating $8 million for that purpose in FY38 and FY39. Even more funding was acquired from federal

emergency relief programs that were created to employ as many American workers as possible during the Great Depression. An immense amount of construction was accomplished through projects undertaken by the Work Projects Administration (WPA), Public Works Administration (PWA), Federal Emergency Relief Administration (FERA), and Civil Works Administration (CWA) at almost all Air Corps ground facilities across the country. Of the $12 billion appropriated by these relief agencies from 1932 to 1939, $1.5 billion went to the establishment, construction, and maintenance of civil and military air stations. Of that amount, perhaps $70 million went to projects on existing Air Corps bases.[51] It appears, however, that little of the emergency relief work at Air Corps facilities involved technical construction. Most of that effort was applied to housing and other non-technical construction projects, as well as improvements to the landing surfaces themselves.

Much of the work authorized under the Wilcox Act still remained to be executed at the end of 1938. Nevertheless, a good start had been made on the program, and the standard plans that would shape later construction efforts were in place by that time. In addition, while not all of the regional aerodromes needed for the GHQAF had been established, the CAA program of expansion had been quite successful, and hundreds of dispersal fields were already in place by 1939. Though technical construction still lagged behind demands, non-technical construction had received a valuable boost from emergency relief programs. While much work remained to be done, the Air Corps ground facilities already in place by 1939 would form the nucleus of the immense expansion program that was about to begin in response to growing tensions in Europe and the Far East.

Navy and Marine Corps Aviation Construction Following World War I

The Interwar Years constituted a period of significant growth for naval aviation, particularly in the areas of aviation technology, naval aviation doctrine, and aircraft carrier operations. The period witnessed an evolution in naval aviation, from a handful of small detachments of primitive float planes and flying boats accompanying each fleet, into a force of seven dedicated aircraft carriers, each recognized as a capital ship integral to fleet operations. By the late 1930s, each carrier was assigned its own squadrons of fighter, dive-bomber, and torpedo-bomber aircraft boasting unprecedented speed, range, and offensive power, plus new levels of technological complexity. Long-range patrol aircraft operated off of purpose-built seaplane tenders, and smaller scout aircraft were

MAJOR THEMES AND CONTEXTS

- Completion of Wartime Construction Projects
- Limited Postwar Construction
- Five-Year Program Construction
- Vinson-Trammell Navy Act Construction

assigned to essentially every battleship and cruiser in the fleet. Impressive performances in yearly fleet exercises had proven the value of naval aviation in modern naval warfare, and the U.S. Navy had made respectable strides in integrating this new technology into its fleet and its doctrine.

These advances were made despite a chronic lack of funding support for the Navy's air arm — a recurring theme that would plague naval aviation throughout the Interwar Years. Year after year, funding requests by Navy aviation leadership were slashed to a bare minimum. Faced with a difficult choice, Navy aviation leadership opted to concentrate on acquiring the best aircraft possible in the greatest numbers allowable, and took pains to demonstrate their critical value to the fleet in modern naval warfare. This was probably a wise choice, since any failure to demonstrate naval aviation's ability to operate with the traditional battle line would most likely have resulted in even less-enthusiastic funding support from a tradition-minded admiralty. Unfortunately, this emphasis on fleet operations and aircraft procurement often left little or no funds to finance the personnel programs that would provide the highly trained crews needed to fly the new aircraft. Moreover, the same lack of funds crippled any attempt to provide the aviation shore facilities that were necessary to support the growing air arm. As the aircraft inventory expanded without a corresponding expansion of aviation shore facilities, chronic overcrowding at bases only worsened. In the 1930s, especially with the aid of emergency relief funds, the Navy was able to institute a limited expansion of its aviation infrastructure, but no truly effective expansion in aviation shore facilities was possible under the existing funding situation. Significant progress was delayed until 1938, when the armed services began to expand in response to growing tensions in Europe and Asia, and increased funding support allowed for a more comprehensive building program at naval air stations. Until that time, the Naval Air Service had to scramble to provide as much shore support for its operations as possible given the circumstances, and this fell far short of the ideal in most cases.

Demobilization and Early Funding Problems (1919 – 1925)

In the years immediately following the end of WWI, the general pattern for the Interwar period was set. Demobilization and drastic funding cuts ensued immediately, and Navy aviation leadership made the choice to emphasize aircraft acquisition and integration with the fleet over personnel and infrastructure programs. While this policy dictated that little progress would be made in maintaining, updating, and expanding aviation shore facilities, significant advances were made in the areas of administration, aviation technology and doctrine, and aircraft carrier operations.

Wartime Expansion Cut Short

The rapid demobilization program forced on the Navy at the end of World War I abruptly cut short its wartime program for the expansion of aviation shore facilities. It had planned to spend $123 million on aviation construction in the last months of 1919. Half of this amount was intended to pay off contracts that had already been authorized, and for which funds had already been committed. The balance was to be spent on the establishment and maintenance of nine air patrol stations and 25 rest stations on the West Coast, and 20 patrol stations and 34 rest stations on the East Coast. The money for these projects was never released to the Navy, however, and these early plans had to be abandoned.[52]

While funding for naval aviation was extremely limited, one indication that the Navy still considered aviation a vital interest can be seen in the fact that a new bureau was organized in 1921 to better administer the aviation program. Previously, administration of the aviation program had been indirect and inefficient. A Director of Naval Aviation was in charge of producing plans for the program, but he had no direct authority over personnel in the Navy bureaus who actually conducted the business of aviation, and thus no way to ensure that the plans were carried out. The Bureau of Construction and Repair, for example, had authority over aircraft production and acquisition, while the Bureau of Ordnance controlled weapons development, and the Bureau of Navigation had ultimate oversight of aviation operations. In July 1921, these functions were centralized to a great degree in the new Bureau of Aeronautics, led by Chief of Aeronautics Rear Admiral William A. Moffett. This centralization was limited somewhat by the fact that the other bureaus still conducted some of the nuts-and-bolts operations in their various jurisdictions, but the new Chief of Aeronautics now had some of his own people within those bureaus. Ideally, he could simply state what he wanted done and expect the other bureaus to act on his directives. Predictably, the actual functioning of this system fell short of the ideal, and tensions still remained between Aeronautics and the older bureaus — especially the Bureau of Navigation, which retained oversight of aviation training. Nevertheless, the new system was definitely a step in the right direction. Moffett served the bureau well until his death in the crash of the *Akron* in April 1933.[53]

Postwar Funding Problems for Naval Aviation

The Naval Air Service experienced major funding problems throughout the period. This was caused not so much by a lack of Congressional support, but by a bureaucratic idiosyncrasy in the funding process and the Navy's own reluctance to push too hard for appropriations it suspected it would never get. In particular, the Navy's fiscal policy dictated that all funding requests must pass from

each bureau through the Bureau of the Budget, which would institute whatever cuts it thought necessary, then pass this amended budget on to Congress for approval. The heads of the individual bureaus were never allowed to approach Congress directly, relying on the support of the Budget office to obtain the desired funding. Unfortunately for naval aviation, the Budget Bureau habitually cut Bureau of Aeronautics requests substantially before submitting them for Congressional approval. The resulting chronic lack of funding support cannot really be blamed on Congress, who appears initially to have been unaware that the Navy aviation funding request they received had already been slashed below critical levels by the Bureau of the Budget. This practice continued throughout the period, despite late Congressional protests that the Bureau of the Budget was acting with almost dictatorial powers within the Navy, at times preventing Congress from adequately funding naval aviation projects which had originated in the Congress itself.[54]

The shortage of funding created serious personnel problems for Navy aviation leadership, who could not afford to provide sufficient numbers of qualified pilots and ground crews to fulfill their assigned duties. The problem would only grow more serious as naval air operations expanded — particularly when new aircraft carriers were due to come on line, posing new demands for aviation personnel. Naval Reserve Officers generously stepped in to fill the holes left in the regular ranks by the lack of funding. Many veteran fliers provided invaluable volunteer service with little or no pay and support during these crucial years. It was clear, however, that this system could not stand if naval aviation was to expand as planned.[55]

Any attempt at rational, coordinated programs of expansion for the aircraft inventory, personnel program, and construction support was out of the question for the time being. In 1922, Moffett proposed a standard aircraft complement for each ship, and advocated increased funding to procure these aircraft and construct the aviation shore facilities necessary for their support. He envisioned a program of steady growth over a four-year period, but when the General Board and the fleet balked at the size and timing of the program, he extended it to a five-year period. The plan was still not approved, but it appears to have been the model for the actual Five-Year Program that would be enacted in 1926.[56]

Advances in Naval Aviation Technology and Doctrine

The leading figures in naval aviation, particularly Admiral Moffett, saw from the start that their future would depend on integrating aviation operations with the fleet. Emphasis was therefore placed on developing the best aircraft types for this purpose, on acquiring as many of them as possible, and on developing

operational doctrine for their use at sea with surface vessels. As early as 1919, Navy aviation leadership took steps to ensure the future inclusion of aviation operations with the fleet by integrating a squadron of H-16 flying boats with the surface forces as they wintered in Guantanamo Bay, Cuba. These aircraft were limited, however, to operating from the shore. The tremendous potential of ship-borne aircraft would not be demonstrated until the Fleet Exercise of 1923.[57]

It was already apparent in 1919 that efficient combat aviation operations with the fleet depended on the use of landplanes operating from aircraft carriers. That year, Congress appropriated $690,000 for the conversion of the old collier *USS Jupiter* into an experimental aircraft carrier. The conversion began immediately, but was not completed until March 1922, whereupon the vessel was re-christened as the *USS Langley* — the U.S. Navy's first aircraft carrier. Experimentation with carrier operations proceeded immediately upon the *Langley's* commissioning. Special attention was given to determining the most efficient aircraft types for carrier operations, to developing effective arresting gear, and to designing a reliable catapult system. In March 1925, the Navy invited aircraft manufacturers to design a new carrier aircraft. The Curtiss, Vought, Douglas, and Martin aircraft companies all provided new designs, and the Martin offering that was finally accepted was the all-metal SC — the Navy's first all-metal aircraft.[58]

Aircraft carrier development did not stop with the *Langley*, however. The Washington Disarmament Treaty of February 1922 set limits on the tonnage of capital allowed on the vessels of all participants. Under this agreement, two heavy cruisers already under construction for the U.S. Navy — the *Lexington* and *Saratoga* — would have to be scrapped. To avoid this wasteful proposition and to provide the Navy with the large, fast aircraft carriers that it clearly needed, the ships' designs were heavily modified to convert them into carriers. Construction began in 1922 and was completed in 1926.[59]

Advances were also made in aircraft technology, both in the areas of seaplanes and flying boats, and in landplanes. In May 1919, shortly after the Armistice, Navy pilots set a world aviation landmark by being the first to cross the Atlantic in an aircraft. This was not a nonstop flight (the first of which was accomplished by Charles Lindbergh in May 1927), but was the first instance in which an aircraft was flown across the Atlantic under its own power. Three NC flying boats left NAS Rockaway en route to Newfoundland, the Azores, Lisbon, and England. Only NC-4 completed the journey, with the other two ditching in the sea at various points along the way (unintentionally demonstrating the flying boats' exemplary sea-keeping abilities in the process). Another long-distance landmark was set in 1925, when a PN-9 flying boat crossed the Pacific from

California to Hawaii. Once again, this aircraft was forced down some 450 miles short of its destination, but succeeded in riding the waves safely to Pearl Harbor with the aid of jury-rigged sails.[60]

Carrier aircraft also made significant technological advances in the early 1920s. The development of a dedicated torpedo plane was a key project in this field, with the first ground-up design being completed in 1923. The Naval Aircraft Factory's PT torpedo plane entered service in that year, followed by the Douglas DT in 1924. Other general technological advances were made in the mid-1920s, including more advanced and reliable flight instruments, all-metal airframes, propellers, and hulls, and air-cooled engines that provided more horsepower per pound than their liquid-cooled counterparts. A significant testing arena for these new technologies was found in international airplane racing circuits. Navy personnel, like their Army counterparts, took an active part in these contests from 1923 – 1930, winning many trophies, setting and resetting numerous world speed records, and contributing greatly to aircraft design. In particular, engine designs were rapidly advanced, with the first radial engines entering service in 1923.[61]

Another significant impetus to naval aircraft development during the period was the *Ostfriesland* bombing tests conducted off Hampton Roads in 1921. Naval leaders disputed the more ambitious claims of Mitchell that the day of the battleship had ended. They argued that the *Ostfriesland* tests were inconclusive on that issue because the targets had been stationary, had no damage control parties, and had not been defended with their own guns or with friendly air cover. Nevertheless, the tests did serve to convince the admiralty that much more had to be done to advance naval aviation technology and strength, especially in carriers for landplanes, which clearly outperformed seaplanes and flying boats.[62]

The Fleet Exercise of 1923 was the first to include aircraft operating directly with the fleet — in this case, just seaplanes operating from cruisers, mimicking entire squadrons of aircraft operating from slow carriers. Nevertheless, their ability to launch successful mock attacks against the Panama Canal impressed Navy leadership. This episode began a long tradition in which yearly fleet exercises both proved the value of naval aviation, and brought attention to the need for further development of aircraft and aircraft carrier technology and strength. Dive-bombing and Close Air Support tactics developed by the Marine Corps in Haiti and Nicaragua in 1919 and 1925 were also adopted by Navy pilots. Dive-bombing practice and diving shows were begun at NAS North Island in the mid-1920s, and this practice would eventually lead to the design of the first purpose-built dive bomber by Martin in 1930.[63]

Lighter-than-air (LTA) aviation also made strides during the early 1920s, despite the general consensus within the Navy against its use in conjunction with the fleet. LTA aviation occupied a special place in the attentions of Admiral Moffett, who consistently fought for continuing support of this activity. The first significant developments in rigid airships were made with the *USS Shenandoah*, which became operational in October 1923. This was the first dirigible constructed in the United States, and much was learned about LTA operations through experiments with *Shenandoah* during its short life. The Navy's first dirigible made a relatively poor showing during fleet exercises, however, with its inferior ability to operate in adverse weather, and its resulting dependence on numerous support facilities over a wide geographic range to give aid in emergencies. Problems experienced in the 1924 Fleet Exercise demonstrated the need for a network of mooring masts across the country to ensure safe operation, and these were actually provided despite the lean funding environment of the early 1920s. On 3 September 1925, the *Shenandoah* departed NAS Lakehurst en route to Columbus, OH. Over eastern Ohio, it encountered a severe storm, broke in half, and crashed in two pieces, killing 14 members of the crew. Shortly after the disaster, in 1924, the Navy purchased the *USS Los Angeles* from Germany, and this dirigible acted as the primary LTA test bed until the mid-1930s.[64]

Construction Program Stagnation

While the Navy was able to make significant strides in aviation technology and doctrine, little progress was made in the area of aviation shore facilities. Very few new construction projects were approved for air stations throughout the early 1920s, although some minor improvements and repairs were spread over a number of stations throughout the country. Beginning with the FY20 appropriations, the Navy was officially limited to just six aviation shore facilities in the Continental United States, and rarely allowed any support for needed expansion at any of them. The Bureau of Aeronautics was forced to make do with WWI-era buildings at all of its air stations. With so little money appropriated for the construction and maintenance of hangars, the state of these structures — many of temporary construction, and some of wood — was rapidly declining. Without money to construct new hangars to replace those in decay, overcrowding was becoming a real problem at many bases. At some installations, there simply was not enough hangar space available to house all the aircraft operating at the installation. Excess aircraft had to be left outdoors in the elements, and the resulting rapid deterioration cut into the expansion of the modern aircraft inventory that so occupied the attentions of naval aviation authorities.[65]

Hangar construction in 1919, immediately following the war, was limited to the completion of wartime projects. Two hangars were completed in that year at

North Island, and one was finished at Hampton Roads. The two North Island hangars were constructed from the same plan, which apparently conformed to the original Goodhue design and was approved by the Bureau of Yards and Docks* in May 1918. Each featured three 110 x 100 ft bays for an over-all footprint of 110 x 300 ft. Each bay was spanned by a closed gabled steel truss at a clear height of 24 ft. These hangars featured concrete interior walls and stucco cladding, with timber roof sheathing. Each side elevation was decorated with distinctive stucco-clad buttresses in Goodhue's Spanish Colonial Revival style. The doors of these hangars were also quite distinctive, consisting of motor-operated sliding panels that followed a curved track inside along the sidewalls of the structure for storage. Each hangar cost $130,000 for the original construction (Figure 3-17).[66]

The Hampton Roads hangar was constructed from a 1919 Bureau of Yards and Docks standard design entitled "Steel Seaplane Hangar (with lean-tos), 2-Sections — 150 x 180 x 35 ft" (Figure 3-18).[67] The Hampton Roads hangar, as constructed, closely followed this plan, featuring two 150 x 180 ft bays, for a footprint of 300 x 180 ft, with two 38 ft lean-tos that lengthened the structure to a total of 376 ft. Each bay was spanned by a closed gabled steel truss at a clear height of 35 ft. The hangar featured steel siding, a timber roof deck, and asphalted asbestos roof sheathing. Sliding doors were received by distinctive, exposed steel frame door tracks. The original construction cost $236,000.[68] The same "Steel Seaplane Hangar (with lean-tos), 2-Sections — 150 x 180 x 35 ft" standard plan was later employed for new construction at North Island and Pearl Harbor in 1921.

The funding cutoff for FY20 dictated that no new hangars be constructed in that year. North Island did, however, receive a new warehouse that was completed in 1920. This structure was derived from a standard hangar design that had been intended for the Hampton Roads air stations, but had never been constructed there. The plan was entitled "Steel Seaplane Hangar, 3-Sections — 100 x 100 x 24 ft," and featured three bays of 100 x 100 ft, for a total footprint of 300 x 100 ft. Each bay was spanned by a closed gabled steel truss at a clear height of 24 ft.[69] For the North Island project, the plan was renamed as "Storehouse — Hangar

* 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.

D," but no substantive changes were made. When actually constructed, however, the storehouse featured five of the standard 100 x 100 ft bays, and thus measured 500 x 100 ft. Corrugated galvanized steel cladding and roofing were employed according to standard, and the cost was $67,500 (Figure 3-19).[70]

The two new hangars, completed at North Island and Pearl Harbor in 1921, constituted the entire construction effort for that year. The North Island hangar conformed to the "Steel Seaplane Hangar (with lean-tos), 2-Sections — 150 x 180 x 35 ft" standard in all respects except that it featured only one of the planned hangar bays, thus measuring only 150 x 180 x 35 ft. It cost $121,130 to complete (Figure 3-20). Four hangars of the same design as the two 1919 structures had actually been envisioned in the Goodhue design, but funding limitations had dictated that only one of these cheaper hangars be constructed.[71] The Pearl Harbor hangar appears to have been the first hangar constructed at that installation. It, too, conformed closely to the same standard plan, featuring two 150 x 180 ft bays, for a total footprint of 300 x 180 ft. Each bay was spanned at a clear height of 35 ft by a closed gabled steel truss, and cladding, roofing, and exposed steel door frames were all to standard. It appears not to have included the standard lean-tos, however.[72]

Funding was even more scarce in FY22, allowing no new technical construction for the Bureau of Aeronautics. In all of that year, 22 contracts totaling a mere $1 million were let for minor improvement at the Navy's established air stations — an inadequate sum even for proper maintenance.[73] The next year brought little relief, as FY23 funding allowed for the erection of only one simple hangar at Anacostia. This structure featured two 110 x 117 ft bays, for a total footprint of 220 x 117 ft. Each bay was spanned by steel truss-work at a clear height of 24 ft. Plans are unavailable, but Bureau of Yards and Docks documents indicate that this hangar conformed to what the Navy referred to as the "Army Standard Hangar," which also featured 100 ft bays. Both structures were extremely inexpensive to construct, and featured only canvas curtains for doors. The Anacostia hangar was most likely erected from existing stock, as its total construction cost was a mere $46,030.[74]

Acute funding shortages continued in FY24, leading to the closure of three unused air stations, and only the bare minimum appropriations were approved for the maintenance and operation of the remaining facilities.[75] The Navy was forced to make the most of existing facilities, to the extent that unused hangars at recently closed facilities were relocated to active air stations when necessary. For example, a kite balloon hangar and a landplane hangar were relocated from Yorktown to Lakehurst in 1924.[76] Another cost saving strategy was to convert other types of buildings into hangar space. In 1925, a contract was let for a little

over $29,000 to renovate Building 133 — formerly a storehouse — at the Philadelphia Navy Yard. By refurbishing the roof and siding, rearranging the windows, and adding larger doors at one end, this structure was converted into a serviceable hangar. The Navy continued to reuse and convert buildings into hangars well into the 1930s.[77]

Overcrowding Becomes Critical

In FY25, the Naval Air Service received its first appropriation for new technical construction since FY20, made in response to the growing overcrowding at essentially every one of its air stations. The Bureau of Aeronautics was forced to strictly prioritize what little improvements could be made with the new appropriation. The air stations at Coco Solo and Pearl Harbor were judged to be the most critical in time of war, and were also outside the Continental United States, where the six-station limit did not apply. These bases, therefore, were the beneficiaries of the FY25 appropriation.

The overcrowding situation at these overseas installations was indicative of the problem as a whole. At Coco Solo, for example, hangar facilities were limited to a single large steel seaplane hangar measuring 75 x 112 x 24 ft, and two dilapidated wooden hangars from the original WWI construction, each measuring 50 x 400 ft. The steel hangar could accommodate only the two larger patrol planes already stationed at Coco Solo, and was too shallow to house any of the additional six flying boats that the Navy wanted to move there. The wood hangars were too shallow to accommodate any of these larger aircraft, since their 50 ft depth left the plane's tail exposed to the elements. They could be used only to shelter smaller landplanes. Much the same situation existed at Pearl Harbor and at other aviation shore facilities across the United States.[78]

The new FY25 appropriation allowed both Coco Solo and Pearl Harbor to construct a single seaplane hangar each. These hangars were originally planned to conform to a new standard design known as "Seaplane Hangar Design A." This plan consisted of a three-bay structure, measuring 330 x 160 x 24 ft. Each bay was to be spanned by a 110 ft flat gabled steel truss, and the three bays laid out side-by-side provided a total footprint of 330 x 160 ft. The plan featured steel siding and wood roof decking, with asphalted asbestos roofing. Distinctive exposed steel framed door runners extended beyond each side of the structure to accept the manual sliding doors (Figure 3-21).[79] In the end, the Bureau of Aeronautics decided to limit the new hangars to only two bays — in order to keep down the cost to a point that Congress might actually approve the projects — but the hangars otherwise conformed to the standard plan.[80] The original three-bay design, though, was used repeatedly at numerous other stations across the coun-

try and around the world, including the original hangar at the new Sand Point, WA, air station in 1928, two hangars at Coco Solo in the same year, a new hangar at the Squantum reserve field in 1931, and another at Pearl Harbor in 1934. These new projects would be authorized in response to the findings of a number of boards that sat in the mid-1920s, and would eventually advocate a substantial expansion in American air power.

The Aeronautical Boards of the Mid-1920s

A series of boards sat in the mid-1920s to determine the roles of aviation in the Navy, the funding levels necessary to support those roles, and the best way to advance naval aviation. In March 1924, the House organized the Lampert Committee to examine the armed services' aviation operations and their relations with the aircraft industry. Besides making recommendations concerning contract practices, this board also advocated the creation of a single, unified Air Force that should be granted $10 million for each of the next five years to allow for a rapid expansion. The Navy responded by constituting the Eberly Board in late 1924, which recommended that air operations remain divided between the two branches. It further recommended that the Navy should be expanded with all haste to the full size mandated by the 1920 treaty limits, and that naval aviation, in particular, be rapidly expanded to keep pace with the Navy, with special attention given to the construction and manning of new fast carriers like the *Lexington* and *Saratoga*. The Navy's Johnson Board sat in April 1925, and recommended a rapid expansion in personnel for the Bureau of Aeronautics. However, its findings were immediately contradicted by the Chief of the Bureau of Navigation, Rear Admiral Shoemaker, who recommended that a limit of 750 pilots be placed on the Bureau of Aeronautics and that flight pay — which he found elitist and objectionable — be no more than a 10 percent bonus. The Taylor Board was organized in September 1925 to iron out the differences between the Bureaus of Aeronautics and Navigation, but had not yet reported before the findings of the joint military and civilian Morrow Board saw light. This Board's conclusions led to the Five-Year Program of 1926, which would go beyond these smaller questions of personnel to advocate a wholesale expansion of naval aviation.[81] At long last, naval aviation was about to receive a substantial boost that would enable it to take its first steps out of the funding malaise that had so completely dominated it during the first half of the 1920s. While technical construction still lagged behind the expansion of the aircraft inventory, some steps would now be taken to bring construction up to speed and place aviation shore facilities on a somewhat better footing.

The Five-Year Program (1926 – 1933)

The Navy's Five-Year Program of 1926 was a close counterpart to the expansion program of the Air Corps that was known as the Five-Year Plan. Both programs were authorized in 1926, both actually received their first appropriations in FY28, and both were intended to be completed by FY33. Moreover, both programs must, in the final analysis, be regarded to some extent as failures. Like the Army's program, the Navy's Five-Year Program was chronically underfunded, with the result that the Navy was still forced to favor the acquisition of new aircraft over the provision of adequate personnel to man them, and basing facilities to support them. In addition, the Navy suffered from a peculiar lack of large, modern hangar facilities — even more so than the Army — which affected the type of aircraft that they could efficiently acquire and operate. While significant expansion of the aircraft inventory was accomplished, and a few improvements were made to basing facilities, neither gain lived up to the high expectations of the program, limited by a lack of funding.

Impact of the Morrow Board

In September 1925, only a week after the *Shenandoah* tragedy, President Coolidge established a board of military and civilian aviation and industrial experts to examine the current status of aviation in the armed services, and to make recommendations as to the best ways of advancing those roles in the future. Known as the Morrow Board — named after its distinguished president, New York financier Dwight Morrow — this body heard hours and hours of testimony from representatives of both armed services, the aircraft industry, civilian aviation concerns, Congress, and the Judiciary. It made public its report in November 1925, finding once more against the idea of a single, unified Air Force. It did, however, advocate a rapid expansion of American air power, and considerable attention was given to the importance of naval aviation and the need to strengthen the Navy's air arm. Further, new Assistant Secretaries for Aeronautics were positioned in both the Department of War and the Navy Department, in order to ensure that aviation interests were represented at the highest levels.[82]

Congress Enacts the Five-Year Program

To ensure that tangible results would be realized from this Board's deliberations, Congress passed an act on 25 June 1926 that authorized a steady expansion of the Navy's air arm to a strength of 1,000 planes and two dirigibles over a five-year period. Two-thirds of these aircraft were to be operational at any one time, while one-third were to be held in reserve. Within this breakdown, 512 aircraft were intended for service afloat with the fleet, 208 were for service at overseas

bases, 84 were earmarked for operations with the Marine Corps Expeditionary Forces, 168 were to be used for training operations, and 28 were reserved for shore duties.[83] Evident in this breakdown is the heavy emphasis on operations afloat and overseas, and the seemingly minor strength of activities at aviation shore facilities in the States. This, in fact, was the impression that the Five-Year Program appears to have made on the Bureau of the Budget and Congress, who consistently under-funded appropriations for improvements to these facilities. What is not apparent in the official breakdown of aircraft assignments is the fact that all of the aircraft except those at overseas air stations — including those in operation with the fleet — were maintained and supported by the aviation shore facilities in the States. Whenever the fleet was in port, its aviation elements returned to air stations for training and for maintenance, repair, and overhaul work, temporarily overcrowding the air stations to an even more serious degree than was the norm. Thus, while most Navy aircraft were dedicated to service with the fleet, 95 percent of the maintenance and repair work done on these aircraft was accomplished at shore facilities. Moreover, 60 percent of the Navy's expanding aviation operations were planned to operate from shore facilities in the near future, in the form of new, long-range patrol aircraft.[84]

The Specter of Funding Constraints

Chronic funding problems plagued the Five-Year Program from start to finish, but again, Congress appears to have been less to blame than the extremely parsimonious Bureau of the Budget. In FY28, the Bureau of Aeronautics' request for $40 million was promptly cut by the Bureau of the Budget to only $20 million. This figure was finally raised to $29.5 million by a more generous Congress, but the essential funding dynamic of the program was already apparent. In FY31, a similar process occurred, when Aeronautics requested $53 million, but was cut back to $35 million by Budget, and finally awarded $38 million by Congress. In FY32, a similar request was cut to only $32 million, despite the fact that the Bureau of Aeronautics was then expected to operate a greater number of aircraft.*[85]

* During the Congressional hearings for FY33, Moffett took great pains to show that the proposal for that year had already been cut to the bone by the Bureau of the Budget. The request for the Bureau of Aviation had been cut by more than 20 percent, while other bureaus were reduced by an average of only 4 percent.

Unexpected Impacts on Aircraft Inventory

The funding shortfalls impacted on the Navy's attempts to expand its aircraft inventory, but not in the way one would expect. Rather than limiting the expansion — or delaying it for a number of years, as was the case with the Air Corps — the Navy's funding problems actually led to an increase in the aircraft inventory over and above the planned program. One reason for this unplanned increase stems back to the general lack of support for construction at naval air stations. Denied the authorization to construct newer, larger, more modern aircraft hangars, the Bureau of Aeronautics was forced to subsist with older, smaller structures. These hangars were unable to house the desired number of large new flying boat patrol planes that the Navy planned to acquire in the expansion program. Intent on keeping pace with the program despite the lack of hangar space, the Naval Air Service opted to purchase smaller, less expensive, and less advanced scout planes that required less hangar space. As a result, the Navy's aircraft acquisition program actually proceeded ahead of schedule and under budget until 1930, when new hangar construction began to pick up and the larger patrol planes could be purchased. Thus, in terms of raw numbers of aircraft the expansion program was progressing quite well, but sacrifices had to be made in the technical level of the air fleet, and the acquisition of cheaper planes in unplanned numbers created even more overcrowding at air facilities.*[86]

The Navy actually reached its plane ceiling in 1931, a year ahead of time. At that point, the target number was reduced for economic reasons to 918 for 1932, 928 for 1933, and 965 for 1934 aircraft. Therefore, the last year of the program allowed only for the replacement of obsolete and damaged aircraft. The program as a whole was planned to acquire 1,614 planes over its course, at a total expenditure of $85 million. In the end, it acquired only 1,355 planes at a total cost of just $58.7 million. The smaller numbers and cost were made possible by lower than anticipated aircraft prices, reduced rates of attrition due to better materials and lower accident rates than expected, reduced aircraft complements, and a reduction in the authorized stock of spare parts and extra engines.[87]

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* This is a peculiar case of the size of the hangar actually dictating the size of the aircraft acquired. Note, though, that even here, the older hangars could house the larger planes, but were limited in the number of aircraft they could shelter. The key factor that drove new hangar construction here was not so much the size of the larger aircraft, but the number of them that the Navy wanted to acquire.

Another factor also contributed to lower-than-expected aircraft acquisition rates. The Five-Year Program maintained its 1,000 plane limit despite the commissioning of a number of new vessels that required aircraft complements. Since no extra aircraft were approved for filling these new needs, aircraft had to be skimmed from other sources to outfit the new vessels. By 1933, for example, the Bureau of Aeronautics expected to get extra aircraft approved for the commissioning of the new 8-inch cruisers and its newest aircraft carrier — the *USS Ranger* — but the Bureau of the Budget and Congress never approved them. They had to be trimmed from the aircraft complements of Coco Solo and Pearl Harbor instead.[88]

Shortages of Trained Personnel

Though the program reached its 1,000 plane limit, the chronic lack of funding made it impossible to provide pilots and crews for these planes. While the Navy as a whole found it increasingly difficult to find enough trained officers, its air arm had an even harder time doing so. In 1928, Moffett estimated that he would require 950 extra aviators to meet the growing requirements brought on by the expansion program. But funding shortages dictated that he strip down training programs everywhere except Pensacola, which by itself could not possibly meet the growing need. The Bureau of Aeronautics was forced to rely increasingly on under-trained Reserve Pilots. While these aviators served as well as could be expected from those who practiced their craft only intermittently, funds were not available to provide facilities for more regular training. Even with the help of the reserve aviators, the Navy's air arm was forced to operate throughout the expansion program with a chronic lack of trained pilots.[89]

Impact of Inadequate Construction Funding

In a similar manner, lack of funds, and the emphasis on acquiring aircraft made it impossible for the Bureau of Aeronautics to pursue a technical construction program that could keep pace with the expanding aircraft inventory. Already by 1930, the Navy's expenditures on new aircraft under the Five-Year Program were far outstripping its appropriations for construction at the air stations that had to support them. From FY27 to FY30, expenditures on aircraft totaled some $53.5 million, while those for air station construction were a mere $4.2 million. When examined over the period from FY21 to FY30, the difference was even more striking, with aircraft procurement accounting for over $80 million, and construction support confined to only $5.6 million.[90]

The most extreme impact of this policy was the way insufficient hangar space limited the types of planes acquired by the Naval Air Service, but more general

problems resulted as well. Foremost was the problem of aircraft overcrowding that had already existed before the start of the Five-Year Program, and grew steadily worse over its course. By 1930, serious overcrowding existed at all six permanent air stations in the United States, as well as at Coco Solo and Pearl Harbor, and large numbers of aircraft were left out in the open due to a lack of hangar space. For example, 21 aircraft had to be left unsheltered at Pearl Harbor, 67 at Pensacola, and 80 at San Diego. Inadequate shelter accelerated deterioration of the aircraft, as constant exposure to the elements wore on the airframes, engines, and instruments. The Bureau of Aeronautics estimated that aircraft left in the open deteriorated at twice the rate of sheltered aircraft.[91] In addition, proper maintenance was made more difficult and less regular, as it could not be done outside in inclement weather. And yet, as will be discussed shortly, the Navy funded only a small amount of technical construction in the first half of the Five-Year Program, and essentially none thereafter, hardly leaving the Navy's air stations in better condition at the end of the program than they had been at the beginning.

Further Advances in Technology and Doctrine

Despite the funding problems that hampered personnel and technical construction programs during the Five-Year Program, the Naval Air Service succeeded in continuing the progress in other areas it had begun in the first half of the 1920s. Yearly fleet exercises repeatedly confirmed the importance of aviation in modern naval warfare. The 1929 exercise was the first to include the newly commissioned aircraft carriers *USS Lexington* and *USS Saratoga*, and their fine showing convinced the admiralty of the great value of this type of fast carrier, and the need for many more of the same class. The 1930 exercise saw the birth of the Carrier Group — a sub-unit of the fleet that consisted of a fast carrier plus its cruiser and destroyer escorts — which could act independently of the main battle line. This formation could safely and effectively conduct crucial scouting operations and inflict a sharp punch with its aircraft. Exercises such as these persuaded Navy leadership that many more large aircraft carriers would be necessary, particularly if a Pacific war was to be successfully waged. Six to eight of these larger ships were desired, to be augmented by fast, cruiser-sized carriers that might even mount their own ship-killing guns. In the end, no large carriers were approved, and only one small, unarmed vessel — the *USS Ranger* — was laid down in 1931. When it entered service in 1934, it became the first U.S. Navy vessel designed as an aircraft carrier from the keel up.[92]

Advances in aviation technology included significant progress in the development of long-range flying boats, with the P2Y coming on line in the mid-1930s as the forerunner to the PBY Catalina of World War II fame. Much progress was

also made in developing effective dive- and torpedo-bombers, and in determining the most effective tactics to be employed in their attacks. Important developments also occurred in ship-board aviation technology, most notably the turntable catapult, which allowed the rapid launching of different aircraft types without time-consuming reconfiguration of the catapult mechanism.[93]

A significant strategic doctrinal question was resolved during the period as well, when a long-standing conflict over the respective missions of the Army and Navy air arms — particularly in regard to the air defense of America's shores — was settled in 1930. A 1927 Joint Action of the Army and Navy had divided responsibilities by assigning Army aviation the role of operating with mobile ground forces, and Navy aviation the role of operating with the fleet. This left some room for conflict in the area of shore defense by long-range, land-based patrol and bomber aircraft. In 1930, Chief of Naval Operations Admiral W. V. Pratt reached an agreement with Army Chief of Staff General Douglas MacArthur that relieved the Navy of shore defense aviation, leaving it in the hands of the Army Air Corps. While this did not end the bureaucratic competition for control of coastal air stations, it did provide the Army with the justification it needed to establish the GHQAF and develop its heavy bomber force. More important for the Navy, it concentrated naval aviation activities in support of fleet operations, which was Pratt's stated motivation in reaching the agreement. He felt that, given the Navy's constrained budget, it could not afford to support both offensive and defensive operations in peace time. He chose, therefore, to develop to the fullest possible degree naval aviation's offensive capabilities. This meant concentrating on fleet operations, and Pratt advocated expanding the Navy's carrier force as much as possible, while sacrificing land-based aviation. In effect, this finally put the official seal on an unstated policy that had informed naval aviation since WWI, a priority system in which the development of shore installations took a back seat to the acquisition of modern aircraft and aircraft carriers.[94]

The period of the Five-Year Program also witnessed further developments in LTA aviation. The *Los Angeles* continued to act as a very visible showpiece of LTA aviation until its temporary decommissioning in 1931. It conducted many cruises around the country and in 1929 even accomplished the first successful trapeze landings, in which it took on board its own escort fighters.[95] Based on such successes — and Admiral Moffett's unstinting support — the Navy succeeded in securing authorization for two even larger, more advanced dirigibles in FY29. Contracts were let to Goodyear for the construction of the *USS Akron* and the *USS Macon*. The *Akron* began construction in 1929, and the *Macon* followed in 1933. Each of these huge airships was designed with an internal hangar that could house five pursuit planes to act as its fighter cover, able to be launched and recovered via the trapeze apparatus developed aboard the *Los Angeles*. When

the *Akron* was commissioned in 1931, the *Los Angeles* was deactivated, and the newer ship was used to conduct a great number of tests and exercises to gauge the dirigible's ability to conduct combat operations and coordinate with the fleet. These tests continued until the *Akron's* tragic crash in New Jersey in 1933, in which LTA's firmest advocate, Admiral Moffett himself, lost his life. At this point the future of LTA aviation looked dire indeed, but the newly commissioned *Macon* took over the experimental duties, and exercises began again. The reception for LTA aviation operations with the fleet remained tepid due to its inability to conduct missions in adverse weather. Nevertheless, progress was certainly being made toward persuading a reluctant admiralty of the future value of the dirigible.[96]

A Smattering of Technical Construction

While the Bureau of Aeronautics enjoyed continued success in technological and doctrinal developments, it had much less success in maintaining a vital program of technical construction, and it experienced great difficulty in providing adequate basing facilities for its growing air arm. As noted above, appropriations for construction at the Navy's already limited number of Air Stations were consistently cut well below requested levels, creating a chronic shortage of suitable aviation facilities. This lack of funding support was most acutely felt in 1926, before appropriations for the Five-Year Program officially began, but shortages continued throughout the expansion program, with one notable exception. A good deal of technical construction was authorized in FY28, allowing the Navy to address the most glaring shortcomings in the existing infrastructure. Moreover, an entirely new air station was established in 1928 at Sand Point, WA, to support the air contingents that operated with elements of the battle fleet based in nearby Seattle. Nevertheless, these improvements by no means satisfied the crucial need for expanded aviation shore facilities. By the end of the Five-Year Program, the Naval Air Service's shore installations were in little better condition than they had been before the program, and overcrowding on naval air facilities remained a serious problem.

The first year of the Five-Year Program brought essentially no support for technical construction, as two different funding requests for this purpose were defeated in Congress. Very little work was done to even maintain existing structures during this funding drought. The lone exception to this dismal picture appears to have been the construction of two temporary wood hangars at Pensacola. Very little is known about these structures, as they were torn down by the mid-1930s and no record of them survives beyond the corresponding notation in the Annual Report of the Bureau of Yards and Docks.[97]

The major boost to the construction program came the next year, in FY28. Even then, the regular funding request for technical construction was once more denied by Congress, and it looked for a time as though aviation shore facilities would not be included in the Navy's expansion program. It was actually through the first Deficiency Act of 1928 that funding for the Navy's construction program finally made it out of Congress. This Act provided $1.8 million for technical construction projects at four different air stations. A total of five hangars were constructed under this authorization, with two being added at Coco Solo, and one each at Sand Point, North Island, and Hampton Roads. The two Coco Solo hangars and the Sand Point hangar were all constructed in accordance with the standard Seaplane Hangar Design A. Each featured two of the standard 110 x 160 ft bays instead of the official three, as had the earlier examples of the type at Pearl Harbor and Coco Solo, thus providing a total footprint of 220 x 160 ft. They appear to have closely followed the standard plan in all other respects (Figure 3-22).[98] The North Island hangar may also have been based on the standard Seaplane Hangar Design A, although not enough data is available at this point to make a sure judgment. This structure also featured two bays of approximately 110 ft span, and exhibits the classic flat gabled steel truss-work. Decorative conventions conform to the standard as well (Figure 3-23).[99] The Hampton Roads hangar was certainly not based on the Seaplane Hangar Design A. This structure features a very large massing measuring 200 x 220 ft. More substantial, permanent-type construction is evident, including a good deal of masonry cladding, although structural elements remain steel. The hangar bay itself measures only 110 ft, and is spanned by a flat gabled steel truss at a clear height of 30 ft. Substantial lean-tos make up the rest of the 90 ft of the front facade. This hangar introduced a feature that would become quite common in later designs. A very distinctive clerestory monitor runs the length of the building down the centerline of the roof (Figure 3-24). This monitor allowed more light into the interior of the hangar in order to ease aircraft maintenance work. Many of the World War II and pre-World War II hangars include this type of monitor, or a variation of it.[100]

By the end of FY 28, a fairly respectable amount of new technical construction was completed or underway — a positively remarkable amount given its context. The improved funding support was not to last, however. In FY29, an additional $165,000 was appropriated for the completion of the projects at Coco Solo and Sand Point, but no new construction was authorized and few even minor improvements were funded — none that amounted to more than $10,000. In fact, the FY28 projects were to be almost the only such appropriations secured by the Naval Air Service for new technical construction throughout the entire Five-Year Program. The one exception came in FY31, when Pearl Harbor received authorization for the last of the Seaplane Hangar Design A projects. This structure was

intended as a combined reserve hangar and seaplane erecting shop, and had been under request by the Bureau of Aeronautics for a number of years before it was finally approved. It was not completed until 1934. Another double hangar of the same design, but with a doubled depth of 320 ft, had also been requested but was never approved. The reserve hangar was constructed along the basic lines of the standard plan, with three 110 x 160 ft bays, for a total footprint of 330 x 160 ft. Each of the three bays was still spanned by a flat gabled steel truss at a clear height of 29 ft. This structure differed from the standard in style, cladding, and permanency of construction, however. It featured much more substantial masonry cladding and substantial piered door pockets. Essentially, only the structural elements themselves remain true to standard (Figure 3-25).[101]

This Pearl Harbor hangar was nearly the last new construction approved during the Five-Year Program. Generally, only minor improvement and expansion projects were funded. Most established air stations appeared to have received some of this type of minor construction activity, including repair and extension of ramps and seawalls, work on the hangars themselves, relocation, expansion, and repair of various associated structures, and even the erection of another U.S. All-Steel Hangar at North Island for use as a dope house.[102] The only other new construction was the establishment of the new LTA field at Sunnyvale, CA, which would subsequently be christened Moffett Field in honor of the deceased Chief of the Bureau of Aeronautics, a constant supporter of LTA aviation.[103] These relatively minor programs, however, did little to relieve the serious overcrowding that remained a problem at all of the Navy's aviation shore facilities. Once again, though, a new program of naval expansion was just around the corner, bringing the promise of meaningful expansion to the beleaguered system of Naval Air Stations.

The Vinson-Trammell Expansion Program (1933 – 1937)

To some extent, the effect of the Vinson-Trammell Navy Act expansion program on the Naval Air Service is closely comparable to that of the Five-Year Program. As in the earlier plan, substantial expansion was achieved in the Navy's modern aircraft inventory. This expansion, in fact, remained the Bureau of Aeronautics' primary concern. Once again, aviation shore facilities received comparatively short shrift at the hands of the Bureau of the Budget. Also similar to the earlier plan, the bulk of the new technical construction at the Navy's air stations was achieved in the first half of the Vinson-Trammell expansion program. Perhaps most significantly, aviation shore facilities continued to lag behind the aircraft inventory, and overcrowding problems still remained after completion of this third program of expansion. On the other hand, the Bureau of Aeronautics did succeed in significantly expanding its infrastructure, and was even able to

establish two new air stations. Crucial to this success was a new source of funding that had been unavailable during the Five-Year Program. The Great Depression inspired the creation of the various emergency relief programs such as the previously noted WPA and PWA, and the National Industrial Recovery Administration (NIRA). Over the course of the 1930s, significant growth was made possible through large appropriations from emergency relief funding sources, as millions of dollars were channeled towards technical construction at naval aviation shore facilities. While improvements to the infrastructure failed once again to keep pace with the increase in the aircraft inventory, important strides were made during the period, and a strong foundation was laid for the rapid expansion of the Navy's basing facilities that would pick up speed as war loomed closer in the early 1940s.

Provisions of the Vinson-Trammell Navy Act

The Vinson-Trammell Navy Act of 21 March 1934 called for an expansion of the Navy to meet 1930 London Treaty limits. Significantly, aircraft were specifically included in this expansion, as the Navy sought to redress the current shortage of operational aircraft. Whereas the Five-Year Program had set a specific limit on the number of aircraft for the Navy's air arm, the Vinson-Trammell Act called for the number of operational aircraft to grow proportionally along with the number of battleships, cruisers, and aircraft carriers in the fleet. This alleviated the need for later additions to the program to provide for subsequent expansion of the fleet. As each new ship was due to enter service, a corresponding increase in the aircraft inventory was automatically authorized. No longer would the Naval Air Service be forced to reassign existing aircraft to new ships from other operational sources.[104]

By 1934, 15 new cruisers and one aircraft carrier — the *USS Ranger* — had been commissioned but, under the Five-Year Program, had not been provided aircraft complements. These unsatisfied requirements totaled over 200 aircraft, and the Vinson-Trammell Navy Act authorized the immediate expansion of the aircraft inventory to accommodate these demands. In 1936, Congress authorized the construction of six new cruisers and two large aircraft carriers — the *USS Yorktown* and *USS Enterprise*. Combined with the already outstanding aircraft requirements, the new fleet requirements stood at 273 new aircraft, all of which were automatically approved under the Vinson-Trammell Navy Act.[105] The flexibility provided by the Vinson-Trammell Navy Act proved extremely valuable during the fleet's expansion program. The Bureau of Aeronautics estimated that by 1940, it would require some 2,000 aircraft to outfit the growing fleet, including those required for the new vessels planned under the current expansion program.[106] But as the threat of war loomed larger in the late 1930s, and the fleet

continued to enlarge in response, the Vinson-Trammell Navy Act provided a blanket authorization for the new aircraft required to keep pace with the surface vessels.

Emergency Relief Programs Supplement Funding

Initial funding for the Vinson-Trammell Navy Act was provided by the Emergency Appropriations Act of 1934. Included in this Act was a Congressional authorization of $40 million for shore establishments, including $7.15 for aviation shore facilities. These appropriations allowed for the immediate construction of new hangars at San Diego and Pensacola. At the same time, the WPA allotted more than $3 million for new construction, improvements, and repairs to shore stations nationwide. Supplementary funds acquired from the Emergency Relief Programs were crucial to the Navy's expansion of its shore facilities. By 1939, some $36 million had been allotted from these programs for construction at 30 different Navy installations. Naval Air Stations that received more than $1 million each during this period included Lakehurst, Pensacola, Seattle, San Diego, the Naval Aircraft Factory in Philadelphia, and the new air station at San Pedro, CA. Emergency Relief Programs also helped to finance the construction of two new aircraft carriers. The *Yorktown* and *Enterprise* were both laid down in 1934 with the help of Emergency Relief funds.[107]

Pilot Shortages Continue

Personnel problems persisted throughout the period. The increases to the aircraft inventory authorized under the Vinson-Trammell Act were never supported by increased funding to allow for growing crew requirements. Since active personnel were unavailable to fill these positions, the Bureau of Aeronautics was forced to resort to other sources to provide pilots for new aircraft. At first, the principal source of these new pilots remained the Navy Reserve, but poor funding and poorer career prospects for these aviators led to declining numbers of qualified candidates. In 1935, Congress passed an act authorizing the formation of the Aviation Cadet program. These Cadets could be drawn from college graduates — most often members of Reserve Officers' Training Corps (ROTC) units — who would undergo one year of flight training at NAS Pensacola, followed by three years of active duty with the fleet, and would then be discharged to the Naval Reserve at the rank of ensign. These Aviation Cadets proved quite able at sea, although their lack of experience and general naval knowledge hampered their abilities to act as gunnery observers. Despite this limitation, the Aviation Cadets served quite well as the stop-gap solution for which they were intended, and would later evolve into a permanent source of regular officer pilots.[108]

Developments in Technology and Doctrine in the 1930s

Yearly fleet exercises continued to demonstrate the value of the aircraft carrier in modern naval warfare, and emphasized the need for more of these vessels. However, the 1933 exercise brought with it the final death blow to LTA operations with the fleet. In that year, the dirigible *Macon* provided some useful weather observation information, but invariably was judged destroyed at the first contact with the enemy. Its self-conveyed escort fighters were never strong enough to ward off attacks by carrier-borne adversaries. Following this exercise, LTA aviation was confined to coastal patrol duties. After the crash of the *Macon* in February 1935, rigid airships were eliminated from the Navy's inventory altogether, and LTA operations were confined to blimps.[109]

Technological advances in heavier-than-air aviation continued apace, however. Significant developments continued throughout the 1930s, including new sturdier airframes and increasingly complex super-charged engines that provided ample power at proportionally lower weights. These developments were especially crucial to carrier aircraft, as they provided for higher speeds, higher lifting capabilities, and longer cruise ranges, while maintaining the low aircraft weight necessary for carrier takeoff and landing.[110]

Major Construction Programs

Like the Five-Year Program, expansion under the Vinson-Trammell Navy Act started off with a bang. In 1933, North Island began construction on seven new hangars to accommodate expanded fleet operations in the Pacific. Corry Field, an auxiliary flying field attached to NAS Pensacola, also received four new hangars in the same year, finally providing shelter for training planes that had been left in the open over the past decade. Pensacola itself also benefited, with three of seven newly constructed hangars resulting directly from the Vinson-Trammell expansion program, aided by financing from the Emergency Relief Programs. Numerous other installations also received more minor improvements, but these three were the primary beneficiaries.

The seven landplane hangars at North Island appear superficially similar to the standard Seaplane Hangar Design A, but available plans do not establish any clear link to a standard plan. Each hangar was constructed with a single bay, apparently spanned by the standard flat gabled steel truss-work. The size of the bay is not clear on the drawings so it is not certain that the standard truss was actually used. The general architectural style conforms to the norm, as do the cladding and detailing. The North Island hangars featured the common exposed frame door runners, window layout, roof ventilation, stucco cladding over inter-

nal hollow tile walls, and asphalt shingle roofing. Substantial lean-tos are present along both side elevations, and these appear to be somewhat different than the Seaplane Hangar Design A forms, in that they are lower and broader (Figure 3-26). The only dimension precisely identifiable in the drawings available is the clear height of the hangar bay, at 20 ft. The hangars were completed by 1935, at an original cost of somewhat less than $240,000.[111]

The four Corry Field hangars were constructed from a new 1933 Bureau of Yards and Docks design that was later employed at both the main field at Pensacola in 1937 and 1940, and at the Marine Corps Air Station at Quantico in 1935. This plan featured a single hangar bay measuring 110 x 160 ft, which appears to use the same 110 ft flat gabled truss as the Seaplane Hangar Design A. The clear height of the bay was just under 20 ft. Beyond this structural similarity, the Corry Field hangars differed greatly from the Seaplane Hangar Design A, particularly in their massive corner piers and substantial masonry construction (Figure 3-27). Like the North Island hangars, the Corry Field hangars were completed by 1935.[112]

The third major construction program conducted under the Vinson-Trammell Navy Act was the substantial improvement to NAS Pensacola, still the home of the Navy's pilot training operations. The basic requirements of the plan for Pensacola had already been determined by 1931, but the onset of the Great Depression prevented the Navy from requesting the large appropriations that would have been necessary to enact it. The construction was therefore put off until Emergency Relief Program funds began to become available in the mid-1930s, whereupon construction at Pensacola commenced with heavy support from these sources. In total, the Pensacola construction program entailed four landplane hangars of the type already completed at Corry Field, as well as one larger hangar for landplanes or seaplanes, one dedicated seaplane hangar, and one immense Overhaul and Repair Hangar, which was really two hangars connected by an extensive shop annex. The construction of all of these new hangars spanned the years 1937 – 1940, but only three were directly related to the Vinson-Trammell Navy Act expansion program. In 1937, the first three hangars of the plan were constructed — two landplane hangars, apparently identical in all respects to those already described at Corry Field (Figure 3-28) and the Overhaul and Repair Hangar. The Overhaul and Repair Hangar was far different. It consisted of two large hangar bays, one at each end, separated by a long, low shops annex that was spanned by a series of ceiling monitors to let light into the broad structure. The overall dimensions of the structure were 320 x 204 x 47 ft, with a useable square footage of almost 212,000 sq ft. The assembly line function of the structure is quite apparent in the layout, as one hangar bay allowed entry of aircraft, shops in between provided expansive work space, and the oppo-

site hangar allowed aircraft to exit (Figure 3-29). Exterior styling was consistent throughout the three structures (and the later elements of the general expansion plan as well, in fact), with heavy corner piers, masonry cladding, and copper flashing.[113]

By 1937, site selection was complete for the new air station at Alameda, CA. This facility was planned to support the important fleet operations based in San Francisco, as the Navy gradually shifted its emphasis to the Pacific in response to growing tensions in the Far East. Construction plans for Alameda were in place, although none had commenced until 1938.[114] In that year also, a new fleet air base was established at San Pedro, CA, including the erection of a single hangar.[115] Beyond these planning activities and preliminary construction efforts, strict funding constraints meant that little more in the way of new construction was undertaken on behalf of the Naval Air Service. Only minor improvements were completed at various other stations throughout the country, in a small attempt to keep pace with the steady expansion of naval aviation operations.

The Naval Expansion Act of 1938

This attempt to maintain some semblance of balance between the scope of aviation operations and the aviation shore facilities that supported them was about to become immeasurably more significant. In January 1938, Congress passed President Roosevelt's Naval Expansion Act. This act called for across-the-board increases of 20 percent in the Navy's fleet strength. The aircraft inventory was likewise authorized to grow to a strength of not less than 3,000 planes by 1945. Of course all these new planes would require pilots and basing facilities, both of which were authorized in this important act. By this time, it had become clear to leadership in the Navy and in Congress that it was futile to attempt to expand naval aviation operations without a corresponding expansion of the infrastructure that was necessary to support them. To plan the coming expansion, the Navy organized the Hepburn Board to examine the basing situation and make recommendations for the construction program that must follow. Meeting in late 1938, this board reported out in early 1939, and set the parameters for the rapid expansion in aviation shore facilities that would continue through WWII.[116] A hard lesson in the practicalities of air operations had finally begun to sink in, and the experiences of the Interwar Years would shape the policies enabling the swift growth of the Navy and its air arm during the hurried mobilization for WWII.

Developments in Marine Corps Aviation and Technical Construction

Demobilization and Reorganization in the Lean Years

The Marine Corps was affected in much the same ways as the other services by the demobilization initiative that began after World War I. As force levels contracted in the Navy at large, the Marine Corps was also compelled to minimize its manpower. Major Cunningham led the fight for survival of Marine Corps aviation during this process. He emphasized aviation's role in supporting Marine Corps ground forces in their mission of seizing and holding advanced bases for the fleet. His view of the roles and missions of Marine aviation already hinted at the importance of close air support in landing operations which would become the hallmark of Marine Corps aviation in the Interwar Years, and continues to be its primary focus today. By 1920, Marine aviation had won its fight for permanent status, as Congress passed legislation establishing the Marine Corps at approximately one fifth the strength of the Navy. This meant an overall force level of about 26,000 men, supported by an additional 100 officers and 1,000 enlisted men for the air arm.[117]

In 1920, the Marine Section of naval aviation was officially established, with Cunningham at its head. It was placed under the joint authority of the Major General Commandant of the Marine Corps and the Director of Naval Operations, with Cummingham serving as a sort of liaison between these two figures. In December 1920, the Section was placed under the direct authority of the Division of Operations and Training. This arrangement promoted the close cooperation between Marine Corps ground forces and the Aviation Section that was crucial to the successful completion of the Marine Corps mission. The Aviation Section was further organized into a system of wings, squadrons, and flights. Each wing consisted of two to four squadrons, each squadron made up of two flights. Within this stable organizational structure, actual aircraft and personnel were shifted and reassigned as operational needs dictated. Generally, each wing had only one operational squadron in peace-time, a nucleus around which wartime expansion could be based. In 1924, two air groups were established, with the First Air Group on the East Coast, and the Second on the West Coast, each attached to the Marine Expeditionary Force based on its respective coast.[118]

Throughout the Interwar period, Marine Corps aviation suffered from severely limited funding support, closely analogous to its Navy counterpart. This had the effects of limiting the number of trained personnel in the Aviation Section, of confining the Section's aircraft inventory to old cast-off planes from the Army and Navy, and of strictly limiting improvements to the Marine Corps' few air stations. The Aviation Section experienced the same kind of problems in

maintaining its full complement of pilot officers as did the Navy's Aviation Section. The authorized strength of 100 officers was rarely met, and even had it been possible to do so, it still would have left the Marines short of the pilots needed to accomplish their operational commitments. The Section therefore resorted to training enlisted pilots who could be commissioned in time of war, and relied heavily on the Marine Aviation Reserve Officer Corps to ensure that it would have the necessary number of pilots in the event of a war. These Reservists, like all Marine aviators, received their primary flight training at Pensacola and then went to other Navy and Army flight schools for advanced training. Upon completion of their training, they spent one year of active duty in the Aviation Section, then returned to civilian life until recalled to duty for emergencies.[119]

Due to the lack of funding immediately after World War I, the Marine Aviation Section had to make do with old Curtiss JN-4 Jennies, HS-2L seaplanes, and an assortment of surplus Army aircraft ranging from DH-4Bs to captured German Fokker D-7 pursuit planes, to old Thomas-Morse Scouts. In the early 1920s, the Section received a limited number of newer aircraft, including the Vought VE-7, which was essentially an improved version of the old Jenny, new F5-L flying boats, and six Martin MBT heavy bombers. As late as 1925, the entire Marine Corps aircraft inventory consisted of fewer than 50 aircraft.[120]

Given the difficult funding environment of the early 1920s, the Marine Corps was surprisingly successful in securing adequate basing facilities for its air arm. Immediately following the end of WWI, however, it did not appear as though this would be the case. In September 1919, the Marines' airfield at Miami — the only operational facility of its type in the Marine Corps — was abandoned, and flying operations transferred to the primitive field at Quantico. But by the end of 1920, the basing situation had substantially improved. Air stations were under construction at Quantico, Parris Island, and San Diego, although the latter was simply an addition to the Naval Air Station at North Island. These three facilities would constitute the entire aviation infrastructure for the Marine Corps throughout the Interwar Years. Parris Island received one U.S. All-Steel Hangar in 1919. In 1920, Quantico received its first aircraft hangars, including three standard U.S. All-Steel Hangars acquired from the Army, and two standard 75-Foot Coastal Air Station Seaplane Hangars (Figure 3-30). Two more 75-Foot Coastal Air Station Seaplane Hangars were later added in 1923. In 1925, another U.S. All-Steel Hangar was erected at Quantico, having been transported there from Santo Domingo (The Dominican Republic) when the Marines withdrew in 1924.[121]

Despite the funding problems, Marine aviation made significant advances in tactics and doctrine, and successfully executed a number of combat operations in support of overseas deployments. Aviation operations in the early 1920s revolved around constant gunnery and bombing practice, as well as numerous maneuvers and exercises conducted in conjunction with Marine Corps ground forces. Special attention was given to coordinating ground and air elements of the Expeditionary Forces, concentrating on artillery spotting, air-ground radio communications, aerial reconnaissance and photography, and the coordination of aerial attacks in support of ground forces. Marine aviators also took part in record-setting long-distance flights and the thriving air race circuits that encouraged technological developments and kept military aviation in the public eye. Marine aviation made its initial advances in actual combat aviation during the early 1920s, as elements of the Aviation Section deployed overseas in support of Marine Corps Brigades in Haiti and the Dominican Republic. Aviation operations were largely confined to reconnaissance, mapping, transport, and medical evacuation duties, but limited combat operations were also conducted. Most important, the first dive-bombing attacks were made by members of the Fourth Marine Squadron in Haiti in the summer of 1919. This appears to have been the first time that such attacks were conducted by Marine aviators, and the increased accuracy that dive-bombing made possible was immediately apparent to the Aviation Section, who adopted the tactic for all of its units' regular training regimens.[122]

Marine Corps Aviation Under the Five-Year Program

The Marine Corps Air Section experienced some expansion and modernization of its aircraft inventory as a result of the Navy's Five-Year Program, but no new technical construction was approved. WWI-era aircraft were gradually replaced by newer models throughout the late 1920s and early 1930s. By the late 1920s, the Boeing FB series, the Curtiss F6C Hawk series, and the Vought O2U Corsair dominated the Marine Corps aircraft inventory. These new models featured air-cooled radial engines that offered enhanced power and reliability at reduced weight. New Curtiss F7C Sea Hawk and F8C-4 Hell Divers took over attack duties from the old DH-4s. Atlantic-Fokker and Ford Tri-Motor transports provided valuable new air transport capabilities as well.[123]

Employing these new aircraft, Marine aviators made important advances in close air support tactics during their deployment to Nicaragua, which began in 1927 and lasted into the early 1930s. In a celebrated engagement at Ocotal in July 1927, aircraft from one of the two Marine Squadrons in Nicaragua conducted devastatingly effective dive-bombing and strafing attacks in close support of a beleaguered Marine Corps platoon. Important developments were also made

in the coordination of air and ground elements of the Marine Corps Expeditionary Forces, especially in the use of radios colored panels in directing air attacks on hidden targets. Throughout the deployment, Marine aviators provided invaluable assistance to Marine Corps and allied Nicaraguan ground forces, in the form of reconnaissance, transport, and medevac missions, as well as the close air support missions that remain the center of Marine Corps air doctrine today. As Navy leaders came to appreciate the importance of close air support to the Marine Corps Expeditionary Forces, they authorized a move intended to more closely integrate Marine aviation into the fleet's operational activities. Beginning in 1931, Navy policy dictated that one Marine squadron be assigned to each aircraft carrier at all times. This policy allowed intensive carrier training operations for each Marine squadron as it rotated through its period of fleet duty.[124]

Marine Corps Aviation and the Fleet Marine Force

The Great Depression brought on a renewed funding crisis in the early 1930s. The Marine Corps' reaction to reduced appropriations was to recall all of their overseas commitments, and to consolidate their operations in the United States as much as possible. This period was also one of intense debate over the proper strategic doctrine of the Marine Corps. Some leaders were of the opinion that the Marines should maintain the ability to act as a sort of small, self-contained army, capable of any type of mission. Others thought that the Marine Corps should concentrate exclusively on developing an amphibious warfare doctrine that would help it accomplish its mission of taking and holding advanced bases for the Navy. In light of escalating tensions in the Far East, and the growing likelihood of a Pacific War against Japan, the amphibious warfare supporters triumphed. On 8 December 1933, the new Fleet Marine Force (FMF) was established, providing a force of Marines that would be maintained in a state of constant readiness to act with the fleet. Marine Corps aviation was incorporated into the FMF in the form of Aircraft One (based at Quantico on the East Coast) and Aircraft Two (based at North Island on the West Coast).[125]

To enhance its ability to conduct its new amphibious mission, the Marine Corps developed a new combat doctrine that would inform all of its operations, and ultimately would form the basis of its role in WWII. In 1935, officers from Marine Corps Headquarters and the FMF drew up the *Tentative Landing Operations Manual*, which laid out the Marine Corps doctrine for conducting amphibious assaults. The *Tentative Manual* defined the roles of Marine Corps aviation in amphibious warfare. It noted that Marine aircraft would constitute a primary source of fire support for the landing force — along with naval gunfire support — and that they must provide air superiority over the landing areas to protect the ground forces from hostile air attack. In addition to these basic duties, Marine

aviation must also be able to execute long-range reconnaissance, artillery spotting, and deep interdiction missions.[126]

Clearly, Marine aviation had secured an acknowledged importance in the conduct of FMF amphibious operations. In recognition of this new status, the Marine Corps Aviation Section was removed from the oversight of the Division of Operations and Training, and was given division status of its own. In 1936, it became the Division of Aviation, with its own director. This officer still served as liaison between the Major General Commandant of the Marine Corps and the Navy's Bureau of Aeronautics, but he had much greater direct control over the training and operations of his division. The Navy's Bureau of Aeronautics did, however, maintain authority over the procurement of aircraft, equipment, and logistical support for Marine aviation.[127]

The new amphibious mission allowed for a small amount of much-needed expansion in Marine aviation strength, despite the lean funding environment of the Depression. In 1935, the Division of Aviation included 147 officers (110 of them pilots) and 1,021 enlisted men. By early 1939, these numbers had grown to 191 officers (173 of them pilots), 19 warrant officers (seven of them pilots), and 1,142 enlisted men. This force was backed by about 60 aviation cadets of the Marine Air Reserve. The Reserve had continued to grow in the early 1930s despite a lack of funding so severe that some cadets even had to pay their own training expenses. By 1935, their lot was considerably better with the creation of the official grade of Aviation Cadet, and subsequent funding improvements that supported their training activities. By 1938, the Marine Air Reserve included over 100 pilot officers on inactive status, in addition to the 60 cadets on active duty, 15 students in training at Pensacola, and almost 600 inactive enlisted men. The Marines also received new and improved aircraft for their amphibious support missions, including the Boeing F4F and Grumman F1f, F2f, and F3f series of fighters, all of which featured substantially improved speed, power, reliability, and performance over earlier models. Ironically, Marine aviators found that they were sometimes hindered, rather than helped, by the introduction of faster modern aircraft, which made spotting enemy forces more difficult. They also began to operate new Vought SB2U-series observation planes, and a small number of Great Lakes BG-1 dive bombers. The Douglas DC-2 transport plane — the predecessor of the ubiquitous DC-3 — also entered service in the mid-1930s.[128]

The Division of Aviation's flying operations revolved primarily around the development of the new amphibious doctrine, having withdrawn from all their overseas commitments in the early 1930s. Aircraft One, at Quantico, conducted exercises primarily with the 1st Marine Brigade stationed there. Aircraft Two, at San Diego, concentrated on carrier operations with the Pacific Fleet. Both

squadrons participated in yearly fleet landing exercises, in which the Marine Corps' amphibious warfare doctrine was tested and developed. Advances were made in air-land communications and coordination, the conduct of aerial observation for naval shore bombardment, and especially in techniques of close air support with low altitude bombing and strafing attacks. By 1939 it was clear that Marine aviation had found its niche in the close support of Marine Corps ground forces, working in close conjunction with naval air and surface units.[129]

Technical construction for the Division of Aviation remained slight throughout the late 1930s, though the Division's needs were also rather limited. In FY34, the Marine Corps secured funding for some technical construction to support the expansion of the Division of Aviation. In 1934 and 1935, five hangars were completed at Quantico. Four of them were of the same standard design as those erected by the Navy at Corry Field and Pensacola (Figure 3-31). The fifth hangar appears not to conform to any known standard design, though there are some similarities between it and a proposed plan for a 1926 Navy hangar project at Sand Point. This structure featured a single bay measuring 158 x 80 ft, spanned by a closed gabled steel truss at a height of 28 ft. Exposed steel door runners were found at each end, and both roofing and cladding were of galvanized steel. These five new structures constituted the last expansion to the Quantico facility prior to the beginning of World War II, and served amply in support of the Marine Corps' growing air arm during that conflict.[130]

While Quantico was in readiness for the coming conflict, much new construction was yet to be accomplished at other sites across the country in order to accommodate the wartime expansion of the Marine Corps and the Division of Aeronautics. The Interwar Years had marked a crucial period in the history of Marine aviation — in the history of the Marine Corps in general, in fact. The Marines had survived the post-war demobilization and the lean funding years of the early 1920s and the Great Depression, and had succeeded in appropriating a unique amphibious mission for themselves that is still the primary mission of the Corps today. Marine aviators, moreover, had pioneered new close air support tactics and established the intimate coordination between air and ground forces that also remains the hallmark of the modern Marine Corps. These important foundations laid in the Interwar Years were soon to be drastically and rapidly expanded upon as the United States tooled up for World War II.

Table 3-1. The Interwar Years, U.S. Army aviation.

	1919 – 1925	1926 – 1932	1933 – 1938
Military Conflicts			
Army Aircraft	1919: MB-2 Martin operational 1925: Curtiss P-1 Hawk operational	1932: P-26, first all-metal Army aircraft 1933: Martin B-10 bomber operational	1937: Boeing B-17, Air Corps largest aircraft to date
Army Aviation Operations	Air races and publicity flights aid technical advances and keep aviation in public eye 1921: *Ostfriesland* tests in Chesapeake Bay	May 1927: Charles Lindbergh makes trans-Atlantic flight January 1931: Army Air Corps tasked with land-based defense of United States and overseas possessions Significant technological advances, especially the all-metal plane and the strategic bomber	1933: Test of General Headquarters Air Force (GHQAF) concept in Pacific Coast exercises
Army Aviation Administration	1919: Plans made to establish a comprehensive system of flying fields throughout country	1926: Passage of Air Corps Act of 1926 1926: Establishment of the Five-Year Plan, which calls for more than $18 million in construction over next 5 years	1933: Drum Board identifies seven critical strategic areas in continental United States 1935: General Headquarters Air Force (GHQAF) becomes permanent unit 1935: Wilcox Act passed; blanket authorization for Air Corps expansion
Construction Support for Army Aviation	1919 – 1920: Completion of WWI construction projects, mostly U.S. All-Steel Hangars; $42 million spent on Air Service alone 1920 – 1922: Limited permanent construction at scattered bases 1922: Air Service owns 320 hangars	1926: Only 15 flying fields active, about 1,000 fields of all kinds in United States 1926 - 1929: Early construction scattered over established bases, dominated by 110 x 200 ft steel hangars 1929 – 1932: Substantial expansion at existing bases plus establishment of new bases, dominated by 1929-A, 1930-A, and A-A standard hangar designs 1930: Introduction of new Air Corps standard field layout	Wilcox Act authorizes establishment of five new airfields, four new depots, improvements to technical training facilities 1935: Hickam Field, HI, established, operational by 1937 1936 – 1937: Northwest air base and West Coast air depot established, exhibiting new standard hangar plan and new Air Corps field layout 1936: Over 2,300 flying fields of all types active in United States

Table 3-2. The Interwar Years, U.S. Navy and Marine Corps aviation.

	1919 – 1925	1926 – 1932	1933 – 1938
Military Conflicts			1937: Japan invades China on 7 July 1938: German expansion in Europe
Navy / Marine Corps Aircraft	1919: H-16 flying boat continues integration of aircraft operations with fleet 1922: Vought VE-7SF makes first take-off from an aircraft carrier 1923: NAF PT enters service as Navy's first torpedo bomber 1923: *Shenandoah* (ZR-1) becomes Navy's first rigid airship and first to use helium 1925: Martin SC enters service as Navy's first all-metal aircraft Marine Corps using WWI-era aircraft	1931: *USS Akron* commissioned as Navy's flagship dirigible Marine Corps receives new aircraft models, including Boeing FB series, Vought O2U, Curtiss F6C, F7C, and F8C	1933: Rigid airship *USS Macon* commissioned 1937: Douglas TBD-1 Devastator enters service; Navy's first mono-plane Mid-1930s: P2Y flying boat enters service; primary long-range patrol plane Marine Corps receives new aircraft models, including Boeing F4F, Great Lakes BG-1, Douglas DC-2, Vought SB2U-series, and Grumman F1F-, F2F-, and F3F-series
Navy / Marine Corps Aviation Operations	1919: NC-4 completes first aerial crossing of the Atlantic 1919: Early developments in dive-bombing in Haiti 1921: *Ostfriesland* tests 1922: *USS Jupiter* converted from 11,050 ton collier to first aircraft carrier (*USS Langley*) 1925: *Shenandoah* tragedy	1926: *USS Lexington* and *USS Saratoga* commissioned as Navy's first operational carriers 1928: *Lexington* and *Saratoga* impress observers in first Fleet Exercise to include aircraft carrier operations Developments throughout the period in LTA aviation aboard *USS Los Angeles* Marine Corps close air support developments in Nicaragua	1933: Admiral Moffett killed in the crash of the *USS Akron* 1935: *Macon* crash signals end of rigid airship use within Navy *USS Ranger* commissioned as the Navy's first aircraft carrier designed for that purpose from the keel up Developments in Marine Corps aviation in support of new amphibious warfare doctrine
Navy / Marine Corps Aviation Administration	1920: Naval Appropriation Act of 1920 specifies the maintenance of not more than 6 LTA stations 1920: Marine Corps Aviation Section established 1921: Bureau of Aeronautics founded	1926: The Five-Year Program instituted, calling for 1,000 modern aircraft	1933: Vinson-Trammell Navy Bill signed 1933: Marine Aviation incorporated into new Fleet Marine Force 1938: Naval Expansion Act of 1938, to increase Naval strength by 20 percent 1935: Aviation Cadet program established
Construction Support for Navy / Marine Corps Aviation	1919: wartime construction projects completed 1919: Closure of Marine Corps facility at Miami 1920: Five hangars constructed for Marine Corps at Quantico 1921: North Island and Pearl Harbor receive standard Steel Seaplane Hangars 1923: Two hangars constructed at Quantico 1924: Pearl Harbor and Coco Solo receive standard Seaplane Hangar Design A 1925: One hangar constructed at Quantico	1927: Major construction effort at four Naval Air Stations dominated by use of the standard Seaplane Hangar Design A 1929: Due to limited hangar construction, Navy and Marine Corps resort to adaptive reuse and hangar relocation to house aircraft	1935: New hangar construction at North Island, Corry Field, and MCAS Quantico 1937: Major construction effort begun at Pensacola 1937: New Fleet Air Base established at Alameda, CA 1938: New naval air station established at San Pedro, CA

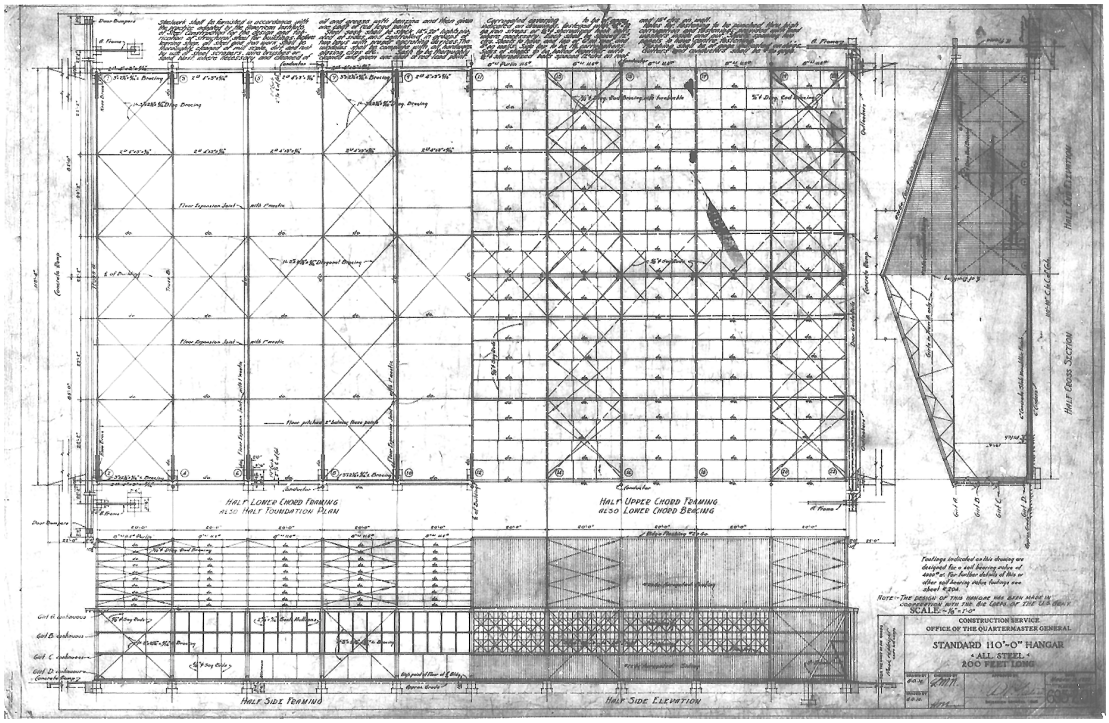

Figure 3-1. Plan No. 695-201, Standard 110 x 200 Foot "All Steel" Hangar, late 1920s.

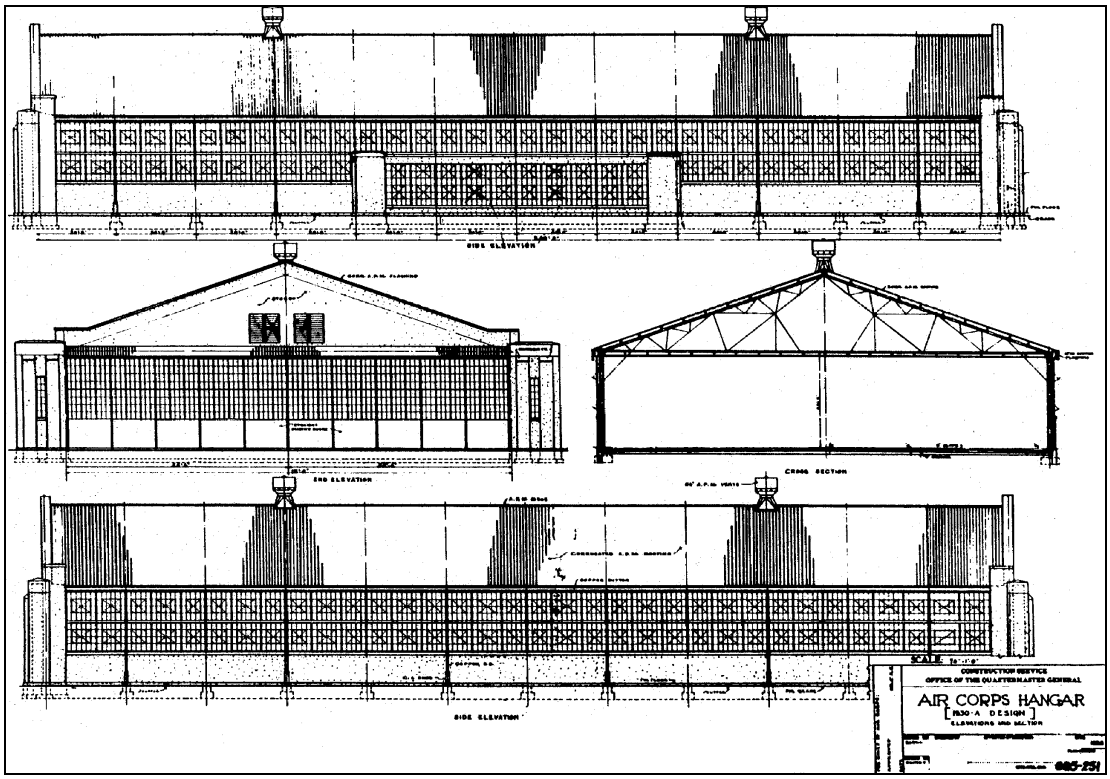

Figure 3-2. Plan No. 695-251, Air Corps 1930-A Design.

Figure 3-3. Air Corps Type A-A Hangars at Barksdale Field, LA, ca. 1934.

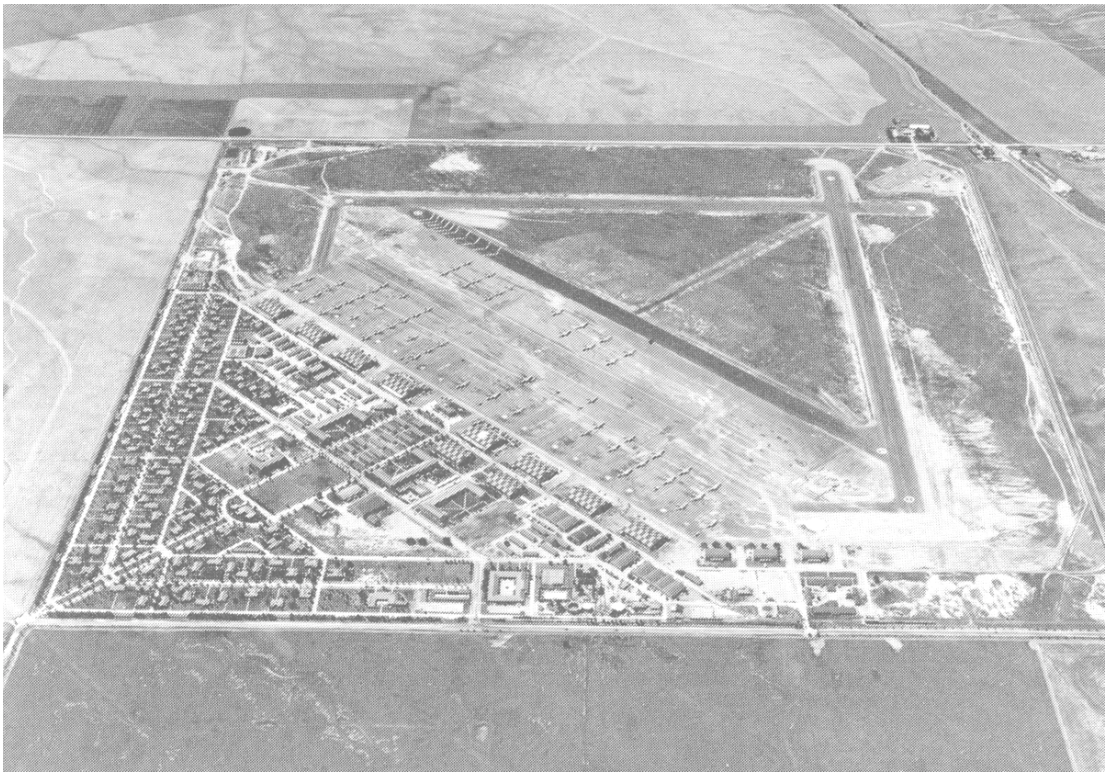

Figure 3-4. March Field, CA, an example of the standard layout resulting from the Five-Year Plan.

Figure 3-5. 110 x 200-Foot Hangars at Langley Field, VA, ca. 1929.

Stations	Expeditionary hangars																New type hangars									△	⌀	□
	A 66 × 40 SF	B 66 × 60 SF	C 66 × 80 SF	D 66 × 100 SF	E 66 × 120 SF	F 66 × 140 SF	G 66 × 160 SF	H 66 × 180 SF	I 66 × 200 SF	J 66 × 240 SF	K 66 × 280 SF	L 66 × 300 SF	M 66 × 320 SF	N 66 × 340 SF	O 66 × 480 SF	P 66 × 760 SF	Q 110 × 100 SF	R 110 × 140 SF	S 110 × 160 SF	T 110 × 200 SF	U 110 × 220 SF	V 110 × 240 SF	W 110 × 300 SF	X 110 × 320 SF	Y 110 × 400 SF	Temporary wooden hangers	Balloon hangers	Airship hangers
Aberdeen (lighter-than-air)	1	1		2																								1
Benning, Camp																												
Bierne, Camp				2																							1	
Bolling Field			3			2	1		1								2			2		1						
Boston Airport					2																							
Bowman Field						2																						
Brooks Field				1		4			1																	12		1
Chanute Field					13																					10		
Chicago																				1								
Columbus, Ordnance Depot																												
Crissy Field					2	1													2									
Douglas Airdrome					1																							
Dryden					1																							
Duncan Field (Air Depot)					1	2				1										5		3				14		
Edgewood																	1											
Fairfield, Air Depot								1	2	1			1						1	1		2				12	1	
Fort Bliss					4																							
Fort Brown					1																							
Fort Clark					1																							
Fort Crockett						1														1								
Fort Crook						1																						
Fort Sam Houston (Dodd Field)					1																							
Fort Leavenworth																				1								
Fort Sheridan						1																						
Fort Bill, Hawaii:																												
Fort Armstrong				2																							1	
Fort Kamehameha																											1	
Fort Ruger																												
Hawaiian air depot				1																								
Luke Field						2			1										1	4								
Schofield barracks				3		14																						
Wheeler Field						4														6								
Kansas City airdrome					1																							
Kelly Field						2			2									1		1						22		
Keyport, N. J.			1			1																						
Langin Field					1																							
Langley Field	2		1	2		23	1		1	1	2	1		1				1		3								1
Laredo					1																							
Lewis Camp						1																						
Little Rock Air Depot																				3*								
Logan Field					1																							
Lunken Air Port						2																						
March Field						2			1																	10		
Marfa					2																							
Mather Field						4			1																			
Marshall Field						4																						
Maxwell Field						3		1		2																		
Middletown Air Depot (Olmstead)					2					2										1								
Mitchell Field				5		3			1	1								1					1					
Norton Field						2																						
Panama:																												
Albrook						1																						
France Field						3														6					1			
Fort Clayton						2																					2	
Philippines:																												
Fort Mills					1	1																						
Camp Nichols	1		1	3				1												3		1						
Clark Field				2		2													6									
Kindley Field				3																5							2	
Phillips Field						3												1										
Pittsburgh (Rodgers)					2																							
Pope Field						4																						
Post Field						4																				10	1	
Rockwell Air Depot						16		1	1	1		4	1															2
Ross Field										1																		
Salt Lake (Woodward)						1																						
Sand Point						1																						
Santa Monica (Clover)					2																							
Schoen Field						2																						
Scott Field	1					2			1						1	1										9	1	1
Selfridge Field						4			3																	12		
Tucson					2																							
Vancouver (Pearson)					1																							
Wright Field		1	2	1	4			2	1								1										1	
Lordsburgh					1																							

Figure 3-6. Chart showing the Air Corp's hangar inventory as of November 1928.

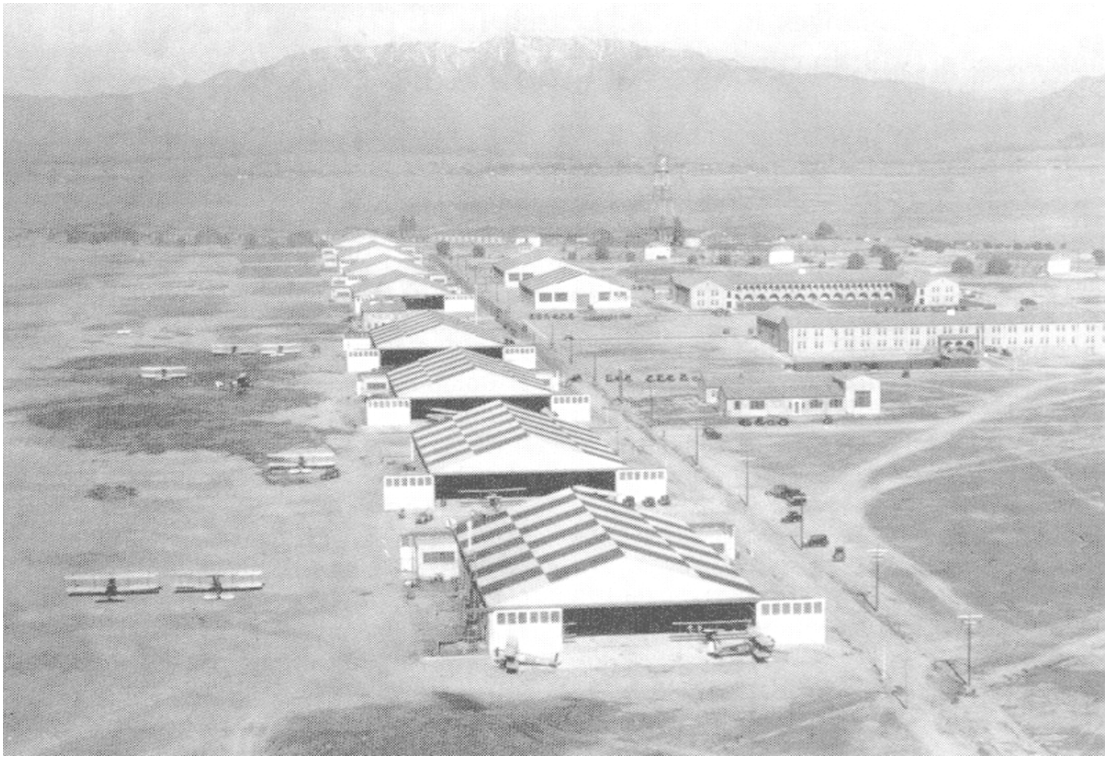

Figure 3-7. Row of standard 110 x 200-Foot Hangars at March Field, CA, ca. 1930.

Figure 3-8. Air Corps 1929-B Hangar at Maxwell Field, AL, ca. 1931.

Figure 3-9. Air Corps Type A-A Hangar at Maxwell Field, AL, ca. 1934.

Figure 3-10. Series of Air Corps 1930-D Hangars form a second flightline in front of the original at Langley Field, VA, ca. 1932.

Figure 3-11. Layout of Barksdale Field, ca. 1936.

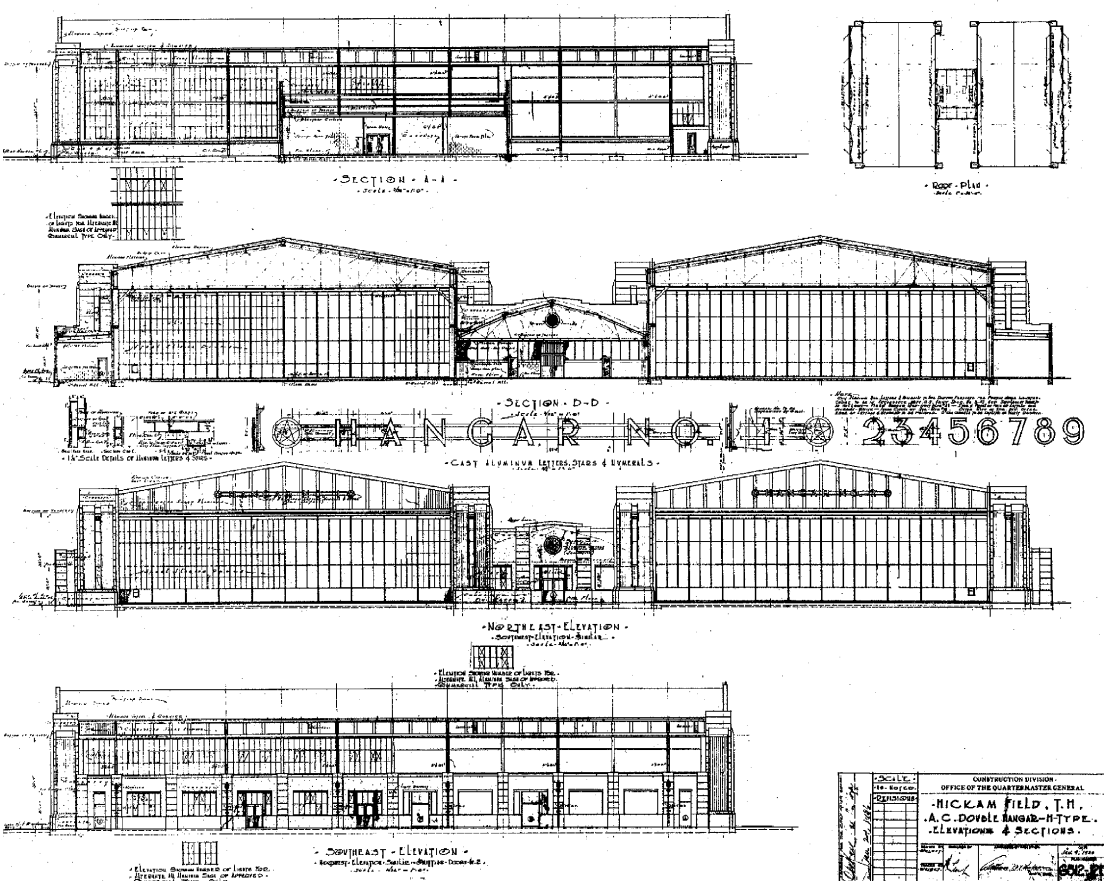

Figure 3-12. Plan of Hickam Field, HI, Air Corps Double Hangars (Type H), ca. 1936.

Figure 3-13. Three-Arch Air Depot Aircraft Maintenance Hangar at McClellan Field, CA, ca. 1938.

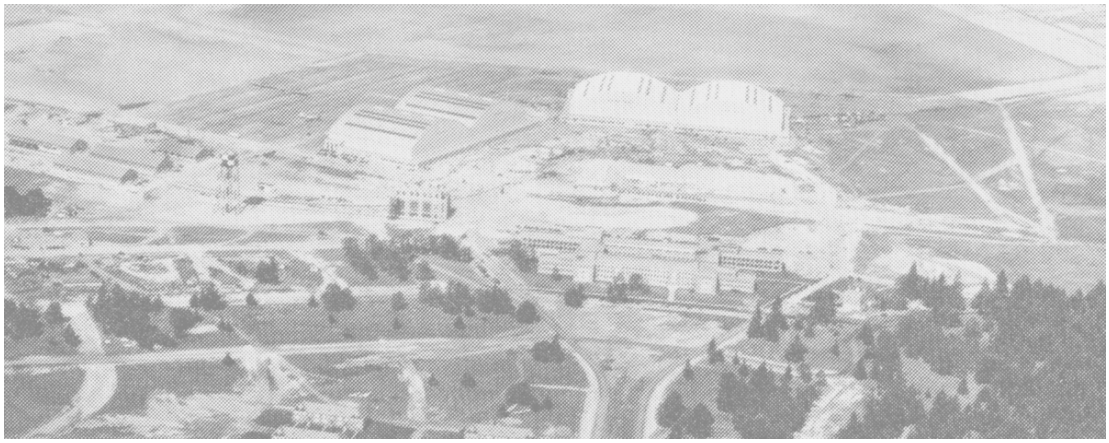

Figure 3-14. Two Two-Arch Air Depot Aircraft Maintenance Hangars at McChord Field, WA, ca. 1940.

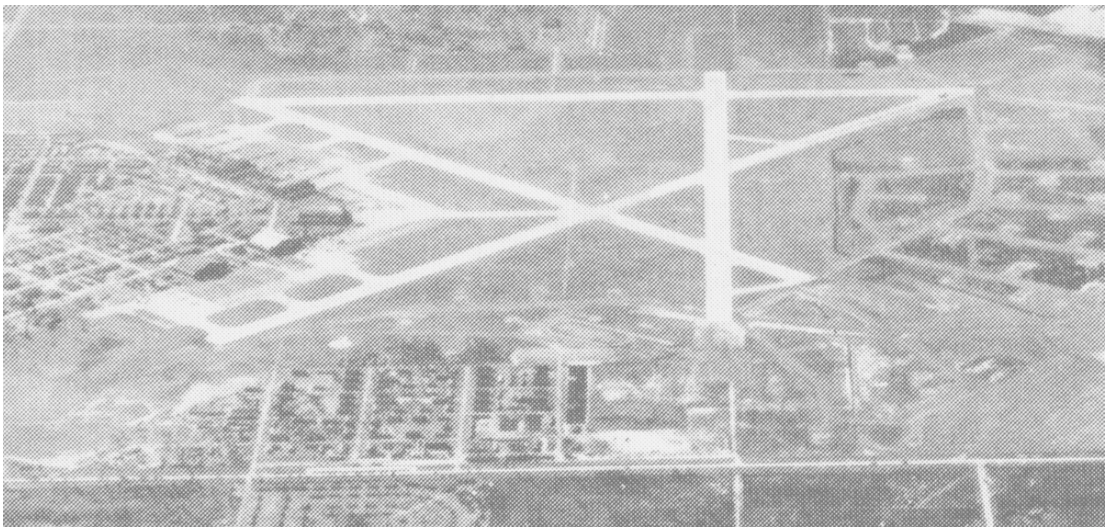

Figure 3-15. MacDill Field, ca. mid-1940s, an example of the Air Corps' late 1930s layout utilizing multiple diagonal runways.

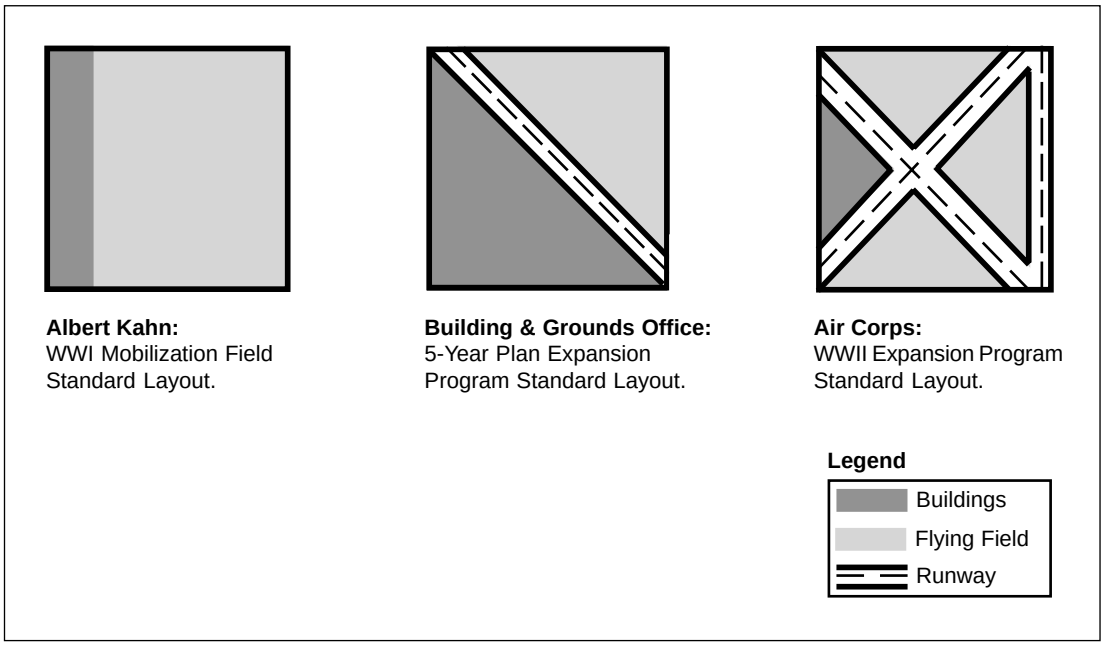

Figure 3-16. Three standard Air Corps field layouts that dominate the Interwar period.

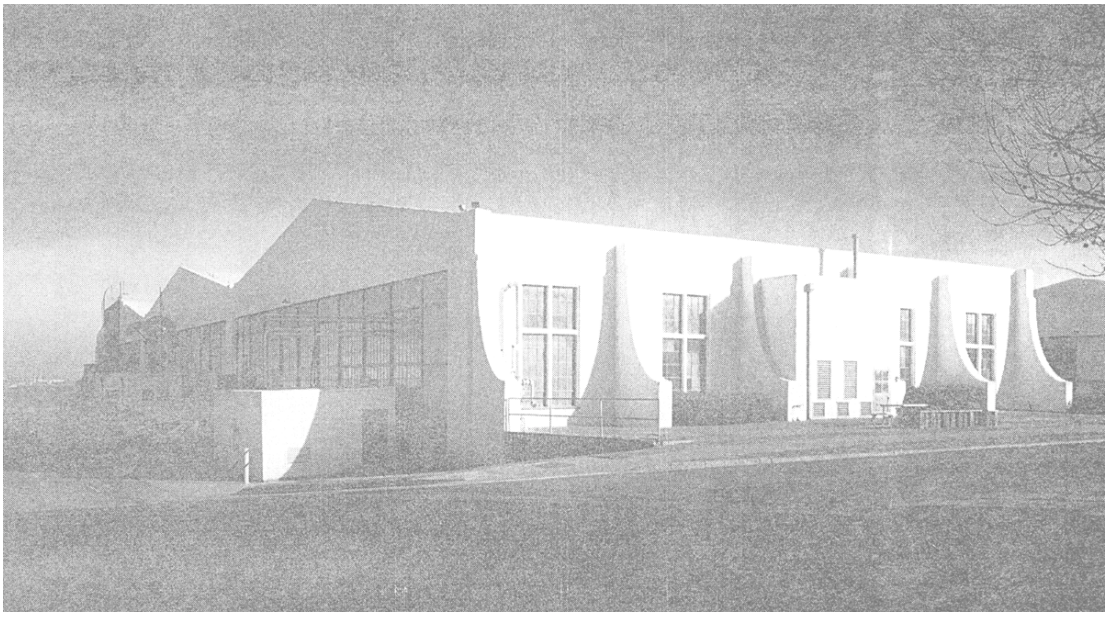

Figure 3-17. Goodhue-designed hangars at Naval Air Station North Island, CA.

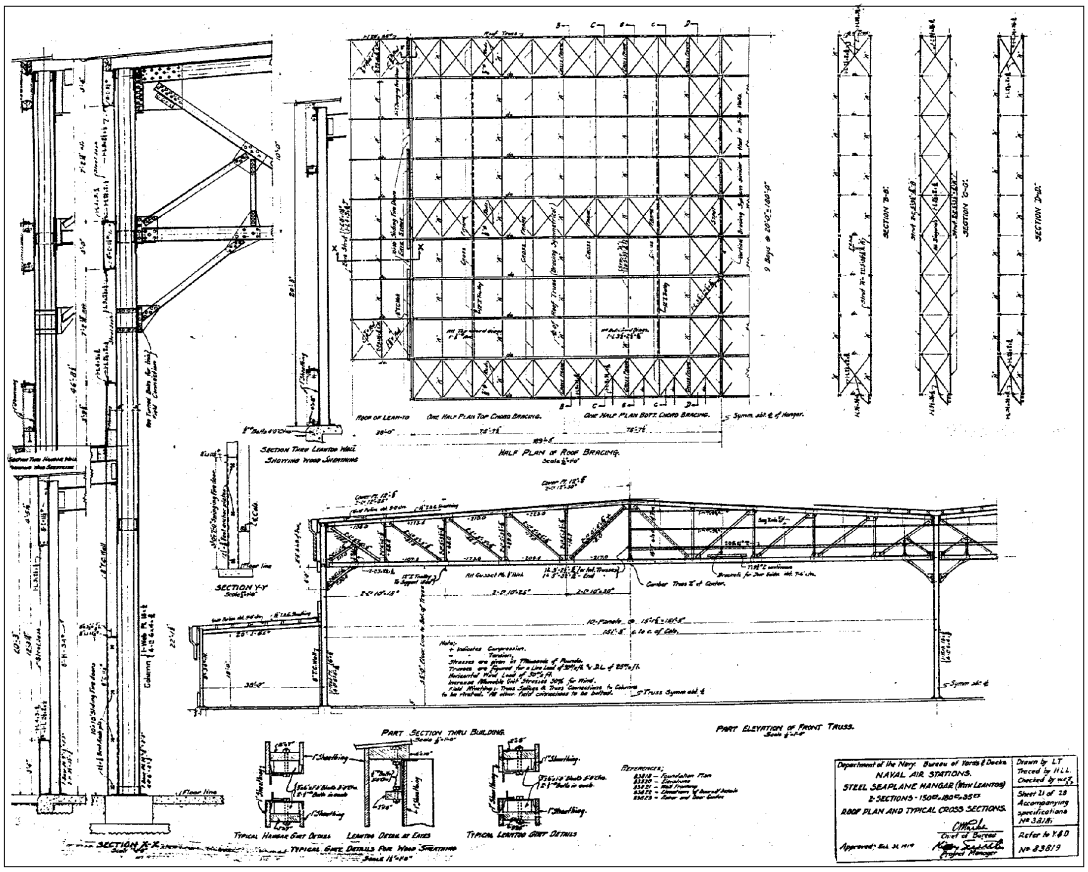

Figure 3-18. Plan of Naval Air Stations Steel Seaplane Hangar, 2-Sections, 150 ft x 180 ft x 35 ft, ca. 1919.

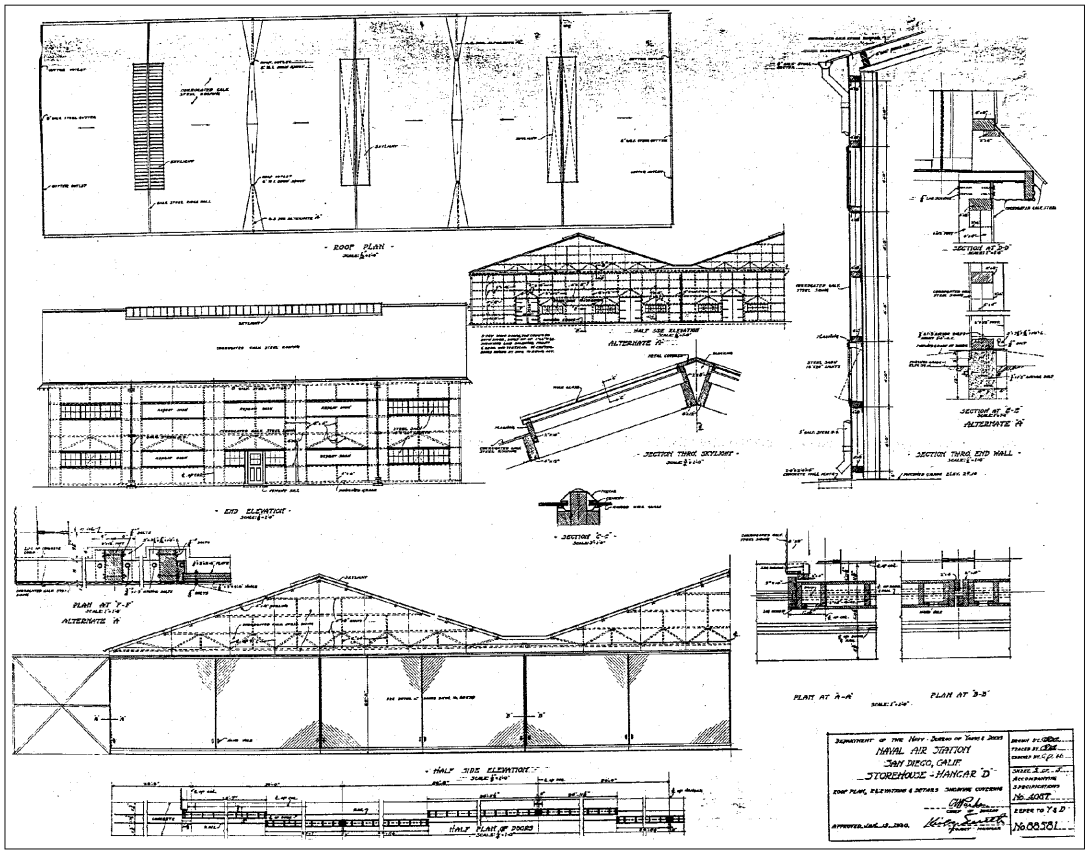

Figure 3-19. Plan of Naval Air Station San Diego, CA, Storehouse - Hangar D, ca. 1920.

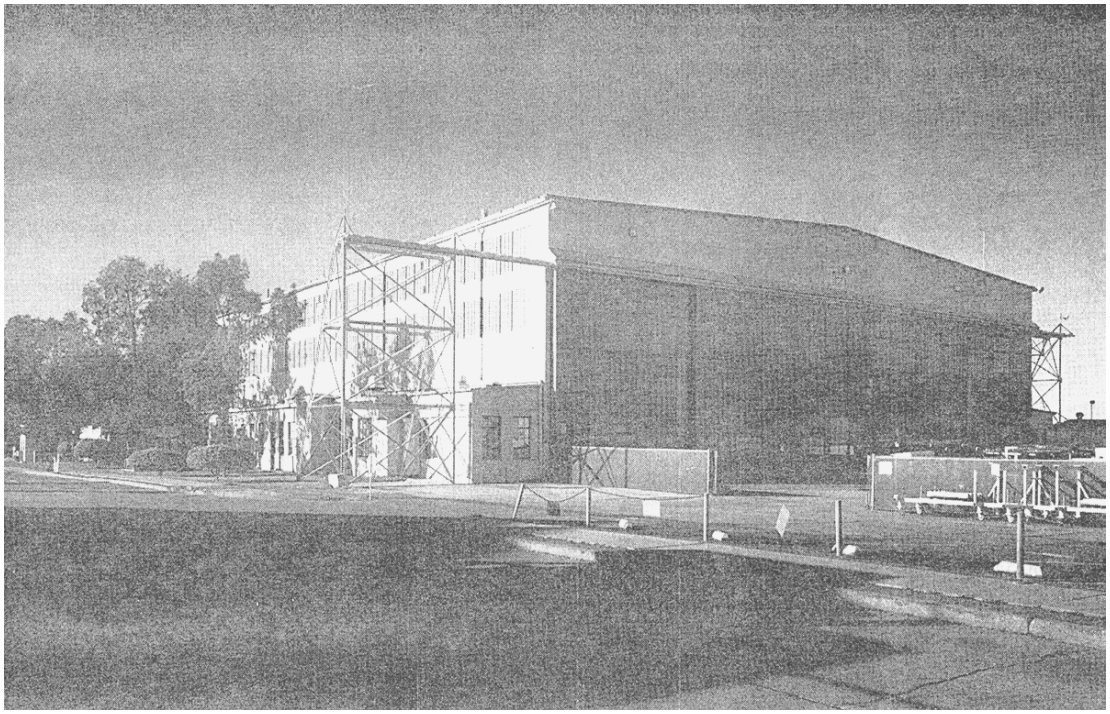

Figure 3-20. One-section version of the standard Steel Seaplane Hangar, 2-Sections, 150 ft x 180 ft x 35 ft at Naval Air Station North Island, CA.

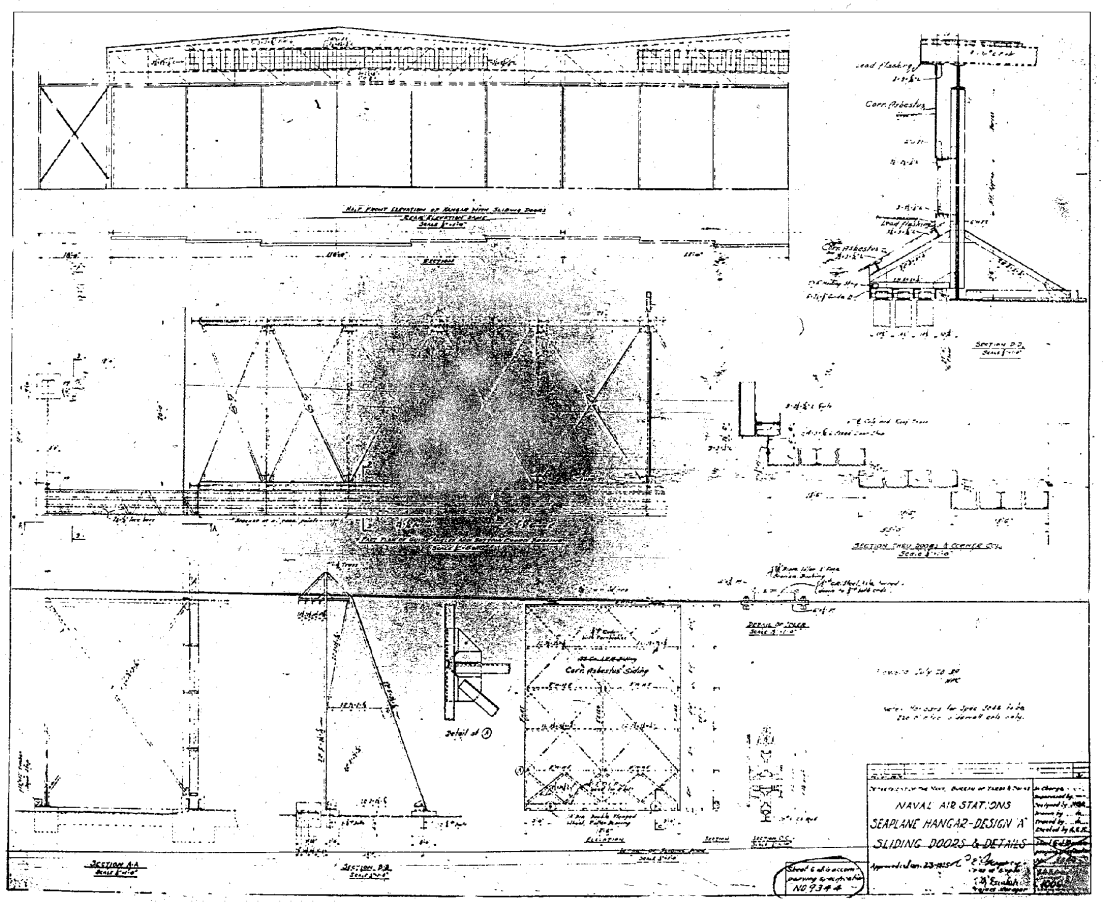

Figure 3-21. Plan of Naval Air Station's Seaplane Hangar Design A, ca. 1925.

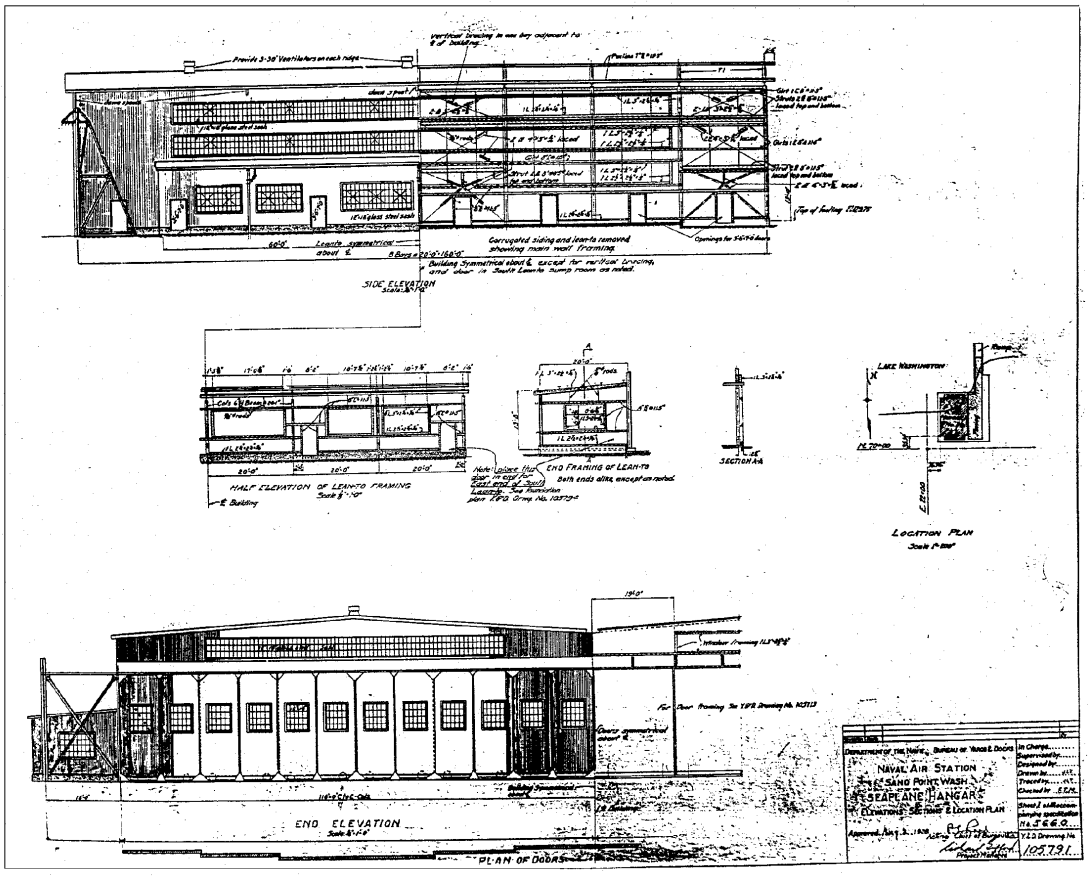

Figure 3-22. Plan of Naval Air Station Sand Point, WA, Seaplane Hangar, ca. 1928.

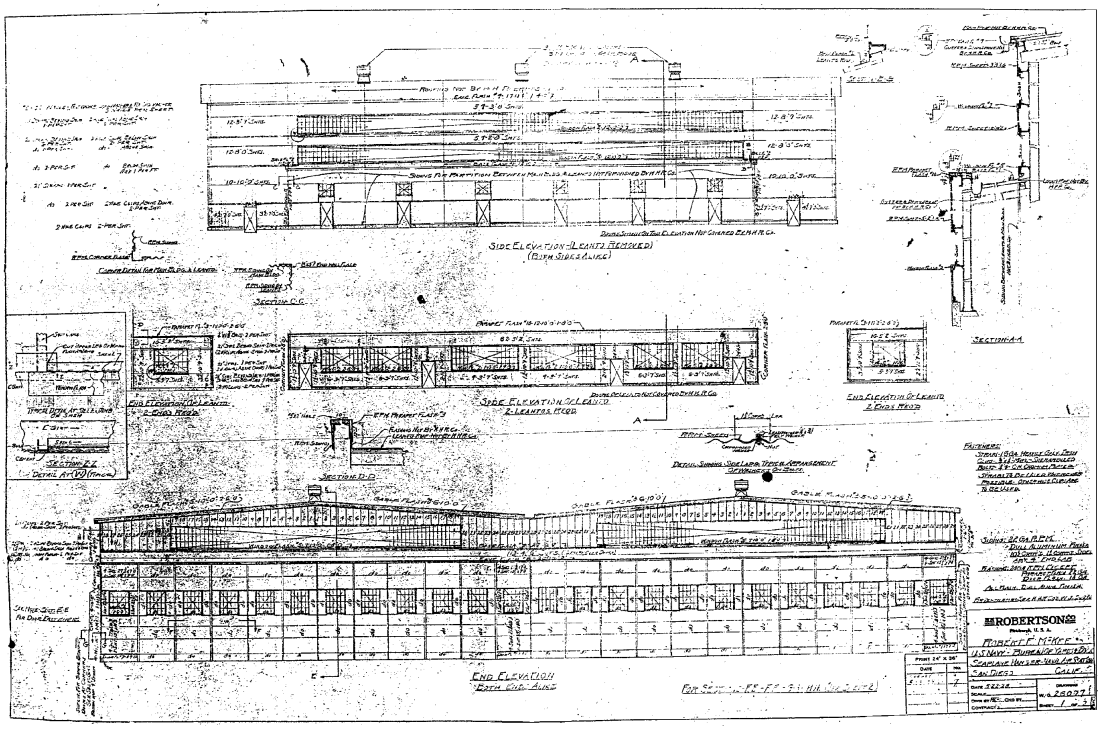

Figure 3-23. Plan of Naval Air Station San Diego, CA, Seaplane Hangar, ca. 1928.

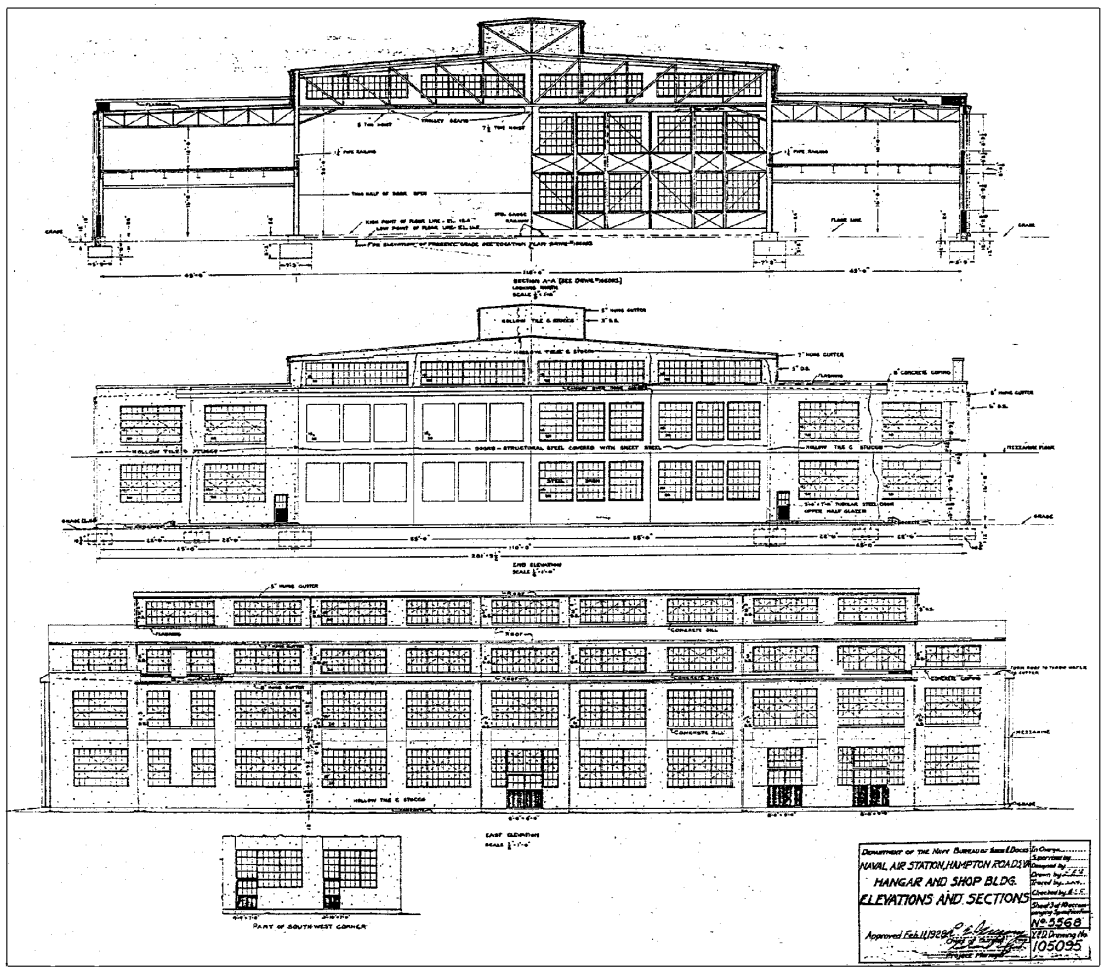

Figure 3-24. Plan of Naval Air Station Hampton Roads, VA, Hangar and Shop Building, ca. 1928.

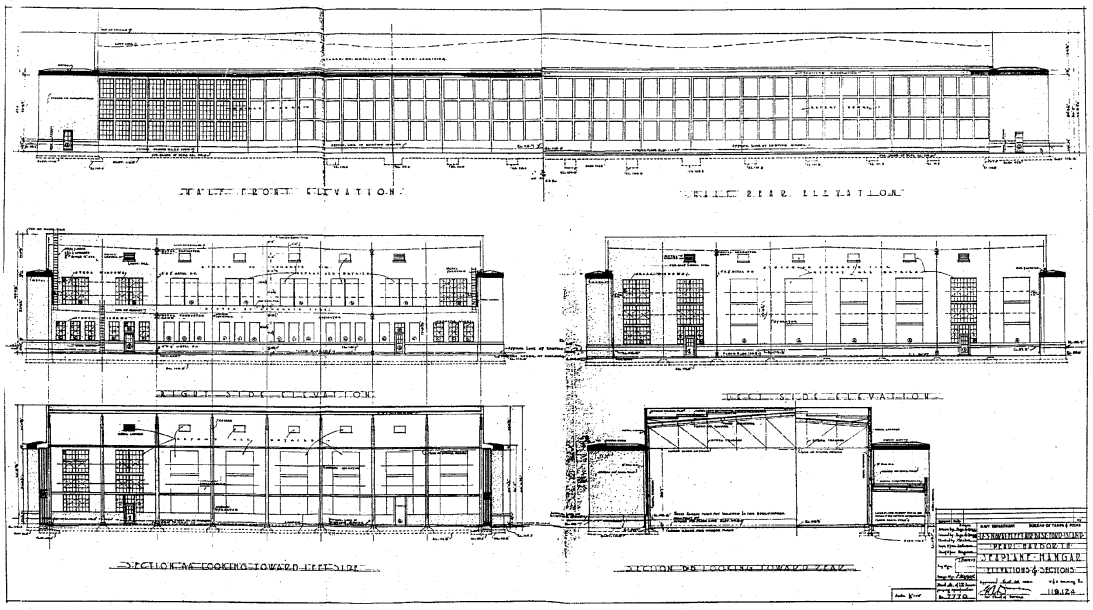

Figure 3-25. Plan of Naval Fleet Air Base Ford Island Pearl Harbor, HI, Seaplane Hangar, ca. 1934.

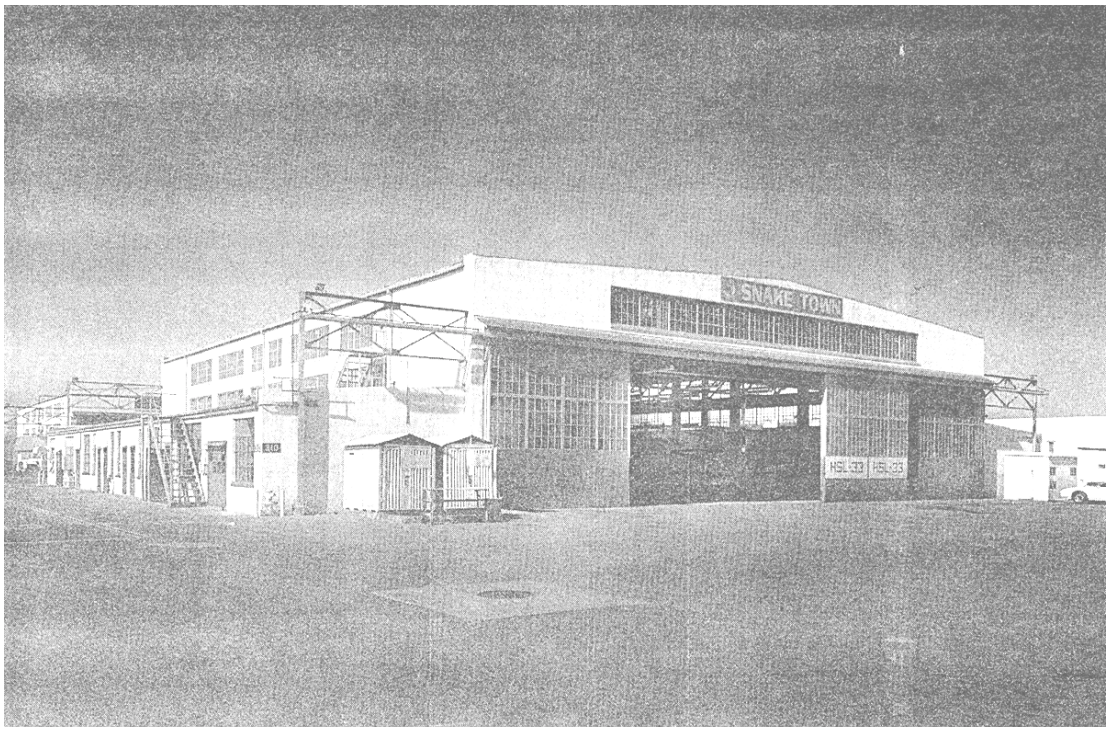

Figure 3-26. One of seven circa-1933 hangars constructed at Naval Air Station North Island, CA.

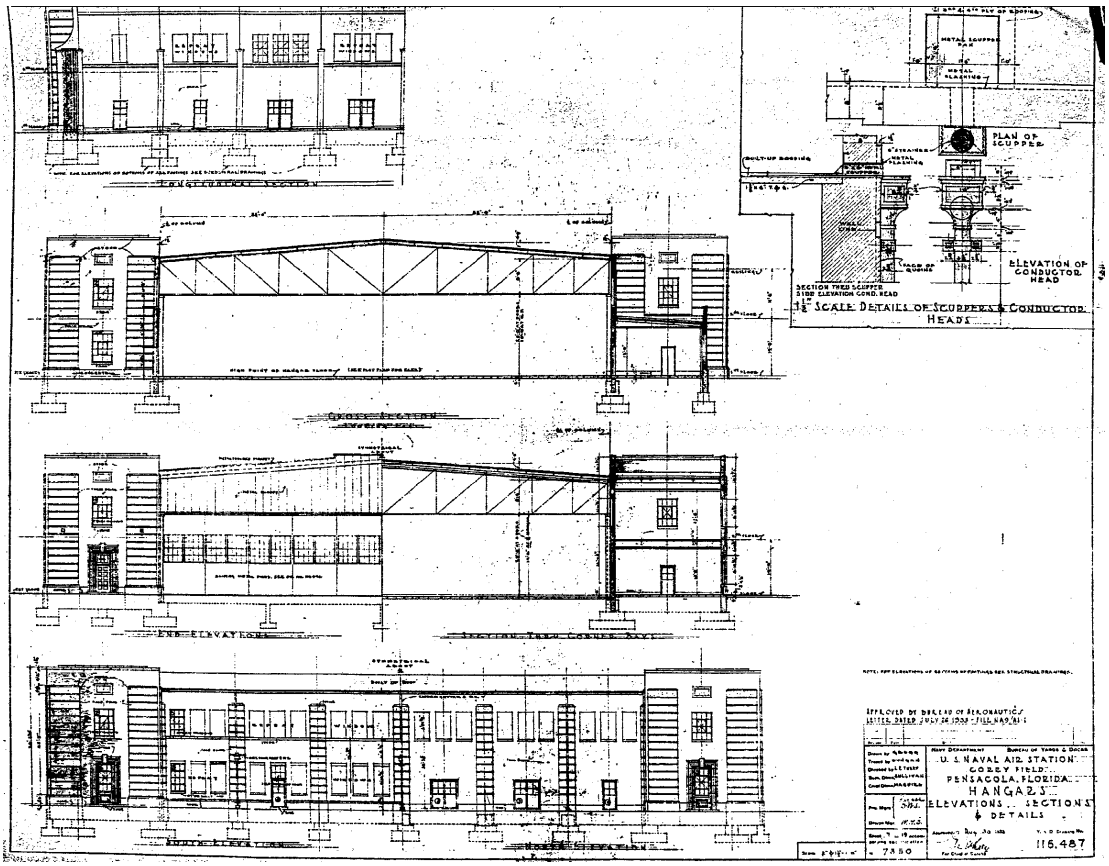

Figure 3-27. Plan of Naval Air Station Pensacola (Corry Field), FL, hangars, ca. 1933.

Figure 3-28. Corry Field-type hangars constructed in 1937 at the main field at Naval Air Station Pensacola, FL.

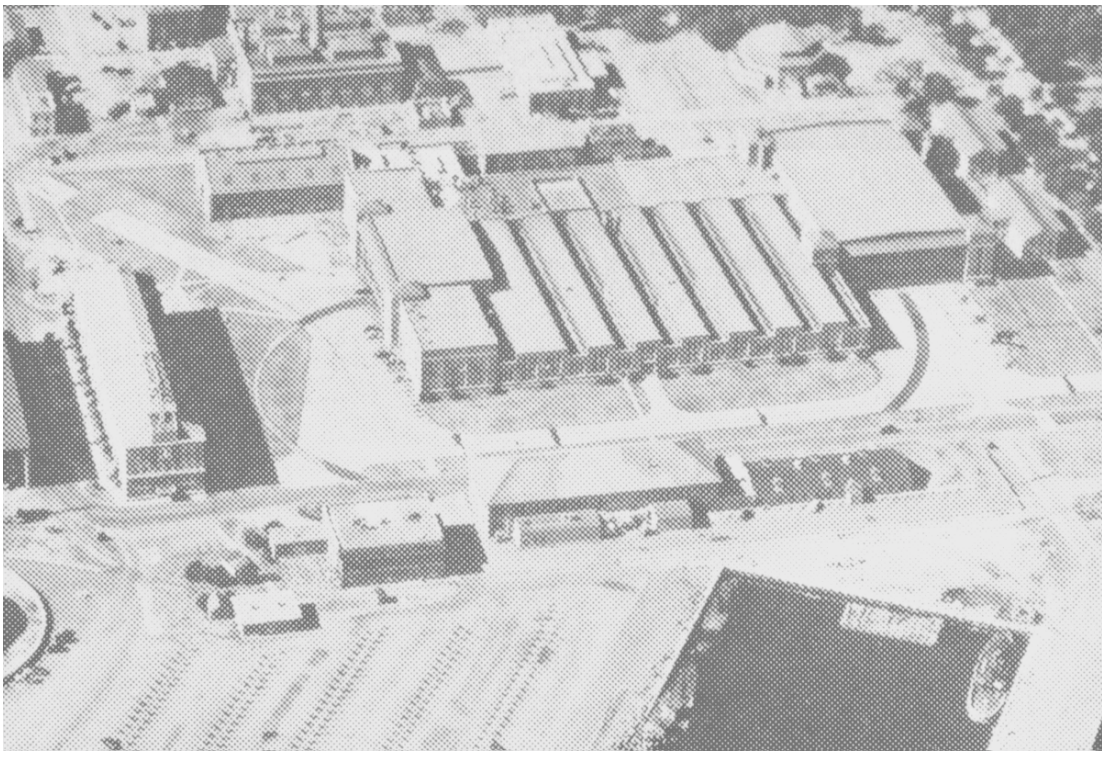

Figure 3-29. Overhaul and Repair Hangar at Naval Air Station Pensacola, FL.

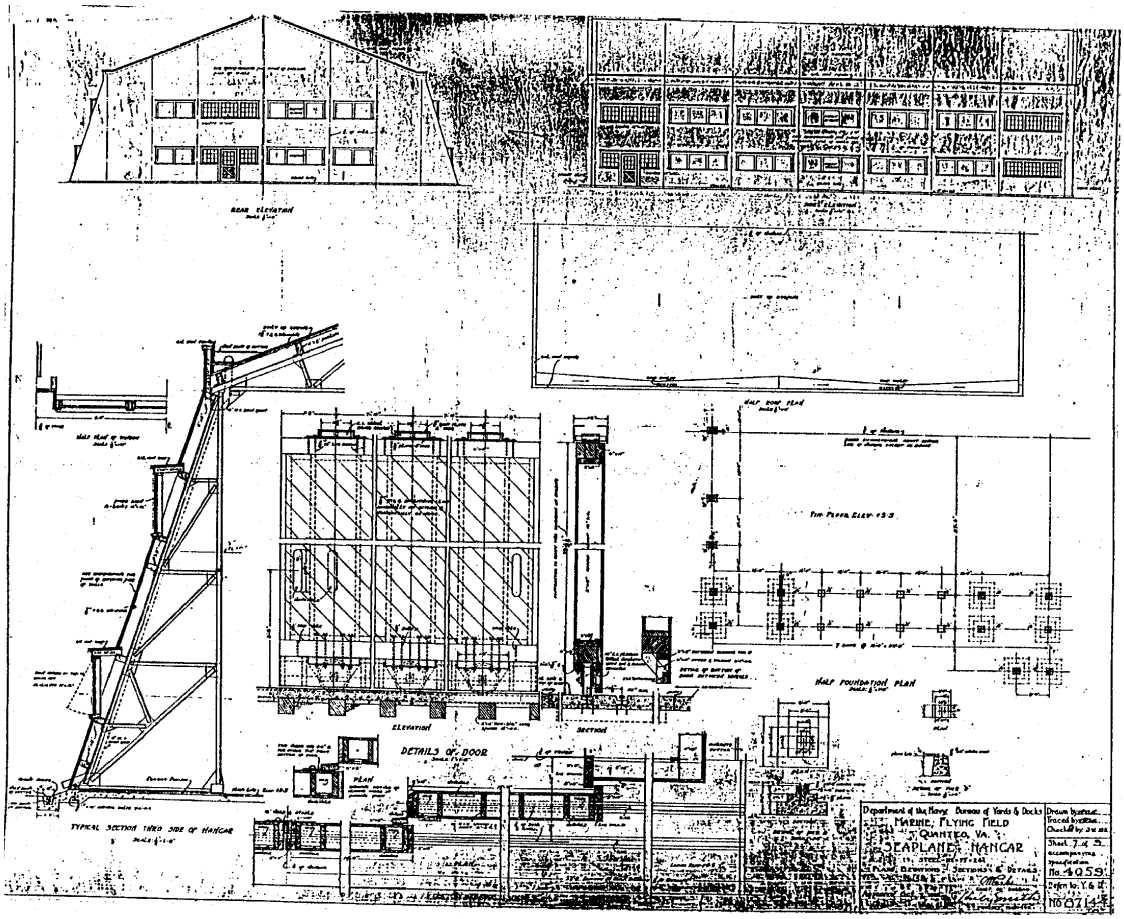

Figure 3-30. Plan of standard 75-Foot Coastal Air Station Seaplane Hangar at Quantico, VA, ca. 1919.

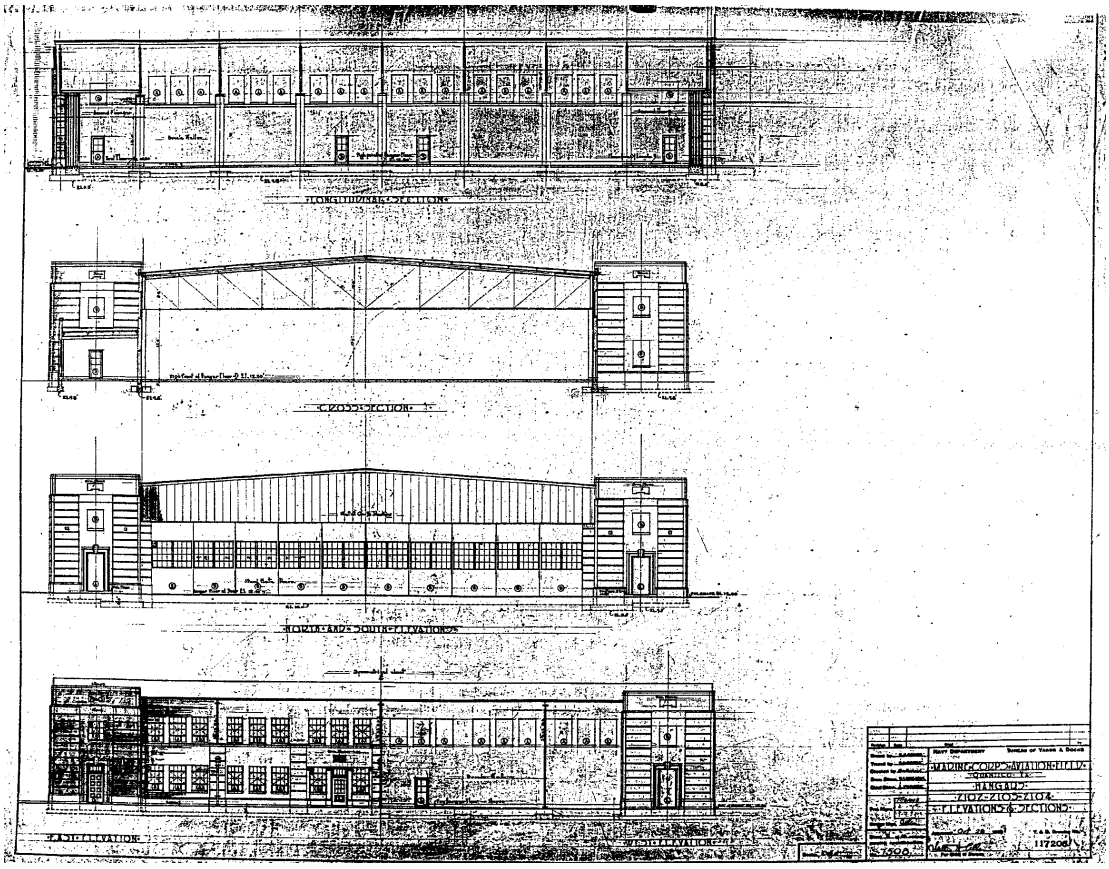

Figure 3-31. Plan of Corry Field-type hangars at Quantico, VA, ca. 1933.

Endnotes for Chapter 3

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3 *Hearings, Real Estate Purchases*, before the Subcommittee of the Committee on Military Affairs, Senate, 66th Congress, 1st Session, 1919, pp 90-91, 104-111. Cited hereafter as *Real Estate Hearings, 1919*. Williamson and Watts Architects, *Architectural/Historical Significance of Buildings at Naval Air Station, North Island* (1988), p 53; Correspondence from Ms. Bethanie Grashoff, Cultural Resources Manager, Fort McPherson, GA.

4 Brown, pp 55, 58; *Real Estate Hearings, 1919*, pp 75-79. Note that Brown also includes Mitchel and Miller Fields, and the Aviation General Supply Depots at Richmond, Middleton, and Little Rock.

5 Brown, pp 57-58; *Real Estate Hearings, 1919*, pp 75-79.

6 Hearings, Real Estate: Survey of Real Estate Owned or Controlled by War Department, Part 2, before a Special Subcommittee and the Committee on Military Affairs, 66th Congress, 3rd Session, 1922, pp 225-249; Hearings, War Department Appropriation Bill, 1923, Part 1, before the Subcommittee of the House Committee on Appropriations, 67th Congress, 2nd Session, 1922, pp 913-914.

7 *Hearings, War Department Appropriations Bill, 1927, Part 1*, before the Subcommittee of the House Appropriations Committee, 69th Congress, 1st Session, 1926, pp 711-714.

8 *Real Estate Hearings, 1919*, p 29.

9 *Hearings, War Department Appropriation Bill, 1923, Part 1*, before the Subcommittee of the House Committee on Appropriations, 67th Congress, 2nd Session, 1922, p 856.

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13 *Bombing Plane Hangar, Construction Completion Report of 2 September 1921, Langley Field, VA* (National Records Center—Suitland, NA RG 77, Box 159, Book Ia), pp 274-282.

14 *Report of the Chief of the Construction Division to the Secretary of War, 1920* (Washington DC: Government Printing Office, 1920), p 21; Curtis, et al., pp 48-50.

15 *Report of the Chief of the Construction Division to the Secretary of War, 1920* (Washington DC: Government Printing Office, 1920), p 21; *Real Estate Hearings, 1919*, p 98.

16 *Hearings, Real Estate: Survey of Real Estate Owned or Controlled by War Department, Part 2*, before a Special Subcommittee and the Committee on Military Affairs, 66th Congress, 3rd Session, 1922, pp 237-238.

17 *Report of the Chief of the Construction Division to the Secretary of War, 1920* (Washington DC: Government Printing Office, 1920), p 21.

18 *2 - 100 x 200' Steel Hangars, Construction Completion Report of 6 January 1923, Langley Field, VA* (National Records Center—Suitland, NA RG 77, Box 159, Book Ia), pp 365-370; Williamson and Watts Architects, p 53.

19 *Hearings, War Department Appropriation Bill, 1923, Part 1*, before the Subcommittee of the House Committee on Appropriations, 67th Congress, 2nd Session, 1922, p 865; *Hearings, War Department Appropriation Bill, 1925, Part 1,* before the Subcommittee of the House Committee on Appropriations, 68th Congress, 1st Session, 1924, pp 942-943; *Hearings, War Department Appropriations Bill, 1927, Part 1*, before the Subcommittee of the House Appropriations Committee, 69th Congress, 1st Session, 1926, pp 748-750.

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28 *Construction Completion Report for Eighteen (18) Hangars at Randolph Field, Texas, 1931* (National Records Center—Suitland, NA RG 92, Box 226, Book 3, Part 6), pp 60-62; *Construction Completion Report for Eighteen (18) Hangars at Randolph Field, Texas, 1931* (National Records Center—Suitland, NA RG 77, Box 201, Entry 393, [folder unmarked]), pp 58-97; *Aircraft Hangars and Towers: Historical and Architectural Overview,* MSS supplied by Randolph AFB, pp 181-223.

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33 *Hearings, War Department Appropriation Bill, 1931, Part 1*, before the Subcommittee of the House Committee on Appropriations, 71st Congress, 2nd Session, 1929, p 665.

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36 *Hearings, War Department Appropriation Bill, 1933, Part 1*, before the Subcommittee of the House Committee on Appropriations, 72nd Congress, 1st Session, 1932, p 1002; *Hearings, War Department Appropriation Bill, 1934, Part 1,* before the Subcommittee of the House Committee on Appropriations, 72nd Congress, 2nd Session, 1933, pp 262-264.

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50 Brown, pp 111-114.

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53 *Ibid*., pp 186-192.

54 *Ibid*., pp 225-227, 259-260.

55 *Ibid*., pp 228-235.

56 *Ibid*., pp 208-209.

57 *Ibid*., p 150.

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61 *Ibid*., pp 211-214, 236-237.

62 *Ibid*., pp 193-204.

63 *Ibid*., pp 214-219.

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67 Bureau of Yards and Docks Drawings on Film Collection, NA RG 71, Roll 10, frame 1-45-268.

68 Bureau of Yards and Docks Drawings on Film Collection, NA RG 71, Roll 595, frame 560-45-56; Bureau of Yards and Docks Drawings on Film Collection, NA RG 71, Box B1 (frame unknown).

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71 Williamson and Watts Architects, p 28; Bureau of Yards and Docks Drawings on Film Collection, NA RG 71, Box B1 (frame unknown).

72 Bureau of Yards and Docks Drawings on Film Collection, NA RG 71, Roll 1172, frames 1405-45-8 through 1405-45-15; Bureau of Yards and Docks Drawings on Film Collection, NA RG 71, Box B1 (frame unknown).

73 *Annual Report of the Chief of the Bureau of Yards and Docks, Fiscal Year 1922*, p 13.

74 *Annual Report of the Chief of the Bureau of Yards and Docks, Fiscal Year 1923*, pp 10-11; Bureau of Yards and Docks Drawings on Film Collection, NA RG 71, Box B1 (frame unknown).

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84 *Hearings, Navy Department Appropriations Bill for 1934*, before the Subcommittee of the House Committee on Appropriations, 73rd Congress, 1st Session, 1933, pp 460-462.

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91 *Hearings, Navy Department Appropriations Bill for 1931*, before the Subcommittee of the House Committee on Appropriations, 71st Congress, 2nd Session, 1930, pp 739-746.

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93 Turnbull and Lord, pp 273-275.

94 *Ibid.*, pp 278-281.

95 *Ibid.*, p 262.

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97 *Annual Report of the Chief of the Bureau of Yards and Docks, Fiscal Year 1927*, pp 9-10.

98 *Annual Report of the Chief of the Bureau of Yards and Docks, Fiscal Year 1928*, pp 8-10; *Annual Report of the Chief of the Bureau of Yards and Docks, Fiscal Year 1929*, pp 10-12; Bureau of Yards and Docks Drawings on Film Collection, NA RG 71, Roll 1172, frame 1405-45-88; Bureau of Yards and Docks Drawings on Film Collection, NA RG 71 (roll unknown), frame 1325-45-2.

99 *Annual Report of the Chief of the Bureau of Yards and Docks, Fiscal Year 1928*, pp 8-10; *Annual Report of the Chief of the Bureau of Yards and Docks, Fiscal Year 1929*, pp 10-12; Bureau of Yards and Docks Drawings on Film Collection, NA RG 71, Roll 1067 (frame unknown).

100 *Annual Report of the Chief of the Bureau of Yards and Docks, Fiscal Year 1928*, pp 8-10; *Annual Report of the Chief of the Bureau of Yards and Docks, Fiscal Year 1929*, pp 10-12; Bureau of Yards and Docks Drawings on Film Collection, NA RG 71, Roll 595, Frames 560-45-117 through 560-45-117.

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102 Williamson and Watts Architects, p 53; *Annual Report of the Chief of the Bureau of Yards and Docks, Fiscal Year 1930*, pp 6-8; *Annual Report of the Chief of the Bureau of Yards and Docks, Fiscal Year 1931*, pp 7-11; *Annual Report of the Chief of the Bureau of Yards and Docks, Fiscal Year 1932*, pp 7-9.

103 Turnbull and Lord, pp 277; *Annual Report of the Chief of the Bureau of Yards and Docks, Fiscal Year 1932*, pp 7-9.

104 Turnbull and Lord, p 285.

105 *Hearings, Navy Department Appropriations Bill for 1935*, before the Subcommittee of the House Committee on Appropriations, 73rd Congress, 2nd Session, 1934, pp 389-390.

106 *Hearings, Navy Department Appropriations Bill for 1936*, before the Subcommittee of the House Committee on Appropriations, 74th Congress, 1st Session, 1935, p 499.

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112 *The Cradle*, p 88; Bureau of Yards and Docks Drawings on Film Collection, NA RG 71, Roll 648.5, Frame 800-45-645D.

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114 *Annual Report of the Chief of the Bureau of Yards and Docks, Fiscal Year 1937*, p 22.

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119 *Ibid*., pp 35-38.

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121 Metzinger et al., *Inventory and Evaluation of Historic Structures and Landscapes at Marine Corps Combat Development Command and Naval Regional Medical Clinic, Quantico, VA* (Champaign, IL: USACERL, 1994), p 21; Temme et al., *Historical and Architectural Documentation Reports for U.S. Marine Corps Recruit Depot, Parris Island, SC* (Champaign, IL: USACERL, 1997), p 30; *Annual Report of the Chief of the Bureau of Yards and Docks, Fiscal Year 1923*, pp 10-11; *Annual Report of the Chief of the Bureau of Yards and Docks, Fiscal Year 1925*, pp 10-12; Bureau of Yards and Docks Drawings on Film Collection, NA RG 71, Roll 585, Frames 561-45-97 to 561-45-98; Johnson, pp 27-28.

122 Johnson, pp 42-53.

123 *Ibid*., p 42.

124 *Hearings, Navy Department Appropriations Bill for 1929*, before the Subcommittee of the House Committee on Appropriations, 70th Congress, 1st Session, 1928, pp 699-703; *Hearings, Navy Department Appropriations Bill for 1930*, before the Subcommittee of the House Committee on Appropriations, 70th Congress, 2nd Session, 1929, pp 539-544; Johnson, pp 54-57, 68; Turnbull and Lord, pp 272-278.

125 Johnson, p 61.

126 *Ibid*., pp 61-65.

127 *Ibid*., p 66.

128 *Ibid*., pp 72-78.

129 *Ibid*., pp 78-82.

130 Metzinger et al., Vol. II, Building 72; Class 2 Property Record, Building 72, MCCDC Quantico; Bureau of Yards and Docks Drawings on Film Collection, NA RG 71, Roll 1121, Frame 1325-45-2; Bureau of Yards and Docks Drawings on Film Collection, NA RG 71, Roll 584, Frames 561-45-33 to 561-45-35.