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Military Aircraft Hangars

Footprints through a Century of Flight

When international conflict threatens national security, the U.S. military response is unmistakable. On the leading edge of U.S. military power is aviation technology—an ever-diversifying arsenal of tactical and strategic aircraft that play a key role in the operations of every military service. Since the first military application of air power almost a century ago, aviation technology has rapidly advanced to meet formidable new mission demands. The aviation technology revolution has not only left its permanent imprint on global politics, it has also left its footprints across the American landscape. The history of U.S. aviation can be read to a great extent in the function, form, and style of its airfield architecture.

A military airfield's "alpha" structure is the aircraft hangar. Typically, the earliest ones were humble structures, little more than sheds intended to keep these new flying contraptions sheltered from the elements. However, aeronautical engineers and pilots relentlessly pushed the envelope in military air power, creating faster and more powerful flying machines—and lots of them. Hangar designers responded in kind by creating large, increasingly sophisticated (and unintentionally glorious) structures tailored to the complexities of outfitting and maintaining a modern airborne arsenal. The variety and quality of military aircraft hangars erected during the 20th century is surprisingly impressive.

Oldest identifiable example of the U.S. All-Steel Hangar at Fort Sam Houston, Texas, c.1917. Photo courtesy Archives at Fort Sam Houston, Texas.

The Threat to Hangars

On military installations today these spacious, magnificent buildings are rapidly being subdivided or consumed wholesale to serve diverse functions, such as research facilities, offices, and gymnasiums. Their structural clear spans provide facility designers a "clean slate" of open, highly adaptable space for consolidating multiple functions previously housed in smaller separate buildings. While adaptability is highly valued as the Department of Defense (DoD) works to reduce its building inventory, historically significant architecture can accidentally be marred or lost in the tumult of short-term budget pressures. If a targeted hangar is at least 50 years old or is thought to have exceptional historic importance, its significance must be reviewed in accordance with the National Historic Preservation Act (NHPA). To efficiently conduct these reviews, facility and cultural resource managers need accessible, reliable historic and architectural information to help determine the significance of hangars.

The Construction Engineering Research Laboratory (CERL) was tasked to study the DoD's aircraft hangar inventory and develop criteria relevant to NHPA requirements. The research was conceived by Dr. Paul Green, U.S. Air Force Air Combat Command (ACC), and funded by ACC and the DoD Legacy Resource Management Program. The product of this study was a comprehensive report intended to facilitate the assessment of a military hangar's historical and architectural significance. The report is now available online for viewing or download at <http://www.cecer.army.mil/techreports/webster98/webster98_idx.htm>.

Study Methodology

In order to serve DoD cultural resource managers, the report had to work well as a quick, random-access reference while providing a coherent, linear historical account of military aviation construction programs. The basic tasks were to

- identify and describe the principal hangar types,

- document their origins, locations, and approximate numbers, and
- provide a context for understanding their aviation and construction history.

The study looked at all DoD aircraft hangars, except those on Reserve, National Guard, Base Realignment and Closure, and overseas installations. The CERL research team made several site visits to better understand military airfield infrastructure and how it is used. The team also visited centralized repositories with military airfield construction record holdings and conducted literature searches. To gather detailed site-specific physical data, a mail-in survey was designed and sent to all installations known to maintain a significant airfield infrastructure. Countless DoD historians, architects, engineers, record drawing stewards, real property staff, and cultural resource personnel responded, and their submittals were collated into a draft database. Although extensive, the draft database included significant gaps that had to be filled with existing data from Army and Air Force headquarters-level real property offices. Although the selected real property records did not include information on specific architectural characteristics, the statistical data they contained greatly enhanced the research team's knowledge base. All of the material collected by the research team, especially the architectural drawings, were used to develop a hangar typology—a tool that provides a classification system based on structural cross-section, principal material, and other physical characteristics.

Versatile CRM Guide

The hangar report can be used in several different ways depending on the needs of the reader. First, the historical narrative will help cultural resource managers understand the place of their local hangars in the national aviation construction context. This text is divided into five chapters that correspond to a major U.S. military conflict or peacetime era. Each chapter is subdivided to address the aviation construction histories of the various military services. Major sections are labeled to identify the principal national aviation construction themes of the era. The report focuses on national contexts that are intended to illuminate local and regional contexts—not to replace them.

Second, the report includes a chapter dedicated to hangar typology, illustrated and cross-referenced with numerous charts, photos, and drawings. The typology chapter can be of great value in helping a cultural resource manager identify hangars in those cases where local documentation is inadequate or missing. When the cultural resource manager identifies the basic type of hangar, he or she can then study the hangar database (included in an appendix) to determine which other installations have similar structures. The database can provide an initial indication of a hangar's relative abundance or scarcity in the national context.

Finally, for quick reference purposes, each history chapter concludes with a simplified timeline comprising a chart of major historical, technological, and programmatic milestones. These timelines help the reader visualize key interrelationships between military activities, defense objectives, technological developments, and military construction programs. All elements of the report—the historical narrative, quick reference timelines, hangar typology, and appendices—are readily cross-referenced to help cultural resource managers make informed inferences in order to fill gaps in local construction records.

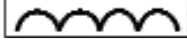
Summary of Findings

The CERL study illustrates how military hangar construction was affected by two overarching trends: changes in air mission requirements and standardization of facility design.

The report documents how air mission requirements evolved in response to technical advances in aircraft. Although larger and more specialized airplanes were constantly rolling off U.S. assembly lines, the most important driver of military hangar demand appears to have been sharp increases in the number and size of air combat groups—especially during the defense buildup before World War II. The relationship between aircraft size and hangar size is actually indirect and complex, and only in a few cases is there direct evidence of a connection. Once the all-metal airplane body went into full production, there was no longer any reason to shelter these aircraft, except during maintenance, repair, and outfitting operations. The major construction challenge then was to provide enough hangar space to handle the enormous servicing capacity required to keep an airborne fighting force in the sky.

As new training, outfitting, and maintenance activities drastically increased the need for new hangars, both the Army Air Corps and the Navy construction programs came to rely extensively on standard designs and plans. The CERL study shows that there was even an appreciable amount of standardization within particular specialties and construction programs. For example, in terms of architecture, air depot facilities can

Table 6-5. Concrete arch cross section typology.

Concrete Arches				
Cross Section	**First Known Use**	**Plan Description**	**Plan No.**	
Open Arch 	early 1940s	Shore Facility Denver Type Reserve Station	486881 520026	⚓
	early 1940s	Monolithic Concrete Seaplane	varies	⚓
	unknown	Shore Facility-Miramar Type	varies	⚓
	mid-1940s	Squadron Operations	varies	✪
	late 1940s	Monolithic Concrete	35 04 01	✪
	mid-1950s	Organizational Pull-Thru	39-01-65	✪
	mid-1950s	Organizational Pull-Thru	39-01-66	✪
	mid-1950s	Organizational Pull-Thru	39-01-67	✪
Transverse Arch 	late 1930s	Monolithic Concrete Seaplane	varies	⚓

Note: The *star* symbol in the right hand column indicates an Army or Air Force plan; the *anchor* symbol indicates a Navy plan.

Concrete Arch Cross Section Typology for military hangars. Created by the Construction Engineering Research Laboratory (CERL).

readily be distinguished from flying training field facilities, and these in turn can be distinguished from technical training facilities.

Not surprisingly, the rarity of pre-1919 hangars is noteworthy, and the rarity of wood frame construction also stands out. One discovery made during the research was that most surviving hangars originally designated as temporary construction are made of steel. This was unexpected because, as a rule, temporary military facilities were usually made of wood. Virtually all wooden hangars—and half of all non-permanent hangars—were constructed during the World War II era. However, only about 25% of the temporary hangars recorded in the CERL database are timber structures. The preponderance of steel temporary hangars in the DoD inventory is accounted for by a World War II-era Air Corps policy that encouraged the use of steel in technical temporary construction. Based on the available data, most of the surviving wood frame hangars appear to be located in Alaska and the Pacific Northwest, where heavy timber was available locally in plentiful amounts.

One particular hangar—the U.S. All-Steel Hangar—warrants special comment. Although it was a classic workhorse design of the World War I era, many installation cultural resource managers do not recognize it and therefore consider it a rarity. This hangar was in fact mass-produced during World War I, but many building components did not reach their intended locations until after the Armistice. Consequently, most U.S. All-Steel Hangars were assembled after World War I and put to alternative uses, such as warehouses or maintenance shops, usually located away from the airfields for which they were originally intended. Many installations today still have one or more of them in use. The structure can be identified by its distinctive 66-foot steel gambrel truss. Due to the modular design of this hangar, however, it was not uncommon to erect them in multiple-bay configurations and in varying lengths. Alternative layouts, such as these, as well as their utilization away from historic flight lines, likely contribute to difficulty recognizing the U.S. All-Steel Hangar on military installations today.

Conclusion

The CERL hangar study has drawn many inquiries from DoD personnel as well as the civilian sector, and some queries have revealed unique and scarce resources. For example, the report has been used to help understand the provenance of historic military hangars located on former military air bases that are no longer owned by DoD. However, the principal goal of the study was to assist DoD cultural resource managers with NHPA compliance reviews. DoD cultural resource personnel report that the study also has proven valuable in the successful conversion of historic hangars to new uses. Furthermore, cultural resource managers at installations with no original design documents have made inquiries when they need additional technical expertise to interpret layouts, structural elements, or nonstandard construction details.

The hangar study should provide cultural resource managers, historians, architects, and engineers a sound basis on which to begin an evaluation of historic aircraft hangars. The big-picture perspective presented in the report will certainly contribute to national-level significance assessments and provide a basis for more meaningful determinations of regional and local significance.

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