HISTORIC AMERICAN BUILDINGS SURVEY / HISTORIC AMERICAN ENGINEERING RECORD

THE ENGINEERING OF FLIGHT

AERONAUTICAL ENGINEERING FACILITIES OF AREA B, WRIGHT-PATTERSON AIR FORCE BASE, OHIO

U.S. Department of the Interior
National Park Service
Cultural Resources

THE ENGINEERING OF FLIGHT

AERONAUTICAL ENGINEERING FACILITIES OF AREA B, WRIGHT-PATTERSON AIR FORCE BASE, OHIO

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Historic American Buildings Survey/
Historic American Engineering Record

National Park Service
U.S. Department of the Interior
Washington, D.C.
1993

Library of Congress Cataloging-in-Publication Data

The Engineering of flight : aeronautical engineering facilities of
Area B, Wright-Patterson Air Force Base, Ohio / edited by Emma J.H.
Dyson, Dean A Herrin, and Amy E. Slaton ; with contributions by Mary
Caballero ... [et al.].
p. cm.
Includes bibliographical references.
1. Wright-Patterson Air Force Base (Ohio)--History. 2. Historic
buildings--Ohio--Wright-Patterson Air Force Base. 3. Aeronautics,
Military--Research--United States--History. 4. Airport buildings--Ohio--Wright-Patterson Air Force Base--History. I. Dyson, Emma J.
H., 1964- . II. Herrin, Dean A., 1958- . III. Slaton, Amy E.,
1957- .
UG634.5.W7E33 1993
623.7'46'072077174--dc20 93-40079
CIP

Cover photograph: Throat of 20-Foot Wind Tunnel, ca. 1940s. (USAF)

PREFACE

Wright Field, currently known as Area B, Wright-Patterson Air Force Base, represents a unique complex of buildings containing specialized facilities and equipment dedicated to aeronautical research and development. The history of American military aviation is closely tied to the history of Wright Field.

There are two distinct eras to this history. First, the original thirty facilities of the Army Air Corps Materiel Division were built in the late 1920s to replace and expand the capabilities of McCook Field, Dayton. Some of McCook Field's original testing equipment, such as the wind tunnels and dynamometer, was relocated to Wright Field. The original facilities are easily distinguished today by their brick exteriors and sloped gable roofs. World War II saw the rapid expansion of operations at Wright Field, with over 300 Army Air Forces facilities built between 1941-1944. These facilities were generally constructed of concrete and created the hangars and flightline complex, with its paved triangular airfield, which can still be seen today. Most of the facilities from both eras continue in use today, representing a treasure of our nation's and the Air Force's aviation heritage.

The Air Force is committed to wise stewardship of Wright Field while continuing the original mission of aeronautical research and development into the next century. As a result, the Air Force commissioned the Historic American Engineering Record to undertake a two-year survey and documentation effort. This publication summarizes the results for all to share in the rich heritage of Wright Field--the true cradle of military aviation!

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INTRODUCTION

In the summer of 1991 the Historic American Engineering Record (HAER) placed a team of six architects, two historians, and a photographer on Wright-Patterson Air Force Base (WPAFB), near Dayton, Ohio, to research and record the historic aeronautical engineering features of the most historic section of the base, the old Wright Field, now known as Area B. HAER, coupled with the Historic American Buildings Survey (HABS), is an agency of the National Park Service, and is charged with the long-range mission of documenting--through written histories, measured drawings, and large-format photographs--the rich engineering and industrial heritage of the United States. HAER is best known for its documentation of "traditional" historic American technology, such as factories, canals, machine shops, bridges, and railroad facilities. As technologies that are considered more modern also begin to age, HAER is beginning to record these "new" sites. The documentation of aeronautical engineering facilities of Area B, Wright-Patterson Air Force Base is one such project.

The construction of Wright Field began in 1926, as the home of the Army Air Corps' fledgling Materiel Division. Although aeronautical engineering activities have continued on the base to the present, HAER was most interested in structures and machinery dating from the early days of aeronautical engineering, the 1920s through the 1940s. The many tasks associated with developing a new aircraft--the design and testing of whole airplanes, parts, and equipment ranging from flight suits to aerial cameras to bombsights--demanded specialized structures and a complex infrastructure. HAER's architects and historians examined buildings, laboratory equipment, and the organization of the site, and documented the complicated testing equipment developed by the Army Air Corps, such as immensely powerful propeller whirl rigs and wind tunnels. Part of HAER's analysis of this equipment was to determine which aspects had been borrowed from existing aeronautical technologies, and which were devised to suit the specific needs of Wright Field's projects. This study placed Wright Field's facilities in their historical scientific context, and also illuminated the budgetary and administrative constraints operating on Air Corps engineers at different times. Few technologies have affected and symbolized modern society as has the development and use of the airplane, and few facilities have influenced aeronautical technology as much as Wright Field and Wright-Patterson Air Force Base.

HAER was initially invited to Wright-Patterson Air Force Base by the base's Office of Environmental Management and its former Historic Preservation Program Manager, Chris Widener. The project was sponsored by that office and the Aeronautical Systems Center of Area B. Needless to say, HAER's documentation could not have been accomplished without the considerable assistance of many people associated with Wright-Patterson Air Force Base, including Colonel William Orellana, Commander, 645th (formerly 2750th) Air Base Wing (ABW); Colonel Eric Beshore, Commander, 645th Civil Engineering Group; Anthony Sculimbrene, Director, Office of Environmental Management, 645th ABW; Diana Cornelisse, Chief, History Office, Aeronautical Systems Center; Ron Sherrill, formerly of the History Office, Aeronautical Systems Center; Dr. Henry Narducci, History Office, Aeronautical Systems Center; Dave House, Chief, Record Drawings Section, and Don Smith, Surveying Technician, Record Drawings Section, 645th Civil Engineering Group. Lois Walker, formerly the Historian of 2750th ABW and now in the Office of the Command Historian, HQ Air Force Materiel Command, made available the files of the base's history office, and aided team members with her extensive knowledge of the base. Finally, Dr. Jan Ferguson, Historic Preservation Program Manager, Office of Environmental Management, 645th ABW, coordinated the entire project for WPAFB, and assisted HAER team members in countless ways.

HAER team members used as initial references a historic structures inventory prepared by the base in association with the Ohio Historic Preservation Office, and the excellent history of the base, From Huffman Prairie to the Moon, written by Lois Walker and Shelby Wickam. In addition to examining the physical structures, HAER architects and historians also consulted sources such as Army Air Corps (later the Air Force) publications (including technical drawings, annual reports, and newsletters), individual departmental histories, and trade journals which disseminated to the public the findings of the Materiel Division. Oral history interviews with current and former employees of the base also helped to establish the intentions and practices of the base's aeronautical engineers.

The documentation for HAER, conducted in 1991 and 1992, was prepared under the direction of Dr. Robert J. Kapsch, Chief, Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER), and Eric DeLony, Chief, HAER. Dr. Dean Herrin, Historian, HAER, and Robbyn Jackson, Architect, HAER, supervised the project. John Burns, AIA, Deputy Chief of HABS/HAER, provided timely guidance on questions of architecture. Team members for HAER included architects Mary Caballero, Elaine Pierce, Mark Pierson, Christopher Widener, and the firm of Hardlines: Design and Delineation (Charissa Wang and Donald Durst, Principals/Partners); historians Emma Dyson, Vance MacDonald, Robert Roggenkamp, and Amy Slaton; and David Diesing, photographer. Additional architectural editing was performed by J. Shannon Barras, Albert Debnam, David Fleming, Natalya Kalinina, and Sanford Garner; and additional historical editing was completed by Lola Bennett, Emma Dyson, and Dean Herrin.

The information included in this inventory is only a portion of the total HAER documentation of Area B. In all, HAER team members produced 52 sheets of measured drawings, over 250 large-format photographs, and written histories of 56 structures. All of the information gathered by HAER teams at Wright-Patterson Air Force Base is available to the general public in the HABS/HAER Collection of the Library of Congress, Prints and Photographs Division, Washington, D.C. This inventory is organized by building number as assigned by Wright-Patterson Air Force Base, and each entry also includes a HAER number which corresponds to that building's documentation record in the HABS/HAER Collection of the Library of Congress. Sources for the inventory entries are listed in the Bibliography.

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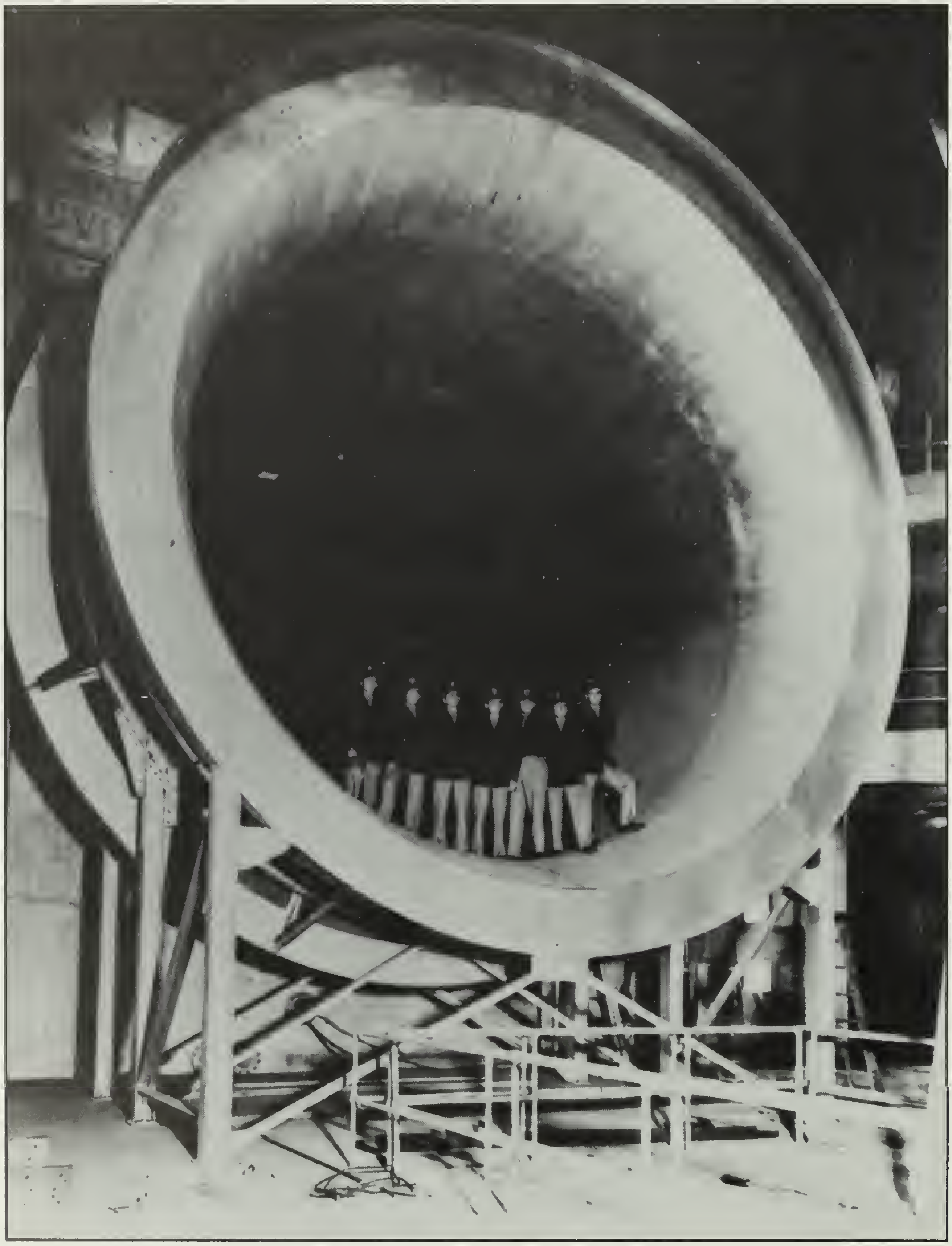

Figure 1: Throat of 20-Foot Wind Tunnel, ca. 1940s. (USAF)

AERONAUTICAL ENGINEERING AT WRIGHT-PATTERSON AIR FORCE BASE: A HISTORICAL OVERVIEW

AMY E. SLATON

The United States Army first demonstrated its commitment to heavier-than-air flight in February 1908, when the Army Signal Corps solicited bids for a military airplane. The contract was awarded to Wilbur and Orville Wright, of Dayton, Ohio, who answered the Army's call for a plane that could reach a speed of 36 miles per hour carrying two people and enough fuel for a 125-mile flight. Although these "specs" hardly compare with those of modern aircraft, for its time the undertaking was ambitious, and its successful fulfillment led to the enthusiastic embrace of aviation technology by its sponsors, and ultimately to an extensive organization for military aeronautical development. After the first contract was awarded to the Wrights, the Army established its Aeronautical Division, with distinct departments to handle aeronautical research and aircraft production. Within a decade, research was itself divided into "basic" and "applied" aspects. Basic, or theoretical research, fell primarily to the National Advisory Committee for Aeronautics (NACA), established in 1915 by a Presidential commission. Applied, or experimental work, was ultimately assigned to the Airplane Engineering Department of the Signal Corps, for which the Army built McCook Field near Dayton in 1917.

The use of air power in World War I inspired still greater confidence in aviation technologies, and by the late 1920s, the Army had moved its aviation engineering activities from McCook Field to the new and much larger Wright Field nearby. Grouping its Engineering Section facilities in a single tract (now known as Area B of Wright-Patterson Air Force Base), the Materiel Division brought together military and industrial aeronautical expertise, and encouraged the interaction of different technological disciplines. Wright Field quickly became a center for the most advanced practices of aeronautical engineering in the country.[1]

From its inception in 1927, the engineering program at Wright Field has been complex and varied. The Materiel Division's engineers developed aircraft equipment (from airframes to engines to instruments), refined the interaction of such parts in the completed aircraft, determined which aspects of airplane design were most important for military purposes (range, speed, or load-carrying capacity), and created specifications and standards for the new technologies of flight. In pursuing these tasks, the engineers tested raw materials, parts, and entire airplanes, both at rest and in flight. Careful analysis of technological problems was completed before any innovation was passed along for general commercial use, and in addition to innovating, the Materiel Division solicited ideas from industry and inspected the work of airplane and parts manufacturers. The engineers at Wright Field also maintained active ties with the other public bodies engaged in aeronautical and material research, including the National Bureau of Standards, the Army Corps of Engineers, and the National Advisory Committee for Aeronautics.

This flexible and multi-faceted approach to aeronautical engineering allowed the Air Service (later called the Army Air Corps, the Army Air Force, and ultimately the Air Force) to ably contend with the budget constraints of peacetime and the production pressures of wartime. From Wright

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[1] Falk Harmel, "A History of Army Aviation," Popular Aviation 3 (1928), 17-19; Materiel Division, United States Army Air Corps, "First Annual Report of the Chief, Materiel Division Air Corps, Fiscal Year 1927," (henceforth, "Annual Report 1927"), 4-5.

Field's personnel came pioneering work in such areas as wind tunnels, propulsion, static testing and aeromedical investigations; the Air Force remains strong in these fields today. Since World War II, Air Force engineers at Wright-Patterson Air Force Base have contributed to the development of jet propulsion, radar, missile guidance and the automation of flight functions. The manner in which Wright Field engineers pursued technological advancement and the results which they achieved assure Wright Field an enduring significance in the history of aeronautical engineering.[2]

History of the Air Service and McCook Field

In charging the Signal Corps with the development of its military airplanes, the U.S. Army indicated its intentions for the new technology: airplanes were to be tools for communication. They would provide a supplement to existing means of scouting and observation.[3] When the Wright brothers produced their airplane for the Signal Corps in 1908, Army aviation consisted of only three officers, ten enlisted men, the one airplane, and a single airship. There was no university support and little industrial support for aeronautics; only Glenn Curtiss presented any real competition to the Wrights in the designing and production of airplanes. Americans soon became aware of a growing European interest in military and commercial aviation, and began to feel the pressure of international competition, an influence that was to bear continually on American aviation development.[4]

In 1909, the British government appointed an official advisory committee on aeronautics, and American businessmen and legislators reacted with their own efforts. Local aeronautical clubs formed to enlist government support for aeronautical research for commercial and military objectives. In response, Congress made its first appropriation specifically for aeronautical purposes in 1911, granting $125,000 for the construction of an airdrome and flying school at College Park, Maryland. Here, the Signal Corps conducted some of its earliest technical experiments on aircraft, including work on aerial photography, radio from aircraft, and machine gun firing from the air to ground targets.[5]

As business and military interest in aviation increased, questions emerged about the best way in which to pursue aeronautical advancement. There was little argument against the idea that this new scientific field would profit most by a centralized approach to research and heavy capitalization. This was a period of great confidence in organized research and development, as is evidenced by the burgeoning federal and industrial laboratories of the day. Accordingly, the National Bureau of Standards, the Army, the Navy, the Smithsonian Institution and several universities each proposed the creation of a large national laboratory to be operated under their direction. Those advocating a more scientific approach to flight technologies supported the creation of a laboratory at the Smithsonian,

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[2] "Annual Report 1929," 23,277; "Annual Report 1928," 235.

[3] Cy Caldwell, "The U.S. Army Air Corps 1909-1939," Aero Digest 35, no. 2 (August 1939), 109.

[4] Harmel, 18; Alex Roland, Model Research:The National Advisory Committee for Aeronautics 1915-1958 (Washington, DC: National Air and Space Administration, 1985), 3.

[5] Roland, 5; Harmel, 18-19.

while those favoring an engineering emphasis suggested that a military venue would be most appropriate. In 1913, President Taft appointed a national commission to study the problem, which recommended a non-military national aeronautical laboratory with a scientific emphasis, to be located in Washington, D.C. Growing public sentiment against bureaucratization and governmental favoritism, however, slowed action on the plan, and the recommendation died in Congress.[6]

Ultimately, as would be repeated in later years, America's foreign relations determined the country's next major expansion of military aviation engineering. Increasingly strained relations with Mexico in 1913 combined with anxiety about growing hostilities in Europe to prompt action by Congress. In 1914 and 1915, Congress appropriated more than a million dollars for military aeronautics, and ordered the creation of an Aviation Section within the Signal Corps. A personnel of 60 officers and 260 enlisted men was authorized, some of whom were put to the task of experimenting with propellers, automatic stabilizers, parachute packs and other projects. At the same time, NACA was created by Congressional approval, at first filling an advisory role to industrial aircraft producers and consumers, but soon establishing its own publications and building its own laboratories. These facilities, in Hampton, Virginia, would come into their own as a center for scientific achievement after World War I as Langley Memorial Field, but from their inception, NACA's laboratories signified the formal separation of pure research from military experimental activities.

By September of 1917, six months after the United States declared war on Germany, the Army had moved to establish McCook Field as the location for its Airplane Engineering Department, an organization that would use scientific information generated elsewhere to pursue *applied* aeronautical engineering. While NACA and the National Bureau of Standards investigated fundamental scientific principles applicable to all kinds of aviation, Army engineers at McCook would develop specifications for particular aircraft, supervise the production of prototype airplanes, and rigorously test the aircraft against evolving standards.[7]

Following the United States' entry into World War I, reports of French, British, and German aircraft aroused Allied concern that our air defenses were inadequate. At the start of the war, 65 officers (of whom 35 could fly airplanes), over 1000 enlisted men, and 55 airplanes made up the Army Signal Corps' Aviation Section. Further, the equipment that did exist was largely obsolete when compared with European machinery, and only five officers were trained as aeronautical engineers. With an infusion of $640 million from Congress, the Army addressed these shortcomings. It established ground schools (including Wilbur Wright Field) to train pilots and mechanics, but the problem of keeping trained mechanics when wartime industry offered higher pay was a substantial one. During World War I the situation was partly remedied by transferring men trained in mechanics

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[6] A. Hunter Dupree, Science and the Federal Government (Baltimore: Johns Hopkins University Press, 1986), 279-391; Roland, 6-14.

[7] Harmel, 20-21; Roland, 22-27; "Annual Report 1927," 235; Roland, 88; George H. Brett, "Materiel Division of the U.S. Army Air Corps," Aero Digest 35, n.2 (August 1939), 47.

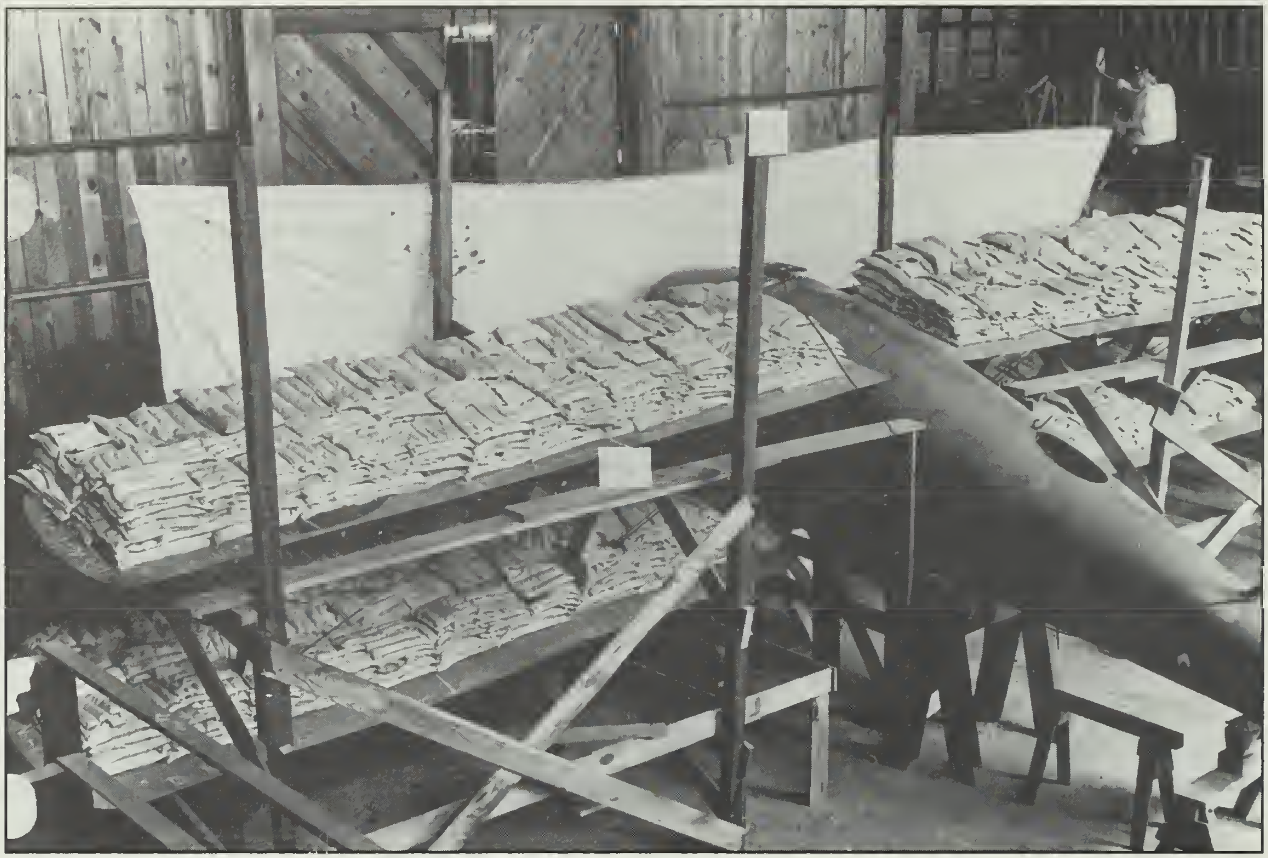

Figure 2: Early static testing at McCook Field. (USAF)

from other branches into the Aviation Section.[8]

McCook Field's contributions to World War I aviation included the development of aircraft design, testing of experimental aircraft and standard production models, engine testing and improvements, machine gun and aerial camera testing, and the development of materials for aeronautical uses. However, the process of aircraft design was not pursued along highly organized lines.[9] There existed after the war some feeling that America's pursuit of sophisticated flight technologies had "come too late," and that one of the lessons of the war for Americans was "the absolute necessity for a continuing program of aircraft development."[10] Thus, in the years following World War I, there emerged an effort to consolidate and organize U.S. military aeronautics. Army

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[8] Harmel, 22-23; Caldwell, 110; "A Little Journey to the Home of the Engineering Division, Army Air Service, McCook Field, Dayton, Ohio," c.1924 (1988 Reprint), 2.

[9] Historical Division (WCYH), Wright Air Development Center, "Trends in Research and Development Processes and Techniques," typed manuscript in "Wright Field Publications File," History Office, 645 ABW, 13.

[10] "A Little Journey...," 1.

aviation development was at this point transferred from the Signal Corps to the newly created Air Service, within the War Department, and the Air Service branch responsible for experimental engineering was officially named the Engineering Division in 1919. Under its auspices, the staff of McCook Field trained mechanical personnel, and took responsibility for the technical development of aircraft, armaments, engines, equipment, and materials. Each task was represented by a section within the Division.

The engineering successes and failures that occurred at McCook Field between 1917 and the 1927 opening of Wright Field laid the groundwork for Army aeronautical engineering in the following decades. Air Service engineers investigated aerodynamic phenomena, propulsion technologies, and structural attributes of aircraft, often inventing or refining analytical methods as they went. Among McCook's most important work was the testing done in its 14-Inch and 5-Foot Wind Tunnels, and on engine torque stands and propeller whirl rigs, which were among the most powerful in the world.[11]

Wind tunnels simulate the flight conditions which airplanes will encounter, and allow measurement of plane lift, drag, and resistance. McCook's 5-Foot Wind Tunnel represented an improvement over earlier examples because it produced winds of much greater speeds for its diameter. It was used to test numerous small scale models, saving the Army thousands of dollars in full-sized prototypes and sparing test pilots significant risks. The McCook wind tunnel was eventually moved to Wright Field (Building 19), in 1929, and continues to be used today for student projects and non-military investigations.[12]

The thorough testing of propellers became important to engineers when increased engine power, and hence higher propeller-tip speeds, began to tax the strength of traditional propellers. McCook's Propeller Shop meticulously fabricated specimens from laminated wood, duralumin and Bakelite. Sophisticated tests in the Shop allowed advancements in the synchronization of machine-gun fire and propeller operation, and in the development of a variable pitch propeller that could ease takeoff and cruise conditions.[13]

The engineers at McCook also initiated methods of static and impact testing. In the former, the stresses and strains encountered in normal flight were reproduced by placing bags of shot or lead bars on wings or other parts of airplanes. In impact testing, a part such as an axle or wheel was attached to a skeleton fuselage and loaded with sand or shot bags to approximate the weight it would eventually bear in operation. The entire assembly was then dropped from a scaffold to recreate actual landing conditions. Until 1922, when mathematical formulae were deemed reliable for the task, engineers at McCook drop-tested not only parts, but entire prototype planes.[14]

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[11] "A Little Journey...," 4.

[12] "A Little Journey...," 4; E.N. Fales, "The Wind Tunnel and Its Contribution to Aviation," Aviation 31 (October 1927), 1054-1057.

[13] Roger Bilstein, Flight in America 1900-1983: From the Wrights to the Astronauts (Baltimore: Johns Hopkins University Press, 1984), 72-3; Lois E. Walker and Shelby E. Wickam, From Huffman Prairie to the Moon: The History of Wright Patterson Air Force Base (WPAFB: Office of History, 2750th Air Base Wing, Air Force Logistics Command, 1986), 180-181.

[14] A.M. Jacobs, "Over the Hump," Popular Aviation (February 1929), 17-18.

Among other accomplishments of the Engineering Division's aircraft engineers were a number of improvements to airplane "power plants," or engines. Superchargers, fuel systems, and air-cooled engines (which were more responsive than liquid-cooled engines in climbing and maneuvering) all underwent refinement at McCook, generally through testing on torque stands and dynamometers, where engine power could be measured with great precision.[15]

McCook engineers also had success with the development of new protective paints and fabrics, new fuels, and specialized materials for aviation use, including lighter and cheaper substitutes for standard materials. Although the Army's engineers sought to work as closely as possible with supplying manufacturers, elaborate chemical, metallurgical, electrical and other laboratories were maintained at McCook, virtually giving Air Service engineers the capacity to build an entire airplane from scratch if they so desired.

In the course of operating McCook's facilities, the Army came to realize that building entire airplanes in-house would not be nearly as economical as utilizing the resources of private industry. Nor did the Engineering Division wish to operate on a "competitive basis" with industry.[16] Instead, its policy was "to encourage the development of a bigger and better aircraft industry," and the Division implemented practices at McCook that would bring this about. The Army's choice of the Dayton area for its aeronautical engineering center grew in part from the city's proximity to the airplane industry in Ohio, and to the automotive industry in neighboring states. Army engineers would develop precise performance specifications for a new airplane, and then solicit design proposals from industry--usually leaving decisions about actual construction methods to manufacturers. In some instances the Engineering Division turned over its experimental data or actual parts to manufacturers under contract. In other instances, Air Corps engineers utilized the findings of industry for its own researches.[17]

These policies had direct practical benefits both for the Army and for industry, and the expansion of Army aeronautical research throughout the 1920s and 1930s reflected a series of mutually supportive decisions by the two interests. The move of the Engineering Division from McCook to Wright Field in 1927 can be traced to this growing belief in aeronautical research as a positive force for both the military and for private economic development.

The Creation of Wright Field

As has been the case in most peacetime periods in the United States, funding for military

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[15] "A Little Journey...," 7-8.

[16] "A Little Journey...," 4; James J. Niehaus, Five Decades of Materials Progress, 1917-1967 (WPAFB:Air Force Materials Laboratory, Research and Technology Division, Air Force Systems Command, 1967), 34.

[17] Kilmer, Major W.G., "Memorandum: For the Engineering Division, War Department, February 13, 1925" (in AFLC Archives, "History of McCook Field [Miscellaneous Correspondence 1918-1926]"), 14; Historical Division, Office of Information Services, Air Research and Development Command, "The First 5 Years of the Air Research and Development Command," (January 1955), 4; Eric M. Schatzberg, "Ideology and Technical Change: The Choice of Materials in American Aircraft Design Between the World Wars," Ph.D. Dissertation, University of Pennsylvania, 1990, 164-166.

research was limited in the early 1920s. The Army's decision to pursue a larger, more modern setting for its aviation engineering research can be associated with two related events that together outweighed objections to funding such a project. In 1924, a group of Dayton businessmen spearheaded a successful drive to keep the Engineering Division in the locality by providing the U.S. Government with donated property; and in 1926, Congress passed the Air Corps Act, significantly increasing the responsibility of the Engineering Division. These were the immediate causes of the establishment of Wright Field, and they point the way to much broader currents in the development of flight technologies.

Local efforts to obtain Congressional funding and a permanent Dayton location for the Engineering Division were led by John H. Patterson, co-founder of the National Cash Register Company and a longtime supporter of the Air Service. The production of aircraft in America had undergone a tremendous expansion over the course of World War I. The 1914 census listed only 16 aircraft companies with an output of 49 planes; by 1918, there existed 300 manufacturers. Patterson saw the possibility of Dayton-area companies joining in this swell. Beginning in 1921, Patterson, and later his son, worked to garner the support of other prominent Dayton citizens, eventually forming the Dayton Air Service Committee and publishing the promotional journal, Aviation Progress. On the basis that the continued presence of the military facilities would bring employment and revenue to the area, and that the region had a cherished identity as the "Birthplace of Aviation," the Committee mustered wide support, and by the end of 1922 had raised over $425,000 for the purchase of 4520 acres of land east of Dayton. The land included the Air Service's Wilbur Wright Field, a flying field and aviation school leased by the Air Service since 1917, and abutted the existing Fairfield Air Intermediate Depot, thus ensuring its easy conversion to a large aviation complex. The property was

Figure 3: Wright Field, 1930. (USAF)

"sold" to the federal government for two dollars, and after Congressional appropriations began in 1925, the War Department abandoned the name Wilbur Wright Field to call the entire property Wright Field, honoring both Wilbur and Orville.[18]

While the citizens of Dayton worked to prepare a site for Wright Field, Congress was moving to expand the Army's air service. In 1926, the Air Corps Act was passed, and a five-year expansion program undertaken. The functions of the Air Corps were threefold: training, operations, and materiel. The Materiel Division was responsible for not only all aviation engineering and research (the Engineering Division became a section within the newly created Materiel Division), but also for the procurement, supply and issue of Air Corps aircraft and materiel. The 1928 Air Corps Annual Report suggests the complexity of its charter:

> In general all activities of the Materiel Division have one ultimate objective: to furnish the Air Corps with suitable aircraft materiel. The attainment of this necessitates the development, procurement and test of aircraft and aircraft accessories; the distribution and maintenance of materiel and supplies in the field; the planning of industrial preparedness; the maintenance of an adequate engineering establishment and testing facilities; the extension of research facilities and technical services to the industry and the other Government agencies; and the dissemination of technical information for the good of the service and the general public.[19]

The added scope of Materiel Division responsibilities mandated by the 1926 reorganization was a very clear justification for the establishment of a facility like Wright Field, but by no means the only one. Private, military, and Congressional boosters offered numerous reasons for the huge investment of time and energy a new field would require, and examination of those reasons reveals a great deal about the climate surrounding aeronautical development. They suggest that Army aeronautical engineering activities encouraged the public's interest in flight, and were furthered in turn by such interest.

For its part, the military envisioned an industrial complex that could produce state-of-the-art aircraft during peacetime, and in so doing also be at the ready in case of another war. The Army allotted funds for contracting out their work, and found industry eager to bid on such work. At the same time, dramatic feats such as the setting of altitude and speed records, the first transatlantic crossing in 1919, and Lindbergh's 1927 flight heightened public interest in aviation. Commercial airlines capitalized on this interest by introducing nationwide and intercontinental schedules.[20]

Some of the advantages claimed for a newly built engineering facility were assured and easily measured. Flight tests of new aircraft at McCook had been conducted directly over the residential area of North Dayton in which it stood; crashes there had caused the death of five civilians, and a more remote testing ground would be safer. The cost of renting and maintaining the buildings at

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[18] Walker and Wickam, 112-114; Roland, 51.

[19] "Annual Report 1928," 28.

[20] Bilstein, 79.

McCook, most of which were erected as temporary structures during World War I, would be eliminated as well.[21]

Other justifications offered for Wright Field were less concrete, but apparently no less compelling. Boosters invoked the interests of national security. Although public sentiment was running against military expansion in the 1920s, the airplane appeared to be a means to improved global relations, a deterrent to aggression and, in a revival of its earliest military role, a communications tool.[22] The Army's staging of a trip around the world by four single-engine planes in 1924 (an attainment to which McCook Field and the Fairfield Depot contributed) bolstered such visions.[23]

Perhaps the most thoroughly elaborated justifications for the establishment of Wright Field involved the interaction of military and industrial interests. Both groups produced public relations materials describing the benefits that would accrue to everyone concerned if the Army increased its engineering activities. As had been the practice at McCook, private industry, through a system of competitive bidding, would be used to develop new technologies. McCook had seen this approach work with such significant achievements as the Barling Bomber, earth inductor compass, high-altitude cameras and films, and aerial torpedoes. Expanded activities at Wright Field promised further business to many manufacturers.

Proponents of Wright Field also cited the ways in which the findings of the Engineering Division could be of use to industry. Aeronautical advancements would directly aid the aircraft industry, and indirectly produce benefits to American commerce as a whole. Among examples of the latter from McCook's engineers were the first model airways in the U.S. (from Dayton to Washington, DC); night-flying equipment used by U.S. Air Mail; night illumination of flying fields; and crop dusting. Most dramatic was the development of new, more reliable instrumentation, "essential," one historian has pointed out, "for commercial airlines striving to establish dependable service based on published timetables."[24]

The relationship between military and private industry was not entirely congenial, however. As mutually beneficial as a military/manufacturer exchange of data was, patent litigation plagued Army engineering efforts. In the post-World War I period of retrenchment, the Army received complaints from the private sector that too much research work was going to military engineers, and that more should go to private industry.[25] Further, the Engineering Division continually faced the difficult problem of losing skilled personnel to the private sector, a situation that evoked at best mixed

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[21] "Removal of Experimental Station will Save Government Interest on $3,300,000 Annually," Aviation Progress, 1 November 1925, 36.

[22] Bilstein, 76.

[23] Walker and Wickam, 63.

[24] "Aeronautical Developments Resulting Exclusively from Design and Experimentation by the Engineering Division," Aviation Progress, 1 November 1925, 2-3; Bilstein, 74.

[25] "Annual Report 1929," 18-19; Niehaus, 34.

Figure 4: Building 31, ca. early 1930s. (USAF)

feelings on the part of the military.[26]

But if these difficulties indicate the presence of some friction between public and private aviation development, they also indicate a general belief in the capacities of aviation research, and the shared understanding that the fortunes of military and industry were interwoven. They certainly did not stand in the way of Wright Field. In 1927, the Army began the process of closing down McCook and transferring operations to Wright Field. McCook's Dynamometer Laboratory, Propeller Test Laboratory and 5-Foot Wind Tunnel continued to operate for the next two years while facilities at Wright were readied. Most buildings at McCook were demolished, with materials such as piping, light fixtures, windows, and doors being salvaged for use at the new site.[27]

Wright Field as Planned and Built

Of the 4,520 acres that came under the Army's control, 750 acres on the protected side of Huffman Dam were allocated for the Materiel Division's engineering laboratories and associated flying field. (This parcel is now known as Area B; the old Wilbur Wright Field and Fairfield Air

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[26] F. Trubee Davison, "The Army in the Air," Western Flying 4, n.9 (September 1928), 161; "Annual Report 1928," 234; "Annual Report 1929," 15.

[27] Walker and Wickam, 122.

Depot, in conjunction with later land additions, are known as Areas A & C.) The Army spent three million dollars to create facilities for the Materiel Division's five major sections: administration, experimental engineering, procurement, field service and industrial war-plans. (A sixth section, Repair and Maintenance, was absorbed into the administration and engineering sections shortly after Wright Field opened.)[28] The government began construction on the site in 1926, building large administrative and laboratory buildings, hangars, machine shops, utility buildings, and paved aprons, as well as several specialized structures for the testing of engines and propellers. The transfer of activities from McCook to Wright Field began in March 1927, with more complicated technologies, such as the 5-Foot Wind Tunnel and Dynamometer Lab, coming into operation after the completion of more conventional facilities.[29]

Touring Wright Field today, it is not difficult to distinguish structures that date from the Field's first years in operation. With the exception of the Administration building (Building 11), the thirty structures that were part of the Army's original conception for the Materiel Division's engineering plant (many of which still stand) were almost all built of brick. Early test hangars and shops all have low-pitched gabled roofs and copper entablature. Many have low, square towers rising from their corners. Two tile-roofed, masonry gatehouses frame the Field's entry. They originally admitted visitors to a long circular drive, beyond which stood the imposing Administration building. This vista was disrupted by the addition of two more office buildings in front of the Administration building during World War II, but a sense of austerity and order is still suggested in the uniform design of Area B's original structures. All the early brick buildings stand distinct from the clean-lined concrete buildings of the World War II period of sudden growth, and from more recent buildings of less uniform design.

The consistent style of Wright Field's original architecture can be attributed to a trend in military construction toward the thoughtful and comprehensive design of military complexes. In the early 1920s, military budgets were sharply cut, and many military facilities fell into serious disrepair. Most existing buildings were never meant to outlast World War I, and living and working conditions on many Army posts were almost untenable by the middle of the decade. With the inauguration of the five-year air expansion program in 1926, the government moved to correct the situation by modernizing Army plants, and part of its response was to create new posts that had some architectural merit. It fell to the Quartermaster General to fulfill this agenda, and Wright Field, largely designed by the Quartermaster Corps, was one such well-planned post. If not beautiful in the strict sense of the word, it did convey the seriousness of purpose of the Army's aeronautical engineers. The Field's original buildings combined the functional characteristics of modern factory design--fireproof brick construction, large windows, minimal ornamentation--with the dignified, neo-Classical profiles favored for contemporary institutional architecture.[30]

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[28] Brigadier-General W.E. Gillmore, "The Job of the Materiel Division," U.S. Air Services 13 (December 1928), 38; Brigadier-General W.E. Gillmore, "Work of the Materiel Division of the Army Air Corps," Society of Automotive Engineering Journal 25, n. 3 (September 1929), 233; Walker and Wickam, 127.

[29] "Annual Report 1928," 223.

[30] Lenore Fine and Jesse Remington, The Corps of Engineers: Construction in the United States (Washington, DC: Office of Military History, 1972), 42-50; Alan Gowans, Styles and Types of North American Architecture: Social Function and Cultural Expression (New York: Harper Collins, 1992), 211-217.

Overview

Prior to 1900, the Army Quartermaster Corps had official responsibility for military construction, but actually had few large-scale commissions. An engineering division generally built all bridges, roads and fortifications, and ordnance divisions erected arsenals, and there were few large permanent posts to require the Corps' services as a construction crew. World War I created an unprecedented need for large-scale housing, storage and production facilities, and with this change in scale came the new conception that "construction was the key to preparedness."[31]

As had occurred with the development of aviation engineering itself, controversy arose over who should take responsibility for this newly recognized aspect of American defense. In 1918, the idea of a centralized, independent "Construction Division of the Army" gained popularity. The division would prepare plans, specifications and estimates for all military construction projects. During World War I, a unit along these lines built dozens of camps, training centers and airfields. This independent Construction Division was shifted by law to the jurisdiction of the Quartermaster Corps in 1920.[32] Thus, when the Army decided to build Wright Field virtually from scratch, it was the Quartermaster Corps that drew up plans, chose contractors, and supervised construction. Some construction, particularly on the field's infrastructure, was done by internal repair and maintenance crews, but the appearance and function of the original Wright Field buildings can be attributed to the Quartermaster Corps.

Operation of Wright Field

Many of Wright Field's buildings were "purpose built" to house particular engineering functions. Over the years, the actual use to which the buildings were put changed frequently, as organizational structures and engineering programs changed. The history of Wright Field operations might best be understood in terms of the general functions that were housed there: administration, engineering, procurement, and testing of Army aviation materiel. Each of these broad tasks was subdivided into more specific functions as national military agendas evolved. During its early years, Wright Field's facilities provided an integrated, self-sustaining area for aeronautical research and development, with ample and conveniently placed facilities for administrative, technical, and production work.

Construction at Wright Field began with the Administration Building (Building 11) and its neighbor, the Main Laboratory Building (Building 16). The two structures share a common foundation. Contractors from Dayton and Columbus followed Quartermaster designs for the Administration Building, and took almost a year to complete the building. Gas locomotives running on a system of railroad tracks hauled concrete from a central mixing plant; derricks lifted the concrete to the top of the building for placement, following standard practice of the day for efficient and continuous concrete pouring. The building was finished with stucco, and adorned with porcelain shields over the doors. A figure modeled after Rodin's sculpture, "The Thinker," graced these emblems, pondering a winged globe held in his right hand. As the headquarters of the Army Air Corps Materiel Division, Building 11 contained not only the offices for each section of the Division

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[31] Fine and Remington, 7.

[32] Fine and Remington, 24-40.

and such facilities as a dispensary, but also an Air Corps Engineering School and for several years, the Army Aeronautical Museum. The Engineering School produced officers trained in engineering specialties; in the early years of Wright Field when few university aeronautics programs existed, it was one of the only sources of scientifically trained officers for key positions in the Experimental Engineering and Procurement Sections and as Division representatives at factories.[33]

The Museum opened at Wright Field in 1932. It contained displays and records of aircraft and parts, many of wartime origin, and was a resource not simply for the interested public, but for engineers working at the field. It was treated as a "living display" where "many hours of needless work might be saved if access could be had to examples of what had already been accomplished." Transferred to the new Technical Data Building (Building 12) in 1935, the Museum was also useful in establishing patent priorities for Air Corps inventions.[34]

Figure 5: Entrance detail, ground floor, Building 12, 1991.

In many ways, Wright Field was designed as a self-contained plant. The operation of Wright Field included a post telephone system, telegraph office and radio station, a meteorological station, and complete printing facilities that generated forms for internal use and technical reports for wide distribution.[35] A firehouse (still in use) and heating plant served the field, the latter supplying steam to all of Wright Field through underground tunnels. Correcting one of the costlier defects of McCook Field, Wright Field's designers included railroad access so that coal for the heating plant and many other supplies could be brought directly to the site.

Concern with efficient operation characterized large-scale engineering and manufacturing enterprises of all kinds in the 1920s, and was carried into the design of buildings at Wright Field. The Main Laboratory Building (Building 16) embodies this goal. The one-story structure, adjacent to the Administration Building from which its operations were directed, provided 150,000 square feet of uninterrupted floor space for the Materiel Division's Experimental Engineering Section. As was standard practice for modern factories, saw-tooth monitors, or skylights, evenly illuminated the workspace. As was also typical of contemporary factory management, the Main Laboratory provided physical proximity and thus easy communication between all the different groups working within. The Engineering section was subdivided into five branches--Aircraft, Power Plant, Equipment, Materials

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[33] "Annual Report 1928," 234; "Annual Report 1931," 210-211.

[34] "Wright Field," Brochure, Materiel Division, U.S. Army Air Corps, 1938, 29; "Annual Report 1932," 76.

[35] "Annual Report 1932," 54.

and Armament--and interaction between them was an inherent part of Army engineering methodology. As the Assistant Secretary of War wrote of the Main Laboratory in 1928:

> In this room are housed the various research units, and the fact that they are under one roof, in one room, affords splendid coordination and promotes efficiency of operation to a degree that would be impossible under other conditions.[36]

Communication between research units was crucial because changes to the structure or performance of one part of an aircraft affected others. In many cases, the nature of the armaments to be carried by an aircraft, and the manner in which the armament was to be "delivered," determined overall criteria for plane structure and performance. But within that general hierarchy, different technologies had to be accommodated: a stronger engine might require a larger propeller, which might itself cause heavy vibration, which would in turn require development of a stronger fuselage, and so on. A 1952 Air Force report on trends in its own research and development processes claims that, "Between 1920 and 1945 it was usually possible to create an effective airplane from a collection of parts developed independent of each other." The report explains that the "weapons systems" approach of coordinated research did not find a place in aeronautical engineering until after World War II. The arrangement of laboratories at Wright Field, however, suggests that such a system was actually in place much earlier.[37]

The Aircraft Branch of the Engineering Division addressed the structure of military airplanes, and within this branch, the different technologies that comprised the modern aircraft were themselves treated as specializations. Propellers, structural elements, and engines (or power plants) all had their own research facilities, and experts in each area had their own means of organizing their research.

From the earliest investigations of powered flight, propeller design and the incorporation of propellers into airplane design were perceived as distinct areas of investigation. Designers had to create a propeller "as efficient as possible in converting rotative motion to forward motion," but also capable of operating "in combination with both engine and airframe (airplane less engine and propeller) and...compatible with the power-output characteristics of the former and the flight requirements of the latter."[38] At Wright Field, as at McCook, the fabrication of propellers was treated with the utmost precision. Using laminated wood, duralumin, and Bakelite, technicians working in the Main Laboratory Building constructed propellers up to 45 feet in diameter, creating specimens "so delicately balanced that even a splash of paint on the tip of one blade is enough to cause unbalance and enough vibration to make operation extremely dangerous."[39] These, and selected commercially produced specimens, were then tested on the Propeller Test Rigs (Building

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[36] Davison, "The Army in the Air," 61.

[37] "Annual Report 1930," 21; "Annual Report 1928," 56; "Trends in Research...," 2.

[38] Walter Vincenti, What Engineers Know and How They Know It (Baltimore: Johns Hopkins University Press, 1990), 141.

[39] "The Materiel Center and You: A Handbook for Your Guidance," Civilian Personnel Section publication, Wright Field, 1939, 31.

20A), constructed on the edge of Wright Field and put into operation in May of 1929.[40]

Engineers at Wright Field continued the emphasis McCook personnel had placed on the development of controllable pitch propellers. Wright Field's test rigs, however, were through the 1930s the largest propeller test rigs in the world. Powered by 2,500-, 3,000- and 6,000-horsepower electric motors, the three rigs enabled Wright Field engineers to whirl-test propellers at speeds up to 4,300 revolutions per minute. The rigs were arranged in a line that allowed the slipstream of one propeller to be thrown into the range of the propeller behind it--which would be the propeller under test. Thus, the conditions of flight were simulated.[41] Thick timber- and steel-beam canopies over the rigs prevented pieces of broken blades from flying loose, until World War II prompted the rigs' complete enclosure.

An equally important body of research at Wright Field was that done by the Aircraft Branch's Structures Development and Test Laboratory. Through theoretical analysis, static testing, and the work of associated sheet metal, wood and machine shops, this unit created the first practical all-metal monocoque airframe (in which the aircraft's shell absorbs most of its structural stresses), a breakthrough that led to the first sub-stratosphere airplane.[42] This work was accomplished in the immense, glass-walled Final Assembly Building (Building 31) and attached shops (Building 32). Static and dynamic testing proceeded along the lines of that done at McCook, although on a larger scale: contract airplanes, commercial airplanes bought on the open market, and engine mounts for existing airplanes were all tested in the first year of the facility's operation.[43]

The Aircraft Branch at Wright Field also maintained an Aerodynamic Research and Test Laboratory, the unit responsible for the operation of Wright Field's wind tunnels. McCook Field had initiated Air Corps work with 14-Inch and 5-Foot Wind Tunnels, both of which were relocated to Wright Field where engineers continued the testing of small airfoils and propellers in the former, and complete airplane models in the latter. Wright Field's wind tunnel engineers demonstrated that the 5-Foot Wind Tunnel could accommodate larger models than had been thought, thus expanding its usefulness. Such work in the early days of Wright Field set the stage for dramatic accomplishments with the much larger 20-Foot Wind Tunnel completed in 1943.[44]

With the move to Wright Field, the Aircraft Branch also established three new laboratories. The Accessory Design and Test Laboratory had responsibility for testing wheels, brakes, landing gear and other such parts. The Lighter-Than-Air Unit was responsible for Air Corps balloons and non-rigid airships. The Special Research and Test Laboratory refined design specifications for Air Corps airplanes. These laboratories produced such innovations as separately controlled landing wheels

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[40] "Annual Report 1929", 249; "Annual Report 1931," 12.

[41] Walker and Wickam, 131; Davison, "The Army in the Air," 61.

[42] Walker and Wickam, 130.

[43] "Annual Report 1928," 57.

[44] "Annual Report 1928," 50; "Wright Field," 10.

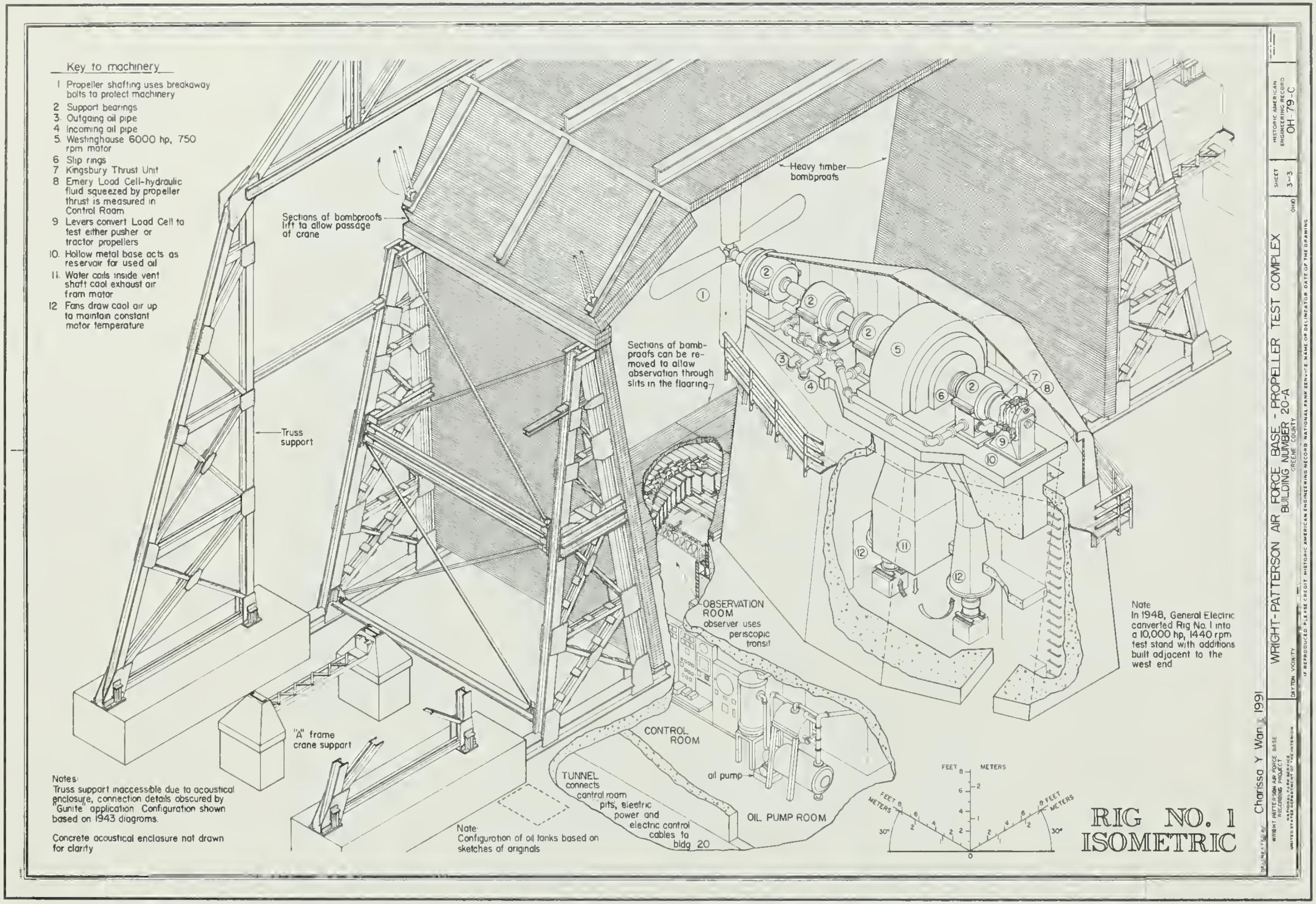

Figure 6: Isometric view, Propeller Test Complex, Building 20A, 1943. (Delineated by Charissa Y. Wang, HAER, 1991)

operated by pedals on the rudder bar, and new cockpit arrangements that allowed a forward observer to photograph, bomb, observe, radio, or direct combat from the same position.[45]

Like the Aircraft Branch, the Power Plant Branch at Wright Field had as its priority the pursuit of greater power for aircraft without added size or weight, in this case through the study of engine design. The Branch was equipped to test engines with up to 2500 horsepower, a level of power not actually attainable by engines when the Power Plant Branch's facilities were constructed. Specific engine research projects were chosen through both laboratory tests and the correction of troubles reported back to the Branch by Air Corps pilots. Both kinds of problems were researched on the torque stands and in the dynamometer laboratory, two of the most significant facilities at the original Wright Field.

The dynamometer housed in Building 18 calibrated and measured the power of engines. Wright Field dynamometers could tolerate the running of engines up to 1500 horsepower, or furnish a blast of air to air-cooled engines in a simulation of flight conditions. Additionally, the dynamometers held meters for determining fuel or oil consumption, engine revolution counters, tachometers, and instruments for ascertaining operating temperatures. A "cold room" allowed liquid or air-cooled engines to be tested to 50 degrees below zero Fahrenheit. Personnel working in this laboratory wore electrically heated clothing.[46]

The torque stands (Building 71), set in a series of imposing 40-foot-high concrete stacks that barely diminished the noise from within, allowed engines to be endurance tested for up to 150 hours. There were seven torque stands in the original facility, but over the next decade twelve more were added, all equipped with observation rooms. The Fuel Test Laboratory, in which fuel and lubricant properties were investigated, completed the Power Plant Branch's main facilities. Fuel system pumps submitted to the Air Corps by private manufacturers were also examined here. Another priority of this laboratory was the standardization of both Army and Navy fuel requirements, a method of reducing demands on the oil industry and costs to the government.[47]

While cylinders, valves, and carburetors received due attention at the Power Plant laboratories, much research focused on the problems of engine cooling. The development of the air-cooled engine (especially through designing a ring-type cowling for radial engines) was particularly important to the unit's engineers, but not to the exclusion of work on water- and other liquid-cooled engines. In 1929, Power Plant engineers successfully applied high-temperature liquid cooling to the water-cooled engine, an advance that allowed radiators to be reduced in size by 70 percent. These two advances reduced engine weight considerably and provide an example of how the basic flexibility of the Engineering Division led to new innovations.[48]

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[45] "Annual Report 1928," 48-58.

[46] "The Materiel Center and You," 29-30; "Wright Field," 16-17.

[47] "The Materiel Center and You," 30; "Wright Field," 17-18; "Annual Report 1928," 73; "Annual Report 1931," 17.

[48] "Annual Report 1929," 22.

In addition to the Aircraft and Power Plant Branches, the Experimental Engineering Section also contained the Equipment Branch, a unit devoted to the development of a large variety of technologies. Navigation equipment and instruments were among its primary responsibilities, including instruments that measured engine performance and other aspects of flight such as altitude or speed.

New instruments were among the Equipment Branch's most visible accomplishments. Air Corps engineers and pilots captured public imagination with widely publicized feats of "blind" flying over uncharted waters or through dense fog.[49] This was, in fact, the kind of work that had direct and obvious benefits for commercial aviation, and in 1931 the Materiel Division reported "a decided improvement in [aircraft radio] design and efficiency...due largely to the interest shown by commercial manufacturers in Government requirements." Such interest created new sources of supply for technological equipment vital to Army aeronautical projects.[50]

Findings on the operation of instruments contributed to progress in radio investigations. At Wright Field the Air Corps worked in cooperation with the Signal Corps, which not only aided in the

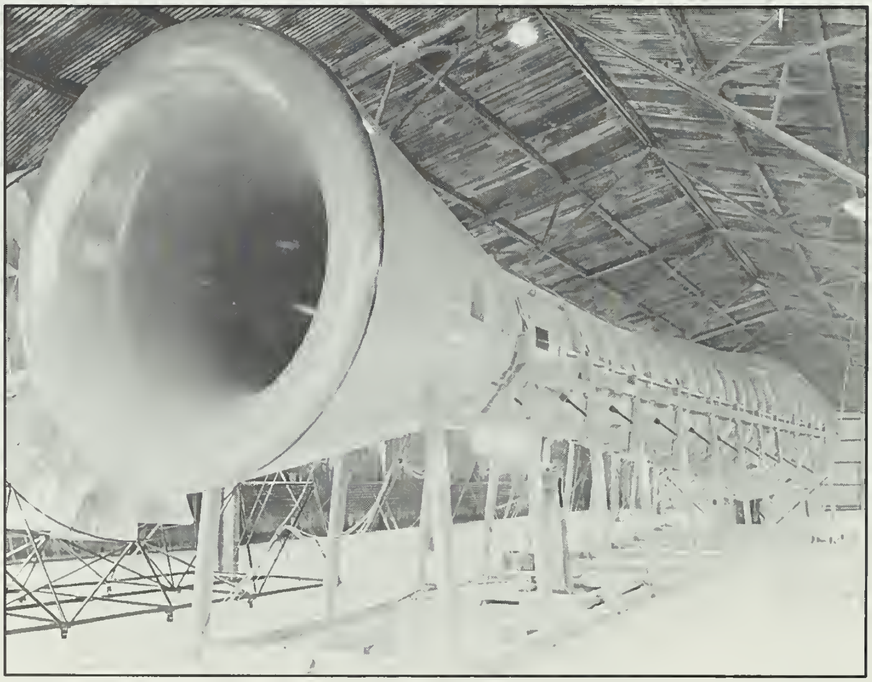

Figure 7: 5-Foot Wind Tunnel, ca. late 1920s. (USAF)

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[49] "The Materiel Center and You," 22.

[50] "Annual Report 1931", 15.

development of aircraft radio equipment, but maintained the Materiel Division's Aircraft Radio Laboratory (Building 17). Radio compasses, radio guiding station trucks for landing fields, and "interphone systems" that allowed passengers in multi-place airplanes to speak with each other emerged from this unit.[51]

The Equipment Branch was also charged with the refinement of aerial photography, used for terrain mapping and reconnaissance. Several sophisticated cameras developed for precision photography and survey work came out of this unit, and were put to use on many peacetime projects. In addition to aiding in United States Geological Survey mapping, Air Corps aerial cameras were used to photograph natural disasters such as floods and fires, efforts that received much positive attention from the press.[52]

The Equipment Branch's Parachute and Clothing Laboratory also produced notable innovations, particularly the triangle parachute, patented by Col. Edward L. Hoffman in 1930. This development "represents one of the first formal attempts to apply engineering principles to canopy design."[53] The Parachute and Clothing Laboratory's work on modifying and standardizing flight clothing later meshed with that of the Physiological Research Laboratory that opened at Wright Field in 1935.

The existence of these two laboratories within the Engineering Section illustrates the Army's integrated approach to aviation research: the pilot was as much a "researchable" component as any other part of a plane, susceptible to refinements in operation and safety. The Materiel Division's entire approach to aeronautical engineering was characterized by this kind of open inquiry. Virtually any aspect of aviation that could be identified was worthy of careful scientific attention.

The two remaining units of the Equipment Branch, the Electrical and Miscellaneous Equipment laboratories, attended to various small details that nonetheless greatly facilitated Air Corps work. The Electrical Laboratory produced such significant innovations as a portable-by-air field lighting system, and the Miscellaneous Equipment Laboratory developed streamlined generators, highly portable shelters and wing jacks, and oxygen equipment needed for high-altitude flying.[54]

The Materials Branch of the Materiel Division's Engineering section had far more than a "support" role for the Division's more "complex" technologies. In fact, the development of high durability, low weight materials for all aspects of aircraft operation was extremely important, particularly because the conditions of war might suddenly render a given raw material unavailable. Cost was sometimes a factor in Air Corps materials researches, but more often, the practicalities of production--again, with an eye toward the nature of emergency war conditions--determined viable

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[51] "Annual Report 1928," 235; "Wright Field," 25; Gillmore, "The Job of the Materiel Division," 41.

[52] "Annual Report 1928," 99-103; Gillmore, "The Job of the Materiel Division," 41.

[53] Walker and Wickam, 135.

[54] Walker and Wickam, 136.

material innovations.[55]

The first scientific investigations of materials for U.S. military aircraft were those that followed the Signal Corps' issuance of military airplane specifications in 1916. The specifications set very broad quality requirements for metals, protective coatings, wood and fabric. In 1916, their interpretation and enforcement could not be met by the industrial plants building aircraft at that time. The National Bureau of Standards and the Forest Products Laboratory answered some of the military's early needs in this area before the Signal Corps established its own materials lab.[56] It is also important to note that interest in materials research and development was blossoming throughout the country in this period, resulting in the formation of many trade associations, commercial laboratories and university department laboratories devoted to the precise testing of building and manufacturing materials.[57]

Materials research at McCook Field was divided into the following tasks: liaison, chemical, physical testing, metallurgical, wood, textile and rubber. By 1930, the Materiel Division had exhibited a clear commitment to replacing fabric wing coverings and other airplane parts with metal, and wood was losing its primacy in aircraft design.[58] However, the general organization of materials investigations was carried over from McCook to Wright Field, where the Laboratory's work was assigned to the northeast corner of the Main Laboratory Building and to a foundry and garage (Buildings 46 and 51), across B Street from the Laboratory Building.[59]

Because the Materials staff was responsible for the inspection of manufactured airplanes and parts, an expansion of Air Corps procurement (which occurred about the time of the move to Wright Field) meant that less time was available for research. Nonetheless, in its first years at Wright Field the Materials Branch accomplished a great deal in the areas of metal fatigue, magnesium casting, and the strengthening of aluminum alloy and steel tubing for columns. As with all Engineering Section work, that of the Materials Branch was coordinated with other units on the site, contributing to research on cold-weather starting problems, propeller performance, and flight clothing.[60]

The Experimental Engineering Section was also responsible for armament development, not in the area of munitions themselves, but rather their incorporation into aircraft. The difficulties of attaching 2,000-pound bombs to airplanes built for lightness and agility, and the problems of manipulating machine-guns behind slipstreams of 160 miles per hour were substantial. The Armament

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[55] Gillmore, "The Job of the Materiel Division," 39.

[56] Niehaus, 3-5.

[57] See Frank G. Tatnell, Tatnell on Testing (Metals Park, Ohio: American Society for Metals, 1966) and H.F. Gonnerman, "Development of Cement Performance Tests and Requirements," Portland Cement Association Research Department Bulletin 93 (March 1958).

[58] Niehaus, 9, 57; Schatzberg, 258.

[59] Niehaus, 40.

[60] Niehaus, 44-55.

Branch refined gun mounts, bomb racks and release mechanisms for greater reliability in the Armament Laboratory (Building 21). A test range to the east of Building 21 allowed for the testing of guns mounted on aircraft.[61]

A number of Materiel Division functions placed at Wright Field did not require laboratory facilities because they focused on organizational aspects of Air Corps operation. The Procurement Section issued specifications for planes, purchased most of the equipment and supplies used by the Air Corps, and coordinated inspections at manufacturing plants. These jobs were difficult because so much of the equipment desired by the Air Corps was either not yet manufactured or not yet standardized when needed. The work of Procurement was "a process of persistent, creative problem solving." Standardization of manufacturing processes and the elimination of duplicate stock were also pursued by the Procurement Section in its role as primary liaison between the Materiel Division and private manufacturers.[62]

Other coordination functions were performed for the Air Corps by the Materiel Division's Industrial War Plans and Field Service sections. The former studied procurement conditions relative to the exigencies of war, following the conception that "the conduct of war is not only a matter of man-power, but it is more particularly a matter of natural resources, engineering skill and production possibilities."[63] As commercial aircraft production grew through the early 1930s, the task of securing potential sources for raw materials and component parts became somewhat easier. The Field Service Section was responsible for the flow of supplies to Air Corps facilities. It administered the Air Corps' depot system, and tracked storage, salvage and other logistical problems of the Corps. The trend toward standardization also shaped the Field Service Section's work, as it worked on creating a standardized nomenclature for the myriad pieces of equipment and types of supplies needed to keep Air Corps operations running smoothly.[64]

Wright Field 1929-1939

The early history of Wright Field embodies an interesting set of contradictions. While the nation's interest in aviation was growing, and belief in the possibilities of general technological development was unflagging, an atmosphere of economic and military retrenchment was taking hold. The beginning of the Great Depression in 1929, just as Wright Field opened, brought significant changes to the Engineering Section. Budget cuts curtailed numerous specific projects of the Materiel Division and caused a reduction in paid personnel. Air Corps engineers felt themselves to be "severely handicapped" in their efforts to "maintain leadership in military aeronautics and to solve the problems so vital to the Air Corps but of no immediate interest to the Industry."[65]

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[61] "Annual Report 1928," 97; Gillmore, "The Job of the Materiel Division," 42.

[62] Walker and Wickam, 128-9.

[63] Gillmore, "The Job of the Materiel Division," 42.

[64] Ibid., 42; "Annual Report 1931," 19.

[65] "Annual Report 1932", 58; "Annual Report 1934," 5.

Figure 8: B-17 Bomber over Wright Field, ca. late 1930s. (USAF)

Yet, work continued at the Wright Field laboratories: new buildings were constructed, and new projects undertaken. A slowdown in the drain of trained personnel to industry helped somewhat, as did lower prices for raw materials and services--both results of the depressed economy. Overall, however, work at Wright Field during the 1930s was done on a selective basis. Army aeronautical engineers simply could not hope to do all the work they thought necessary.

Areas of concern to Air Corps engineers in the 1930s included landing gear research, for which a new laboratory was created in the old Aircraft Assembly Hangar (Building 31) in 1938; refinement of automatic pilots; and equipment for recording and analyzing flight during take off and landing. The new static test facility (Building 23) was built in 1935 to accommodate aircraft too large for the 1929 static test laboratory in Building 31. The new laboratory developed cushion and tension loading pads that replaced the use of dead weight for load testing and greatly added to the precision of such research.[66]

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[66] "Wright Field," 22; "Annual Report 1937," 11, 20-21; "Annual Report 1931," 13.

Among the most dramatic developments at Wright Field in this decade was the founding of the Physiological Research Laboratory in 1935. Located within the Equipment Branch of the Engineering Section and headed by Captain Harry Armstrong, this laboratory was devoted to "the investigation and elimination of hazard to flying personnel." These hazards ranged from freezing, loss of consciousness and even death, to the strange phenomenon wherein test pilots tended to lose their dental fillings after repeated high-altitude flights.[67]

Aeromedicine had attracted military interest since 1917, when the Signal Corps established a program for physical exams for its flying personnel with an associated Medical Research Laboratory. A School of Aviation Medicine was formed in 1926, but few of its graduates were trained to address the rapidly changing conditions of flight--problems that prompted Captain Armstrong to propose creation of a Medical Research Laboratory to the Materiel Division, the central source for new engineering technologies. The Administration Section's Medical Branch at Wright Field had little interest in pursuing this type of research, and Armstrong's proposal was accepted.[68]

In the customary interwoven fashion of much Air Corps research, a portion of the new Physiological Research Laboratory's work was determined by concurrent improvements to power plants, which, by 1934, could carry airplanes to 30,000 feet. Such "over-weather" flying called for the development of a workable pressurized cabin, long a dream of aircraft engineers. A high-altitude laboratory was built to aid this research in 1937 (in Building 16). Its pressure chambers could simulate altitudes up to 80,000 feet above sea level. (At the time, only Harvard University had a comparable pressure chamber, and that was designed for researching pressures at great depth, rather than high altitudes.)[69]

The laboratory treated biomedical and physiological problems as discrete research subjects. The effects of centrifugal force and barometric pressure changes on the body, and issues of physical aptitude were continuing topics of research. Laboratory personnel volunteered to be used as human guinea pigs for most work.[70]

Some construction at Wright Field during this period proceeded with the assistance of the new national relief programs, under the supervision of the Materiel Division's Chief of Maintenance or the Quartermaster Corps. In 1934, the Civil Works Administration provided 185,000 man hours to Wright Field for such tasks as upgrading the flying field, painting buildings, and landscaping. On a larger scale, a new static test building (Building 23), a basement for the Main Laboratory Building (Building 16), and an elaborate new Technical Data Building (Building 12) were built as part of Works Progress Administration (WPA) efforts to replace appropriations for military construction that had all but disappeared. Because most WPA money had to be paid out in wages to largely unskilled

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[67] "Annual Report 1935," 6; "Captain Harry G. Armstrong Will Head Department...", unidentified newspaper clipping in Flat Files, 645 ABW History Office, Wright Patterson Air Force Base.

[68] Charles Dempsey, 50 Years of Research on Man in Flight, Air Force Aerospace Medical Research Laboratory (Dayton, Ohio: United States Air Force, 1985), xxvii-xxix.

[69] "Wright Field," 14,24; "Annual Report 1937," 26.

[70] Walker and Wickam, 136-137; "Captain Harry G. Armstrong...".

labor, the Army's Construction Division received what has been called "a low return for its relief dollars." Nonetheless, the new buildings at Wright Field were equipped to do the same kind of sophisticated research work that the original buildings accommodated.[71]

The Technical Data Building housed an expanding crew of filmmakers, script writers, artists, translators, librarians, and experts on foreign aviation. The Air Corps had found that still- and motion picture records of experiments and test procedures were helpful to their researches, supplementing the 21,000-item aeronautical reference library. The new Technical Data Building, which is still one of the most ornate buildings at the field, also became the new home of the Army Aeronautical Museum.[72]

Wright Field and World War II

The limited, underfunded nature of the Materiel Division's engineering work changed drastically with the nation's rearmament for World War II. The Air Corps realized that it had fallen behind European countries (both friendly and hostile) in air power. In April, 1939, Congress authorized $300 million for the development of a 5,500 plane air force. In June 1941, the Army Air Corps was reorganized as the Army Air Forces, and comprehensive plans for a wartime force of some 63,000 planes and two million men were inaugurated. Wright Field, and the adjacent Patterson Field, became the center for logistics support of this effort.[73]

The Materiel Division received new technical and administrative responsibilities during the war, and the Army gradually determined that these functions were best handled separately. For technical matters, a Production Section was created, and the Engineering Section was expanded and reorganized. In 1941, the logistics functions of the Air Corps were fully separated from its materiel work through the creation of the Air Service Command, headquartered at Patterson Field (now Area A). In early 1942, the Materiel Division became a command, with its administrative personnel based in Washington and its operations (now designated the "Materiel Center") at Wright Field. A brochure for new employees at Wright Field explained the emerging arrangement: "We may say that Wright Field represents the physical facilities, grounds and personnel to manage and operate them, while the Materiel Center is the engineering and procurement organization that works in Wright Field."[74]

The nature of engineering work at Wright Field changed with the advent of the emergency. The process of military aircraft design had generally been broken down into three kinds of tasks. Research personnel pursued basic facts of use to the air forces without excessive concern for production practicalities; development specialists carried forward the evolution of a particular technology to gauge its usefulness in operation; and production engineers ensured that a technology

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[71] "Annual Report 1934," 8; Fine and Remington, 54.

[72] "The Materiel Center and You," 49; "Wright Field," 29.

[73] Walker and Wickam, 145; "Annual Report 1938," 11.

[74] "The Materiel Center and You," 53; Walker and Wickam, 148.

could be manufactured and employed without undue difficulty. The first priority of research and development had traditionally been qualitative advancements. With the start of the war, the Army Air Forces concentrated its resources on the production of aircraft--emphasizing quantity rather than quality. This production emphasis brought substantial changes to the Materiel Division, primarily the creation of a new kind of organization for handling procurement and supply, and new conditions under which research was conducted.

The first of these changes was under consideration even before the United States officially entered the war, when Wright Field started experiencing difficulties in obtaining raw and fabricated material, personnel, and manufacturing facilities as different branches of the armed services sought to arrange their resources for the possibility of war. Wright Field gained a large staff to manage these problems. The overall trend in this work was toward "decentralized operation with centralized control," a means of taking the most advantage of far-flung material and manufacturing resources, while ensuring efficient management. In 1942, the Army Air Forces divided the nation into four Procurement Districts. These District Offices took over such diverse tasks as public relations (sponsoring plant dedications and labor morale projects, for example) and the administration of an extensive system of financing for war contractors, without which materiel needs could not have been fulfilled.[75]

These functions, along with production scheduling, price adjustment, and material redistribution, constituted a growing field arm of the Materiel Command.[76] Engineering also felt the forces of decentralization: new flight testing fields were established as far away from Dayton as Muroc, California (on the premise that the remote site offered better security, as well as less crowded runways than Wright Field), and flight testing was accelerated at the Army's proving grounds in Florida. But logistical shifts such as these were not as significant to Wright Field engineers as were drastically changed circumstances under which the engineers selected their projects.

A report of Materiel Command's wartime activities notes that in 1939, with threats of war increasing, the Army decided to "more completely divorce production engineering from experimental and developmental engineering lest striving for perfection on the part of men trained in research retard production."[77] The decision of when to halt refinement of an article and put it into production had always been subject to jurisdictional disputes within the Air Corps, but in the context of a war, production concerns simply outweighed research agendas. Wartime objectives of Wright Field laboratories were shaped by administrative and material conditions beyond their control. The technological advances achieved by the Wright Field laboratories during the war were substantial, yet the selection of research projects, dictated by national production plans, ultimately created a military whose strength came from its size, rather than the sophistication of its weaponry. This aspect of Wright Field's history emerged clearly in the nature of its post-war plans.[78]

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[75] Mary L. McMurtrie, "History of Army Air Forces Materiel Command (Materiel Center), 1942," [written 1946], 160-162.

[76] "History of the Army Air Forces Materiel Command 1943," 160-161.

[77] AMC Historical Study No. 284, "Administrative History of the Air Technical Service Command, 1944," [Written 1946], 7.

[78] "Trends in Research...," 8-10.

The physical conditions under which research was done at Wright Field during World War II were extraordinary. Crowding had become a major problem by 1940. Rotating eight-hour shifts, and up to 500 visiting contractors a day pressed the facilities to their limits. The Field's commanding officer wrote in 1941 that, "There is not a single activity at this station which is not terrifically overcrowded and becoming more so daily. Efficiency and morale is suffering..."[79]

Subsequent growth at the site was tremendous: the Field held 20 main buildings in 1927, 40 in 1941, and 300 by the spring of 1944.[80] Structures added at the start of the war included those associated with the greatly increased air traffic at the field. With the Army Corps of Engineers, Wright Field's civil engineers built a new flightline complex that included paved runways to accommodate bombers of unprecedented weight, the first of which was the 140,000-pound Douglas B-19 of 1941. Three of the new runways were 5,600; 6,400; and 7,100 feet in length, respectively. One unique experimental "accelerated" runway, inspired by reports of a similar German project, was built on a ten percent incline to allow shorter takeoffs; this variation was eventually abandoned.[81]

A series of large hangars was also constructed. Among these were hangars used by the Armament Laboratory (Building 22); a Modification Hangar to accompany the new Flight Research

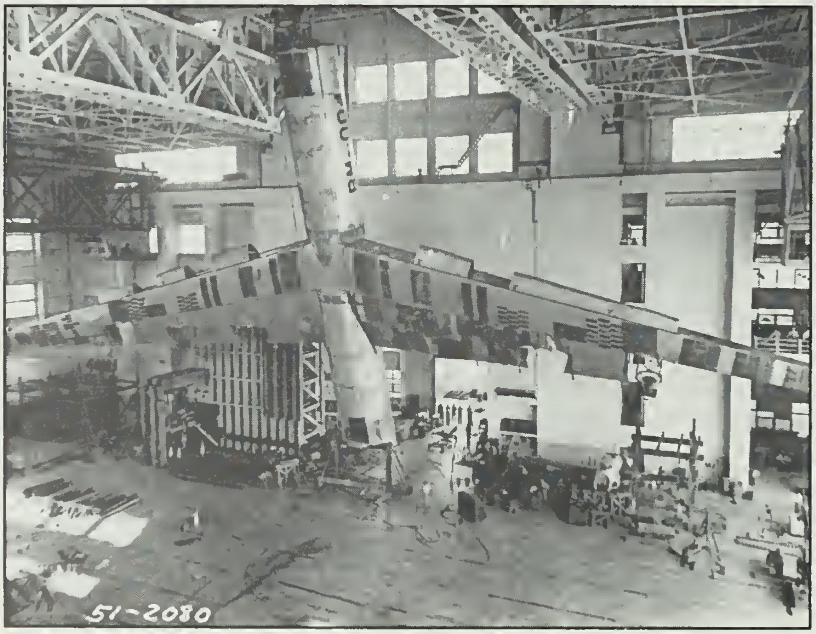

Figure 9: B-36 undergoing test in Building 65. (USAF)

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[79] McMurtrie (1942), 168-169.

[80] "History of McCook and Wright Fields," unpublished manuscript in ASD History Office (no date), 5.

[81] Fine and Remington, 619-621; "Annual Report 1940," 8; Walker and Wickam, 148-149.

Laboratory (Building 4); and twin Flight Test and Modification Hangars (Buildings 1/9). The Air Corps had developed a "Standardized Air Corps Hangar and Repair Building," designed for "economy of fabrication, rapid erection, and possible reuse," to accommodate the great number of new airfields, but the work done at Wright Field was too unusual and varied to utilize this structure.[82] Instead, the difficulties of quickly building large (160-foot) clear span structures, to be used in all weather conditions, were addressed with concrete frame construction methods.

Concrete answered the construction needs of the Materiel Command across wartime Wright Field. Not only was concrete extremely adaptable for large or unusual forms, such as hangars, test rigs and wind tunnels; it was also easily made from widely available materials and with little skilled labor. Army engineers designed structures, and private builders from Ohio and neighboring states built them. Two new, L-shaped administration buildings (Buildings 14 and 15) were erected of concrete almost immediately. The Flight and Modification Test Hangars (Buildings 1/9: a double hangar with an attached operations tower and test office annex) followed. New torque stands (Buildings of the 18 and 71 series), frame covers for firing ranges (Building 22B), and the cold chamber for a new wind tunnel (Building 25) were also built in concrete, but the acoustical enclosure for the main propeller test rigs (Building 20A) presented particular structural challenges. The enclosure had to baffle sound, yet not impede airflow. The solution was found in hollow concrete tubes, laid end-to-end and one atop the other to create a 24-foot-thick wall around the rigs.

The work of Wright Field's laboratories during the war reflected the plans and experiences of Army Air Forces combat operations. Successes and failures experienced by pilots in the field were quickly and carefully reported back to the Engineering Division, which, in the middle of the war, worked on an average of 43 aircraft at any given time.[83] In addition to the quest for airplanes of greater horsepower and maneuverability, significant wartime research projects addressed pressurized cabins for fighter airplanes and the B-29 "Superfortress," the Army's first pressurized-cabin bomber; the refinement of rotary wing aircraft; controllable bombs; anti-icing equipment; and new fuel tanks and methods of in-flight refueling. In keeping with the Air Corps' long-standing approach to aeronautical engineering, specialized laboratories worked on problems in their area of expertise, but in constant association with each other, and with laboratories elsewhere in the public and private sector.

The Engineering Division's Aircraft Laboratory pursued new "low-drag" wings, experimented on jet-propulsion motors of both solid- and liquid-burning types, and expanded the Army's extensive program for the conservation of materials in airplane construction. The Power Plant Laboratory, working in conjunction with contractors, developed higher horsepower engines for fighter and bombardment aircraft, high-output superchargers, leakproof fuel tanks and high-octane fuels. These advancements facilitated the creation of Boeing's B-17 Flying Fortress, a major contributor to American offensive action. Winterization, a problem of concern to the Navy, NACA and the National Bureau of Standards, was also a subject of Power Plant Laboratory work at Wright Field. The Propeller Laboratory joined this anti-icing research, working with the Frigidaire Corporation. Other

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[82] "Hangar-Repair Shop for the Air Corps," Engineering News-Record 127, n.17 (October 23, 1941), 112.

[83] Bennett E. Meyers, "History of the Army Air Forces Materiel Command 1943," 5-6.

Propeller Laboratory projects included a large-diameter propeller for use on bomber type airplanes, and work on dual-rotation propellers (in which two sets of blades turn at the same time but in opposite directions). The emphasis here was on aircraft maneuverability as demanded by combat situations, rather than on sheer speed.[84]

In all areas, the Wright Field laboratories were aided by new testing facilities of the highest caliber, particularly the much-publicized 20-Foot Wind Tunnel (Building 24), erected in 1941 and 1942, a hallmark of the Materiel Command's engineering work.

The new wind tunnel was, as one of many contemporary magazine reports put it, "truly colossal."[85] The 20-Foot Tunnel could accommodate test models with wingspans up to 16 feet, full-size fuselages, and engine-nacelle-propeller combinations. Its two fans, each with sixteen meticulously constructed spruce blades, created gusts of 400 miles per hour that rushed through a solid steel, cone-shaped shaft. The air was recirculated through the tunnel for maximum efficiency, but the 40,000 horsepower alternating-current induction motor that turned the fans consumed so much power that the local power company had to be given advance notice when the tunnel was to be used. The testing instruments themselves were housed in a 68-foot-high reinforced-concrete building, where technicians could observe and calibrate the behavior of models inside the tunnel.[86]

Built at a cost of $2,500,000, the 20-Foot Wind Tunnel offered Wright Field engineers the possibility of testing flight technologies under highly controlled conditions. It was part of a trend toward tunnels with higher wind velocities that could approximate the flying conditions of new, faster aircraft, and the sophisticated culmination of a long line of wind-producing experimental tools.[87] This tunnel, and many others built in the U.S. and abroad in this century, were effective in testing the effect of design changes on airplane drag, stability, and maneuverability at far lower costs than would the building of full-size prototype airplanes.[88]

Despite its impressive specifications, Wright Field's new wind tunnel did not replace the Engineering Division's 14-Inch or 5-Foot tunnels. Nor did it threaten the usefulness of Langley Field's 16 wind tunnels. The need for Wright Field's new tunnel emerged simply because no one kind of tunnel could provide information on all aeronautical questions, no matter how powerful. A small tunnel, such as the Army's 14-inch example, could produce very high wind speeds but hold only very small models and parts. A large tunnel, such as the one at Langley capable of testing full-sized prototypes, would not be suitable for testing the effects of "air compressibility" on planes because it could only simulate low air speeds. Variable-density wind tunnels--of which England, Germany,

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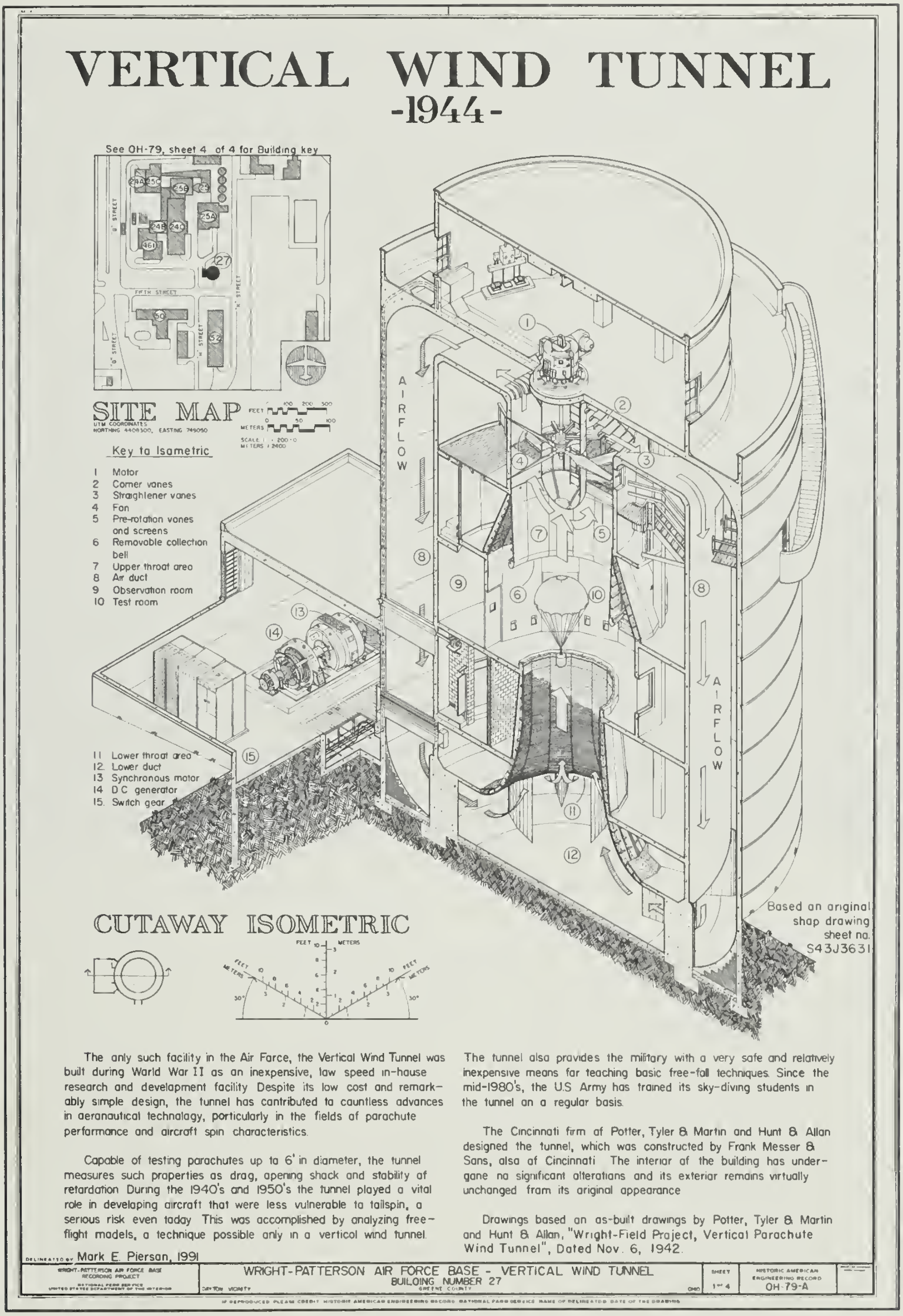
[84] Edwin R. Page, "Power Plants and Propellers," Flying and Popular Aviation, (September 1941), 116, 158.

[85] "Wind Tunnels...Birthplace of Streamlining," Westinghouse Engineer 1, n.3, (November 1941), 70.

[86] "Birthplace of Streamlining...," 70-71; "Wright Field Wind Tunnel," Society of Automotive Engineers Journal 85, n.10 (15 May 1941), 511, 555; "Army Air Corps Builds 400-mile-an-hour Wind Tunnel," Popular Science 140, n.5 (May 1942), 63.

[87] Donald Baals and William R. Corliss, Wind Tunnels of NASA (Washington, DC: National Aeronautics and Space Administration, 1981), 1-2.

[88] Baals and Corliss, 2; "Birthplace of Streamlining," 67.



VERTICAL WIND TUNNEL

-1944-

Key to Isometric

1 Motor
2 Corner vanes
3 Straightener vanes
4 Fan
5 Pre-rotation vanes and screens
6 Removable collection bell
7 Upper throat area
8 Air duct
9 Observation room
10 Test room
11 Lower throat area
12 Lower duct
13 Synchronous motor
14 D.C. generator
15 Switch gear

The only such facility in the Air Force, the Vertical Wind Tunnel was built during World War II as an inexpensive, low speed in-house research and development facility. Despite its low cost and remarkably simple design, the tunnel has contributed to countless advances in aeronautical technology, particularly in the fields of parachute performance and aircraft spin characteristics.

Capable of testing parachutes up to 6' in diameter, the tunnel measures such properties as drag, opening shock and stability of retardation. During the 1940's and 1950's the tunnel played a vital role in developing aircraft that were less vulnerable to tailspin, a serious risk even today. This was accomplished by analyzing free-flight models, a technique possible only in a vertical wind tunnel.

The tunnel also provides the military with a very safe and relatively inexpensive means for teaching basic free-fall techniques. Since the mid-1980's, the U.S. Army has trained its sky-diving students in the tunnel on a regular basis.

The Cincinnati firm of Potter, Tyler & Martin and Hunt & Allan designed the tunnel, which was constructed by Frank Messer & Sons, also of Cincinnati. The interior of the building has undergone no significant alterations and its exterior remains virtually unchanged from its original appearance.

Drawings based on as-built drawings by Potter, Tyler & Martin and Hunt & Allan, "Wright-Field Project, Vertical Parachute Wind Tunnel", Dated Nov. 6, 1942.

DELINEATED BY Mark E. Pierson, 1991

WRIGHT-PATTERSON AIR FORCE BASE RECORDING PROJECT
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

WRIGHT-PATTERSON AIR FORCE BASE - VERTICAL WIND TUNNEL
BUILDING NUMBER 27
DAYTON VICINITY GREENE COUNTY OHIO

SHEET 1 OF 4

HISTORIC AMERICAN ENGINEERING RECORD
OH-79-A

IF REPRODUCED PLEASE CREDIT: HISTORIC AMERICAN ENGINEERING RECORD, NATIONAL PARK SERVICE, NAME OF DELINEATOR, DATE OF THE DRAWING

Figure 10: Vertical Wind Tunnel, Building 27, 1944. (Delineated by Mark E. Pierson, HAER, 1991)

M.I.T. and Langley had examples--could be used to address that question with great precision. Before the end of World War II, the Army Air Force itself augmented Wright Field's 20-Foot Tunnel with a 10-Foot Tunnel (Building 25) that could reproduce altitude pressures or temperatures. In 1944, a Vertical Wind Tunnel (Building 27) was built to assess airplane spin characteristics, and perform helicopter and parachute tests. An 80-foot-tall concrete tower contained a 12-foot cylinder through which a powerful airstream was sent. Observations of the behavior of scale models, and then of human test subjects, were conducted from a recessed balcony halfway up the test section. This wind tunnel is still in use today, standing near the other tunnels in an area appropriately nicknamed "Hurricane Hill."[89]

As the Engineering Division worked on the design of aircraft, other research problems emerged that required rapid solution. The Materials Laboratory developed new finishes for plywoods and other materials that had substituted for the more desirable substances used in peacetime construction. The development of synthetic rubber was particularly important during the war. The Equipment Laboratory augmented the work of aircraft designers with new radio applications, including target-seeking equipment that could respond to light, heat, sound, or reflected radar beams. Their work conjoined with that of the Armament Laboratory on rocket-propelled projectiles, and radar detection systems.[90]

The Engineering Division's Photographic Laboratory created improved cameras, lenses, and flash units to facilitate aerial photography, which was finding increased applications for combat reconnaissance and for the assessment of foreign industrial strength.[91]

Two experimental units at Wright Field attained a new degree of autonomy as the conditions of war dictated their rapid expansion: the Technical Data Section, and the Aeromedical Research Unit. Technical Data became an independent laboratory when it was realized that most of its editing, publishing and translation work, as well as the Technical Data Library itself, actually "had greatest utility for the Experimental Engineering Section."[92] Its responsibilities included the creation of training films for use at Wright Field and at other Army Air Forces posts, and the analysis and recording of much of the Division's experimental work. The data produced at Wright Field laboratories found audiences at many other institutions, yet had to be handled with high security awareness. In addition to the Technical Data Digest, all technical reports of the Materiel Center, and Army Air Forces Information Circulars--together representing thousands of carefully edited pages--the unit also produced important public materials, including booklets of silhouettes of U.S. and foreign aircraft drawn to a uniform scale.[93]

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[89] Baals and Corliss, 2; "New Materiel Command Wind Tunnel Being Built," press release from HQ.AAF Materiel Command, May 16, 1944; "Vertical Wind Tunnel," Electrical Engineering 65, n.6 (June 1946), 265-266.

[90] McMurtrie (1942), 134-141.

[91] McMurtrie (1942), 140.

[92] McMurtrie (1942), 112.

[93] McMurtrie (1942), 112-114, 145-6.

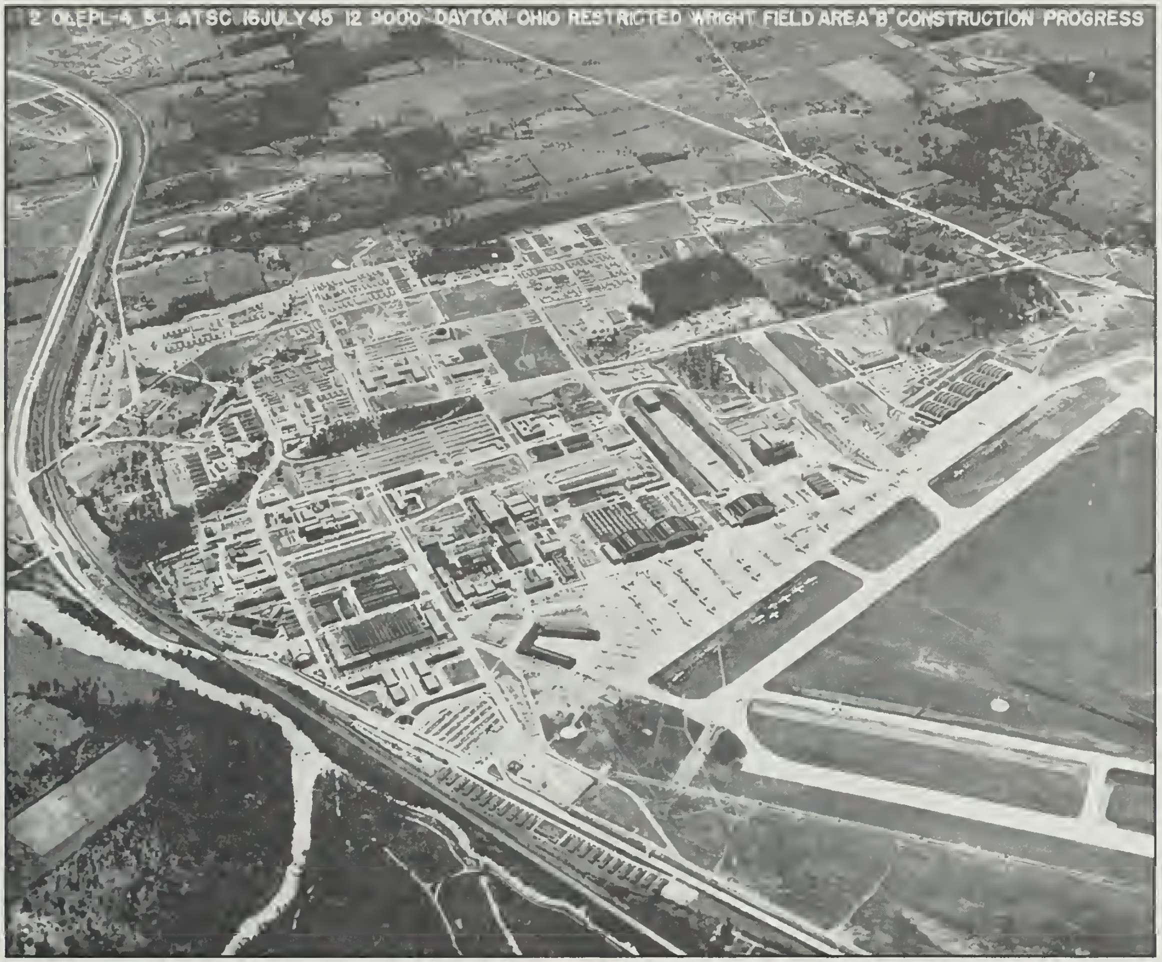

Figure 11: Wright Field, 1945. (USAF)

The Aeromedical Laboratory became an independent unit at Wright Field in 1942, with three subdivisions: Physiological, Biophysical, and Clinical Research. The work of this laboratory followed from improvements to military aircraft that brought greater speeds and altitude, and hence greater stresses on flight personnel. The effects of explosive decompression on air crews caused by the use of the new pressurized cabins were studied with complex equipment. A low-pressure chamber could imitate the decompression a subject experienced from ground level to 40,000 feet in less than 30 seconds; faster when the subject was an animal rather than a human. Blood, respiration, and circulation changes were studied as well. To examine the risks of black-out in rapid climbs or descents, a human centrifuge subjected volunteers to greatly accelerated G-forces by placing them in spinning cockpits suspended from a central shaft. In work that found immediate application in fighter aircraft, the Aeromedical Laboratory also developed oxygen delivery systems that functioned on demand. Clothing appropriate for the very low temperatures of high-altitude flight, emergency rations, and sea water purification systems also emerged from the Aeromedical Laboratory before the end of World War II.[94]

Wright Field After World War II

By 1944, Allied successes were making an end to the war seem possible, and Army concerns about air power were taking on the shape they were to bear in peacetime. Two major trends emerged: the solidification of the Army Air Forces' strong desire to become an autonomous branch of the armed services, co-equal to the Army and Navy; and critical assessments of U.S. technological performance during the war. The first culminated in the creation of an independent U.S. Air Force in 1947. With the Army no longer holding control of military aviation, Air Force aeronautical engineering was more able to pursue the technological strategies it thought best. On January 13, 1948, Wright and Patterson Fields were officially merged to become Wright-Patterson Air Force Base.[95]

The idea that American air power was less technically advanced than that of the German forces strongly affected post-war military planning. In particular, the Germans' success with jet aircraft and guided missile technologies caused alarm, and called into question the whole United States wartime emphasis on aircraft production, rather than qualitative design improvement. A 1945 study by physicist Dr. Theodore von Karman, commissioned by U.S. Army General Henry "Hap" Arnold and titled "Where We Stand," pointed out that Germany's accomplishments were the product not only of excellent scientific personnel, but of substantial government support as well. In August 1945, President Harry Truman ordered the Army Air Forces to "initiate a program of research and development that would insure this country's supremacy in military aviation." The Army Air Forces' program of research and development for 1946 was actually conceived as the beginning of a 5-year plan that would redress the shortcomings of wartime aeronautical engineering.[96]

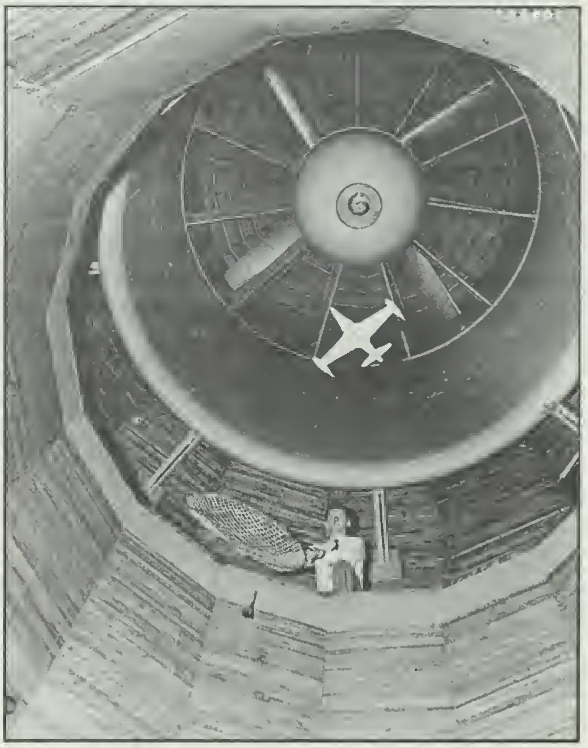

Figure 12: Model being tested in Vertical Wind Tunnel, ca. 1950s. (USAF)

A 1945 reorganization of the Engineering

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[94] McMurtrie (1942), 142-4.

[95] "Trends in Research...," 13.

[96] See Historical Division, Office of Information Service, "The First Five Years of the Air Research and Development Command, United States Air Force," 1955; Clarence J. Geiger, Michael H. Levy and Albert E. Misenko, Thunder in the Skies:The Aeronautical Systems Division and the Development of America's Air Arm, History Office, Aeronautical Systems Division, Air Force Systems Command, 1986, 5.

Division reveals the direction of Army Air Forces technological concerns. Four subdivisions were formed: "Service Engineering" (for the control of aircraft engineering and engineering standards); "Aircraft and Physical Requirements" (including aeromedical and materials units); "Propulsion and Accessories" (treating power plant, propulsion and armaments as a unified subject); and "Electronics" (representing four laboratories at Wright Field for airborne electronics and a fifth in New Jersey for ground systems, as well as radar, communications, navigation and other such functions). This organizational structure shows that propulsion and electronics had a new significance for the Army Air Forces. As the massive task of demobilization and the redirection of wartime industries proceeded, the Army Air Forces turned its scientific resources to cutting edge aeronautical research, taking over some of the fundamental work that had been the purview of private industry and the National Defense Research Council during the war.[97]

The trend toward consolidation during the war had resulted in the 1944 merger of research, procurement, and logistics functions (as represented by the Materiel Command at Wright Field and the Air Service Command at Patterson Field) to form the Air Technical Service Command (ATSC). At this juncture, Wright Field became known as "Area B," and portions of Patterson Field as "Area A." The ATSC became the Air Materiel Command in March 1946, at the same time that the Army Air Forces were creating other commands to deal with strategic, tactical, and air defense missions. The Air Materiel Command (AMC) had three major directorates--Research and Development, Procurement and Industrial Mobilization Planning, and Supply and Maintenance--with the Engineering Division constituting the largest section of the Research and Development unit. From 1946 until 1951, when the Air Research and Development Command (ARDC) became operational, the AMC supervised engineering activities at Wright Field.[98]

In tackling the problems of ever more powerful aircraft, the AMC addressed the difficulty of increasing mechanization in the air to reduce dependence on human efficiency. This called for research into mechanical, hydraulic, pneumatic, and electrical automatic devices for navigation flight control, engine adjustment, and armament use--processes which could become almost infinitely complex if they did not have to be directed by humans.[99]

The problem of jet propulsion was the other great task of Wright Field's engineers in the late 1940s. The Army Air Forces had done some experimentation with jet power during the war, notably on General Electric's XP-59A "Airacomet," test flown at Rogers Dry Lake in 1942. The Airacomet had a top speed of 415 miles per hour, but its range when fully loaded with armaments was only 525 miles. Jet engines could not completely replace conventional power plants because jets consumed huge amounts of fuel, making them impractical for long-range bombers given the technology of the time. Still, turbo-jet, gas turbine, and special fuels all received attention. The Army Air Forces worked closely with NACA, laboratories at the California Institute of Technology and Johns Hopkins, and other institutions in developing jet power. Government programs brought German scientists to work

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[97] Irvin R. Friend, "History of the Air Technical Service Command, 1945," 67; Walker and Wickam, 173.

[98] Walker and Wickam, 249; Albert E. Misenko and Philip H. Pollack, Engineering History 1917-1978: McCook Field to the Aeronautical Systems Division (Fourth Edition), History Office, ASD, 1978, xvi, 2-4.

[99] Friend (1945), 77.

in the United States in the late 1940s and 1950s, bringing some of the most advanced information available on jets to the Air Force's research. The jet engine program, undertaken in Wright Field's Building 18 complex, was headed by Dr. Hans von Ohain, inventor of the first jet engine to fly successfully.[100]

As jet technology became more and more complex, and Cold War initiatives escalated, propulsion became an increasingly important subject of Air Force research, gradually finding an almost autonomous standing. In 1957, the Propeller and Power Plant Laboratories were merged to form the Propulsion Laboratory. A separate Rocket Propulsion Laboratory was created at Edwards Air Force Base in 1959. In 1961, the Air Force Systems Command was formed to unite the development and procurement of new weapon systems under a single authority. Thirteen Wright Field laboratories were separated out from the Aeronautical Systems Division to function as a semi-autonomous unit reporting to their own division headquarters.[101]

Post-war developments in mechanization and jet propulsion brought with them newly sophisticated guided missiles. The "Pilotless Aircraft Branch" had been established in 1945, and the first such missiles to issue from Wright Field were combat-fatigued B-17s and B-24s that were loaded with TNT and more or less pointed at their targets by pilots who bailed out at the last minute. As mechanization and propulsion progressed, however, Air Force engineers developed reliable air-to-air, air-to-ground, and ground-to-ground technologies.

Much of the missile work was done in conjunction with other organizations, such as NACA. Interestingly, jurisdictional disputes arose within the armed services over what constituted "pilotless aircraft" and "guided missiles": Were control fins a type of wing? Did the Army or Navy Air Forces have exclusive rights to the use of wings? The difficulty of designating research tasks was heightened because the Engineering Division also suffered from a shortage of scientific personnel, and could only take on so much work. In addition to contending with the lingering effects of a wartime reduction in scientifically trained university graduates, the problem of competing with inflated private-sector salaries, and some ill feeling about working for the Army, many technicians believed that the Army's bureaucracy restrained initiative and burdened scientists with administrative duties.[102]

Gradually, the laboratories at Wright Field built up their staffs. The year 1946 saw three particularly important events at Wright Field. Pilots set two speed records--flying a Lockheed airplane with a jet engine, and a B-29--and the Aeromedical Laboratory enacted the first successful use of an ejection seat during flight.[103] During 1947 and 1948, Wright Field engineers erected the Radar Test Barn (Building 821). Known as "The Cathedral," this 200-foot-long structure was built of 13 parabolic arches, 78 feet high and with 80-foot spans. To create a space in which radar would not

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[100] Friend (1945), 74.

[101] Fred W. Oliver, Air Force Aero Propulsion Laboratory: Where the Airpower Comes From (WPAFB: Laboratory Operations Office, Air Force Propulsion Laboratory, Air Force Systems Command, 1974), 8.

[102] Friend (1945), 81.

[103] Walker and Wickam, 172.

"echo," the building was constructed entirely without metal. Under the guidance of Bill Bahret, Air Force radar engineers in the mid-1950s studied the relationship between radar and objects, developing "signature control technology" for radar evasion. The work of the Propagation Group, and later the Radar Test Laboratory, in Building 821 extended beyond the problems of aircraft detection to missiles and satellites, and the needs of the Army and Navy, as well.[104]

Among the projects developed by Wright Field engineers in the immediate post-war period were the propeller-driven XB-36 Peacemaker inter-continental bomber, and later the XB-52 and YB-52 Stratofortress combat-mission airplanes. By the time the Wright Air Development Center took control of Air Force research and development in 1951, B-36 research was mostly complete; the first production model flew in 1947 and subsequent modified versions were produced ending with model "J". In 1956 B-52 research was superseded by the B-70 program, which developed a bomber that could achieve speeds of Mach 3 at 75,000 feet, withstanding temperatures of up to 600°F.

As part of a program for hypersonic and extreme high altitude flight, the Air Force launched the X-15 project in 1955. The X-15 was conceived to be launched from a B-52 aircraft after which its engines would give a ninety-second thrust to take it to extreme velocity and altitude. The record high for the X-15 was 354,200 feet at a speed of 4,093 miles per hour in 1961.[105] In 1957 work began at Wright Field on an orbital vehicle named the X-20 Dyna-Soar, capable of maneuverable entry and conventional landing. To accommodate this project and the B-70 program, new ground test facilities were constructed in 1960 for simulation of aerospace flight. Work on the X-20 contributed to the development of the Space Shuttle.

As the subject matter of Air Force research shifted after World War II, so did the Air Force's articulated policy about its engineering work. The Air Force began to feel that it could no longer afford the "leisurely cycle of development, testing and production" that had characterized its earlier engineering efforts. From this perceived pressure came a series of new administrative practices that formalized the "systems" approach to engineering by creating "joint project offices."[106]

Working with von Karman's reports, the government's advisers identified cooperative research as a major component in the progress of German aeronautics, and in the few U.S. wartime projects that had been managed along cooperative lines: particularly the atomic bomb and radar technologies. They proposed that this systematic approach be built into Air Force administrative structures, guaranteeing the simultaneous development of related technologies, such as a carrier that could keep pace with advancements in atomic weapons, for example.[107]

Although presented as a new initiative, this arrangement echoed the structure of Wright Field's earliest researches: coordinated efforts among different laboratories. The scale of engineering

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[104] Ibid.

[105] Ibid.

[106] Misenko and Pollack, 18-19.

[107] "The First 5 Years...," 12.

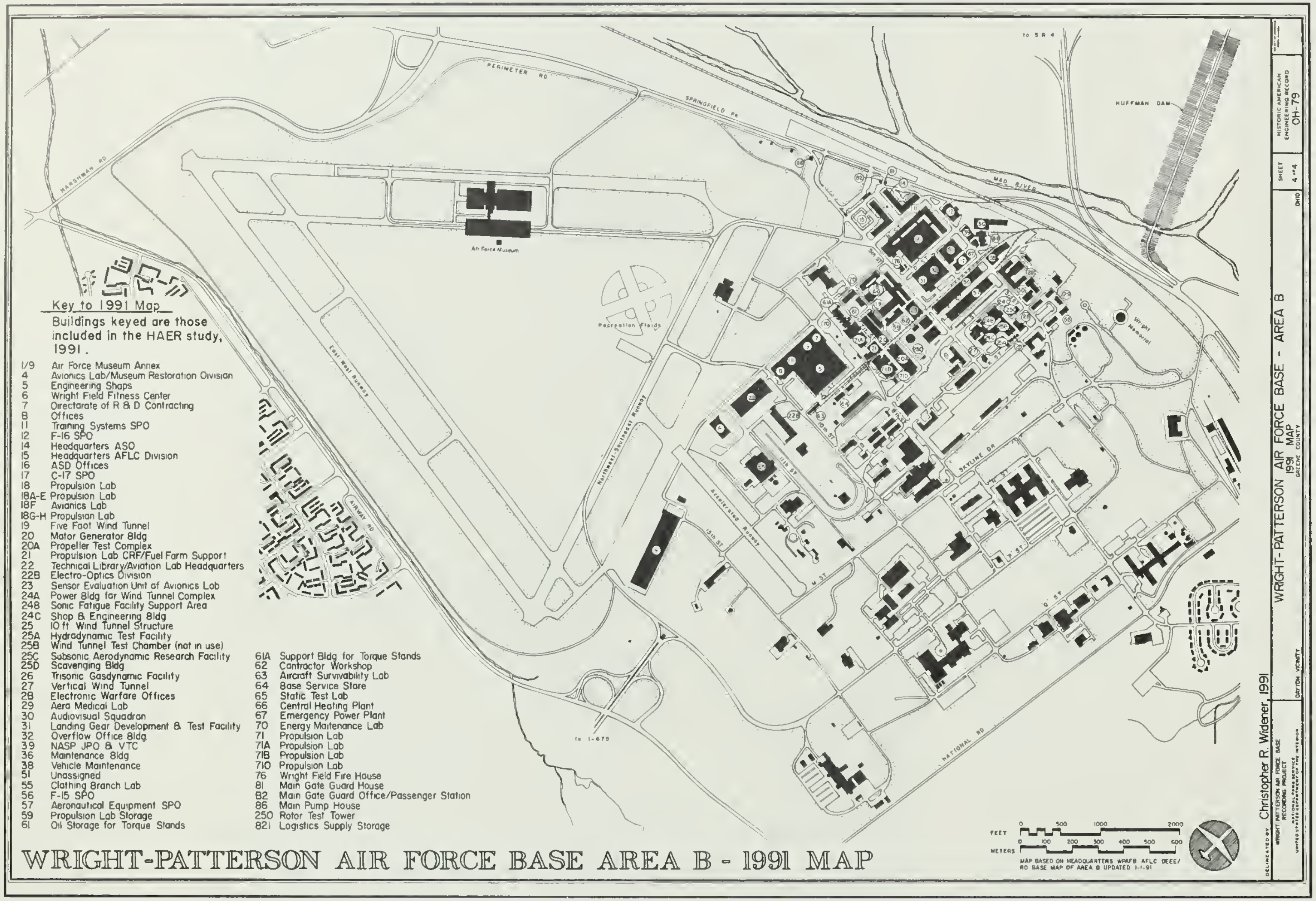

Figure 13: Wright-Patterson Air Force Base, Area B-1991 Map. (Delineated by Christopher R. Widener, HAER, 1991)

research in the late 1940s and 1950s was much greater than that of the 1920s and 1930s, of course, and required larger managerial frameworks. The technologies associated with the creation of a single kind of aircraft, component, or weapon multiplied, and as more efficient organizations were formed to accommodate this growth, even more complex technologies came about.

Conclusion

The history of aeronautical engineering at Wright Field encompasses many very visible changes, and many underlying and significant consistencies that give it its character. When the War Department established McCook Field in 1917, it could not have foreseen the tremendous numbers of technological advancements and new areas of inquiry that arose, and the numbers of personnel and facilities these advancements would engender. Great numbers of organizational changes surrounded military aeronautical engineering in the following decades. By 1952, Wright Field had undergone approximately 24 major reorganizations, or an average of one every seventeen months.[108] But as technologies and experimental methods superseded each other, many general philosophies held true, unaffected by organizational shifts. A desire to share information among laboratories and disciplines, and between military and public sectors has always been present in the engineering programs of the air services. An ability to adapt research programs to changing budgetary conditions and social pressures, without sacrificing extremely high scientific standards, can be seen as well. Finally, one sees the willingness to invent new scientific experimental methods or equipment where existing analytical tools are not adequate. These priorities have allowed the aeronautical engineers of Wright Field to bring about countless technological advances for military and commercial aviation. The buildings of Area B, Wright-Patterson Air Force Base, today offer a site in which to study and appreciate these unique methods and achievements.

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[108] Report, USAF R & D Manpower Requirements, Survey Gp, WADC, 15 May 1952, 1 (cited in Misenko and Pollack, 1).

INVENTORY OF HISTORIC STRUCTURES, AREA B, WRIGHT-PATTERSON AIR FORCE BASE

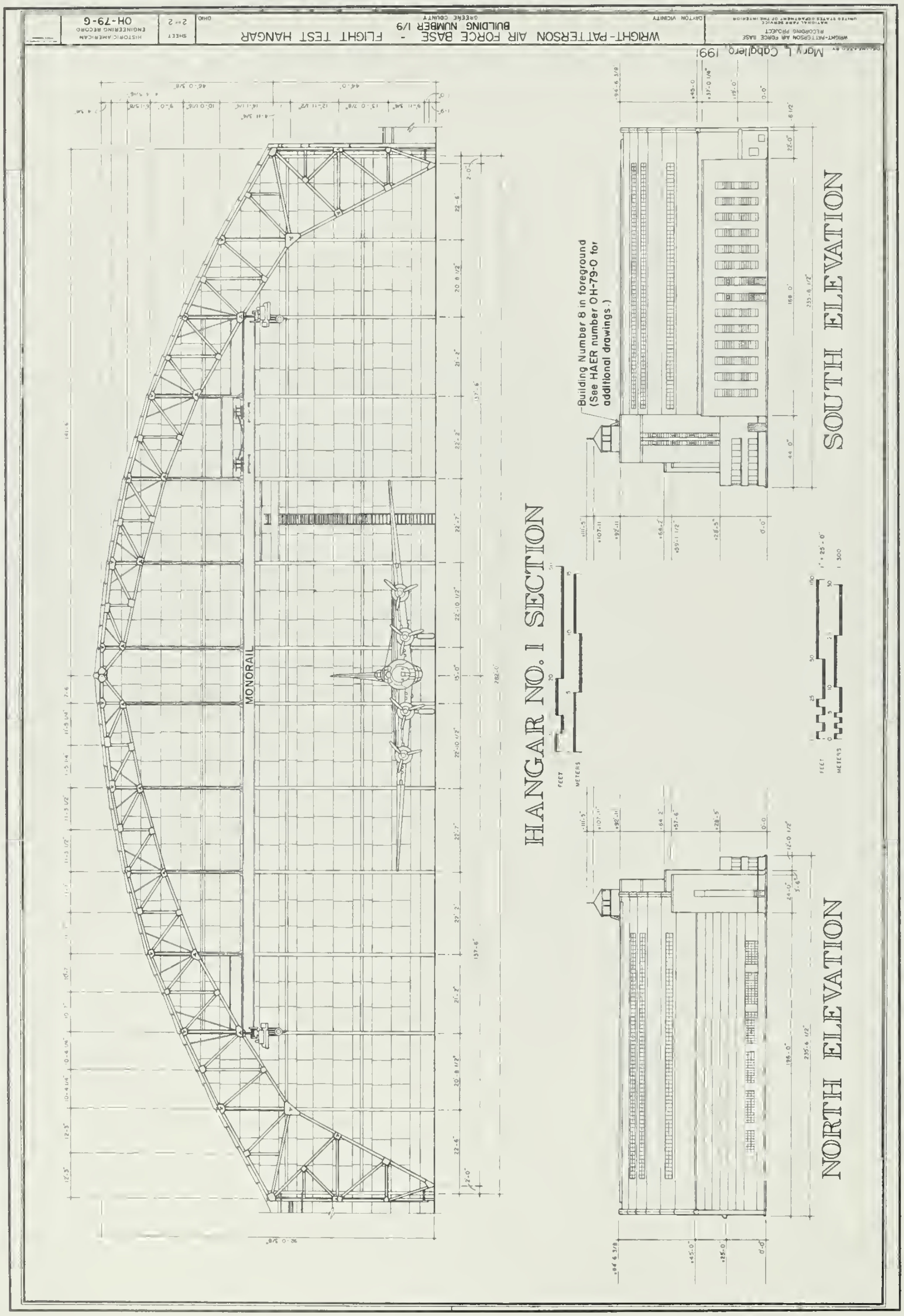


Figure 14: Flight Test Hangars, Buildings 1/9, 1943. (Delineated by Mary L. Caballero, HAER, 1991)

BUILDINGS 1/9: FLIGHT TEST HANGARS

HAER No. OH-79-G

Construction Date: 1943

DESCRIPTION: Adjacent hangars 1 and 9 are virtually identical structures. Constructed from steel-reinforced concrete, they each have a three-hinged barrel-vault roof with exposed composite trusses (compression members of wood and tension members of steel) covering clear spans of 275', and each has concrete towers on the corners. The hangars are 191' deep and 593' wide, with ceilings 90' high at the center. The main doors are 250' wide and 38' high, with metal-framed windows. The area above the door is faced with corrugated asbestos metal. Hangar 9 has a large rear door connecting it to Building 5 which originally housed support facilities.

HISTORY: Built in 1943, Hangars 1 and 9 anchor the World War II era flightline building complex, which also includes Building 5 (Engineering Shops) and Buildings 7 and 8 (offices). The buildings were designed by the U.S. Army Quartermaster Corps and constructed by the National Concrete Fireproofing Company.

Hangar 1 was built as "Flight Test Hangar No. 1," and Hangar 9 as "Experimental Installation Hangar No. 9." Early in the war, the Air Corps had developed a standardized hangar and repair shop building that could be quickly and inexpensively erected at its new airfields. These simple structures could be disassembled and reused elsewhere if required. The wartime hangars at Wright Field, however, were intended as more permanent and specialized buildings. They could accommodate experimental aircraft of unusual size and shape.

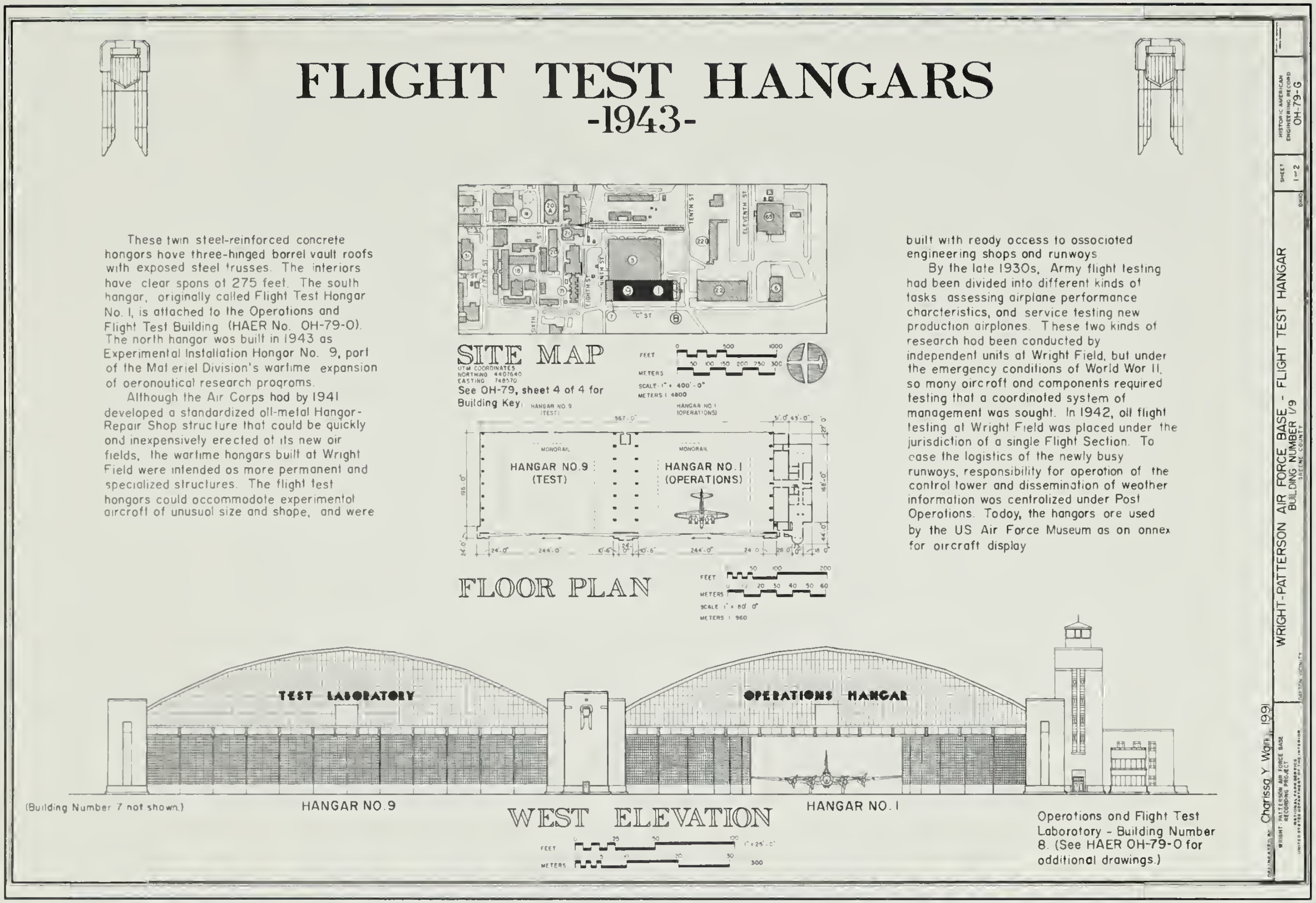
Army flight testing during World War II followed the general form it held before the war, divided between assessing airplane performance characteristics and service testing of new production airplanes as they came off the manufacturers' assembly lines. These two kinds of research had been conducted by independent units at Wright Field but, under the emergency conditions of the war, so many aircraft required testing that a more coordinated system of management was sought. In 1942 all flight testing at Wright Field, no matter what its purpose, was placed under the jurisdiction of a single Flight Section. At the same time, responsibility for coordinating the use of the Field's runways, monitoring adherence to flight regulations, and disseminating weather information was centralized under Post Operations.

The twin hangars face the NW-SE runway, which was built with the E-W runway in 1941-42 to replace the grass runways formerly used. The third leg of the triangle runway was built in 1944. These new concrete runways were among the first in the country and, for lack of more pertinent guidelines, they were built to Ohio highway specifications. The paved runways were necessary for the new heavy bombers under construction and in the planning stages during the war, while the hangars housed aircraft modification and flight test facilities. The modification work that took place in Hangar 1 was supported by the shops in Building 5. The two buildings were connected by a doorway at the back of the hangar. Today the hangars are used by the United States Air Force Museum as an annex for aircraft display.

For sources, see Bibliography on page 215.

Figure 15: Hangars 1/9 complex, 1952. (USAF)

Figure 16: Hangars 1 and 9, center, and Building 7 on left and Building 8 on right, 1991.



These twin steel-reinforced concrete hangars have three-hinged barrel vault roofs with exposed steel trusses. The interiors have clear spans of 275 feet. The south hangar, originally called Flight Test Hangar No. 1, is attached to the Operations and Flight Test Building (HAER No. OH-79-O). The north hangar was built in 1943 as Experimental Installation Hangar No. 9, part of the Materiel Division's wartime expansion of aeronautical research programs.

Although the Air Corps had by 1941 developed a standardized all-metal Hangar-Repair Shop structure that could be quickly and inexpensively erected at its new air fields, the wartime hangars built at Wright Field were intended as more permanent and specialized structures. The flight test hangars could accommodate experimental aircraft of unusual size and shape, and were built with ready access to associated engineering shops and runways.

By the late 1930s, Army flight testing had been divided into different kinds of tasks assessing airplane performance characteristics, and service testing new production airplanes. These two kinds of research had been conducted by independent units at Wright Field, but under the emergency conditions of World War II, so many aircraft and components required testing that a coordinated system of management was sought. In 1942, all flight testing at Wright Field was placed under the jurisdiction of a single Flight Section. To ease the logistics of the newly busy runways, responsibility for operation of the control tower and dissemination of weather information was centralized under Post Operations. Today, the hangars are used by the US Air Force Museum as an annex for aircraft display

Figure 17: Flight Test Hangars, Building 1/9. (Delineated by Charissa Y. Wang, HAER, 1991)

BUILDING 4: MODIFICATION HANGAR AND FLIGHT RESEARCH LABORATORY

HAER No. OH-79-H

Construction Date: 1944

DESCRIPTION: Located at the south end of the Wright Field flightline, Building 4 is an all-concrete structure consisting of five large bays (A through E), and an attached administration section.

The five hangar bays are each 220' long with a clear span of 160', covered by a barrel shell concrete roof, 3" thick and 45' high in the center. On the roof and behind the front overhang, six main stiffening ribs are exposed, measuring 6' 3" in depth, and 2' in width at the crown. Secondary stiffening arches 20" deep and 12" wide are located halfway between the main ribs. The interior ceilings are smooth, which facilitated the use of moveable forms in the building's construction. They also provide light-reflective surfaces. The hangar doors are each 25½' high with a tail door at the top to provide an extra 12' for the entry of large bombers and cargo aircraft. To support the weight of these large aircraft, the concrete floor slab is 8" thick in the 60'-wide center strip, and 7" thick in the 50'-wide side strips.

The hangar doors have steel-sashed, wire-reinforced, multi-paned glass windows. The original windows above the hangar doors have been covered with sheet metal. Between the bays are partitioned spaces 27½' wide which run the full length of the hangars. These have office-type doors and are divided into such areas as offices, storage rooms, and restrooms.

A two-story, rectangular structure (Building 4F) constructed of concrete block with a stucco exterior is attached to the northernmost hangar bay (4A).

HISTORY: Building 4 was built in 1944 for aircraft modification and flight research. It was designed by Roberts and Schaefer Company of Chicago, Illinois, and constructed by Starrett Brothers, Inc. and Michael Pontaretti & Sons, also of Chicago.

Preliminary plans called for wood construction since structural steel was not available for construction during the war. However, the well-seasoned lumber required for this durable structure was quite expensive, and investigation revealed that an all-concrete composition would compare favorably in cost and would reduce the danger of fire.

Movable forms supported construction of the barrel-shell hangar roof; these forms were 84' long, and two sets were used so that work could proceed on two hangars simultaneously. The falsework supporting the roof forms had wheels that ran on rails placed on top of the floor slab. The forms were moved twice for each hangar, and the three sections of each hangar were connected by expansion joints.

Much of this construction project occurred during the winter, requiring a heating system to dry the concrete. The falsework had unit heaters built in, and a canvas cover supported by light wooden framing covered the outer roof. Holes in the roof slab permitted warm air to enter the space between the slab and canvas cover.

With World War II at its peak when construction of Hangar 4 was completed, the Flight Research Laboratory occupied it immediately. Wright Field pilots were responsible for conducting flight tests on new aircraft designs. They flew each aircraft for up to 200 hours and determined maximum speed, range, rate of climb, and altitude ceiling, and the minimum safe distance for landing and take-off. Because the new aircraft needed to be mass-produced immediately, these were called accelerated tests and, to examine more airplanes quickly, they were also conducted at nearby Patterson Field and at Dayton Army Air Field in Vandalia, Ohio. Engineers obtained additional information on fuel consumption, pilot safety, and the performance of instruments through the flight tests.

Aircraft mechanics working in the bays of Hangar 4 altered and modified the airplanes to eliminate weaknesses, improve performance, and install experimental equipment. Hangar 4 was isolated at the end of the flightline because information concerning the experimental aircraft and equipment was often classified. Captured enemy aircraft were also secretly tested and investigated at Wright Field during and after the war.

The cessation of hostilities in 1945 allowed personnel working in Hangar 4 to relax their frenetic pace. For many months after the war, Bay A was not used because of damage from a plane crash early in 1945. Bay E hosted the Army Air Force's Flight Test School briefly before it moved to Edwards Air Force Base in California.

Experimental aircraft modification work continued in Bays A and B until the early 1960s and in Bays C, D, and E until the early 1970s. By that time modern military aircraft were growing too large for both Hangar 4 and the Wright Field (Area B) airstrips. In 1962 the Air Force Orientation Group (AFOG) began using Bays A and B to prepare aircraft for public display. AFOG developed from a 1945 order by General Henry H. "Hap" Arnold to capitalize on the overwhelmingly positive public response to the Army Air Forces Fair held at Wright Field in October of 1945. AFOG personnel subsequently travelled across the country and around the world displaying aircraft and emphasizing the significance of the United States Air Force. This public relations and recruiting assistance program moved its headquarters to Gentile Station in Dayton, Ohio in 1981.

In the 1980s Bays A and B were reassigned to the Avionics Directorate of the Wright Laboratory which returned portions of those bays to the security of former days. Here the Avionics Directorate operates a radar range, laser laboratory, and anechoic chamber. The anechoic chamber has walls, ceiling, and floor covered with wedges of a material that absorbs radio frequencies. This arrangement almost eliminates echoes from the chamber's structure to enable radio frequency research to be conducted in an environment simulating flight, where spurious signals disappear into oblivion. In a normal room, radio signals would reflect many times before absorption by the walls and thus confuse receiving instruments. A taut wire mesh stretched above the floor supports personnel and equipment.

In 1973 the United States Air Force Museum, located on the opposite side of the former flying field, began using Bays C, D, and E for aircraft restoration and preparation of displays for the museum. Bay C contains an exhibit area, where wall displays and free-standing exhibits are planned and prepared. In Bay D mechanics restore and preserve aircraft for museum display. Bay E is used to store artifacts not currently on view in the museum. The office block attached to the northernmost hangar now houses offices for the 4950th Test Wing Resource Management and Aeronautical Systems Center Logistics Support.

For sources, see Bibliography on page 215.

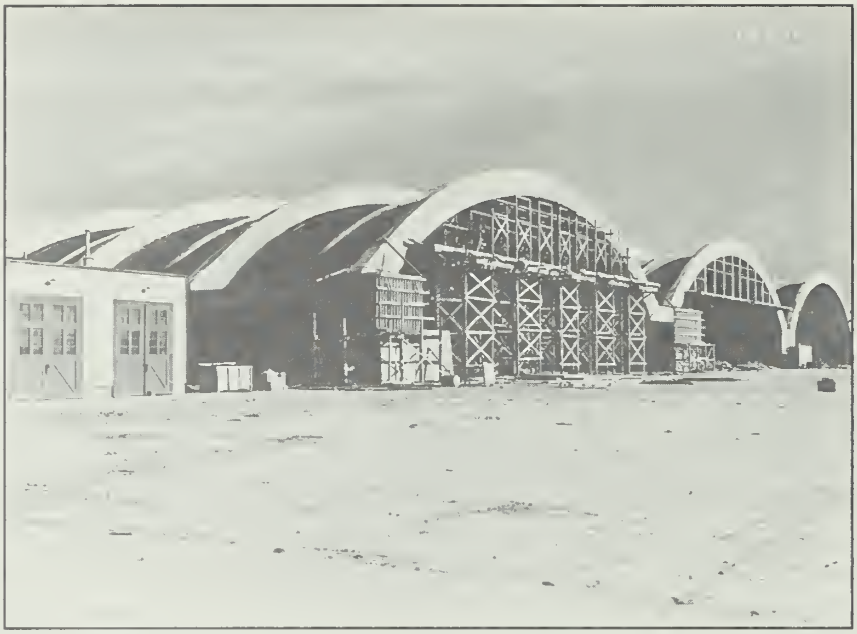


Figure 18: Building 4 under construction, 1944. (USAF)

Figure 19: The five hangar bays of Building 4, looking north, 1991.

Figure 20: Interior view of one of the hangar bays, Building 4, 1991.

Figure 21: Hangar doors, Building 4, 1991.

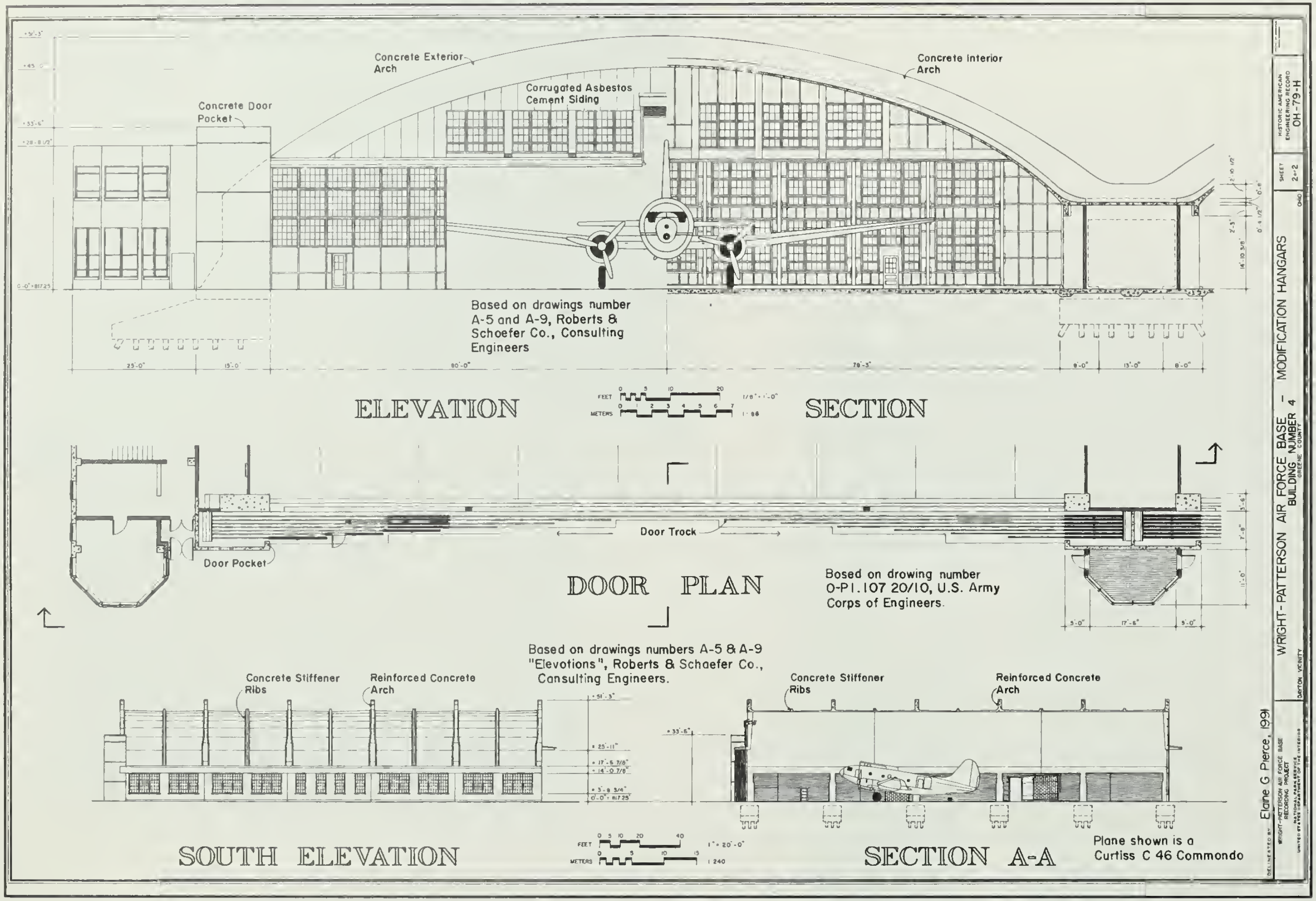


Figure 22: Modification Hangars, Building 4, 1944. (Delineated by Elaine G. Pierce, HAER, 1991)

BUILDING 5: ENGINEERING SHOPS

HAER No. OH-79-L

Construction Date: 1943

DESCRIPTION: Connected to the east side of Hangar 9, away from the flying field, Building 5 is a square one-story building, measuring 360' x 420', with a nine-section barrel-vaulted roof. Over each 40' vault is a long gable-style skylight admitting natural light down to the original wood-block floors below. The barrel vaults are evident in the exterior of the poured-concrete east wall of the building, above a row of steel-sash windows that replaced the original windows in 1984. In 1953 and 1954 the building was extended to the south to incorporate Building 72 (the foundry) into the Engineering Shops. Also in 1954 a two-story covered craneway running east and west was added to provide access for heavy freight and equipment using the railroad spur on the east side of the building.

HISTORY: Building 5 was constructed in 1943 as part of the expanded Wright Field World War II flightline complex. The structure was designed by the U.S. Army Quartermaster Corps and constructed by the National Concrete Fireproofing Company. Columns and roof barrels were constructed first; falsework mounted on rails supported the barrel forms. Plywood sheathing was bent to create the curve of the barrel vaults which were reinforced by a stiff concrete mix to an average thickness of 4".

The building served as the new engineering shops facility to accommodate functions previously conducted in the metal, machine and wood shops (Building 32) which were at a considerable distance from the flightline and the new hangars. Although the Area B (Wright Field) runways are no longer used, Building 5 still serves as a shop facility for the 4950th Test Wing. Technicians construct models of prototype aircraft from metal, wood and fiberglass for wind tunnel testing, both at Wright Field and other Air Force bases such as Langley. Approximately 75 percent of Air Force model makers are employed here. Models developed in the past decade include the F-111 and the Space Shuttle.

For sources, see Bibliography on page 215.

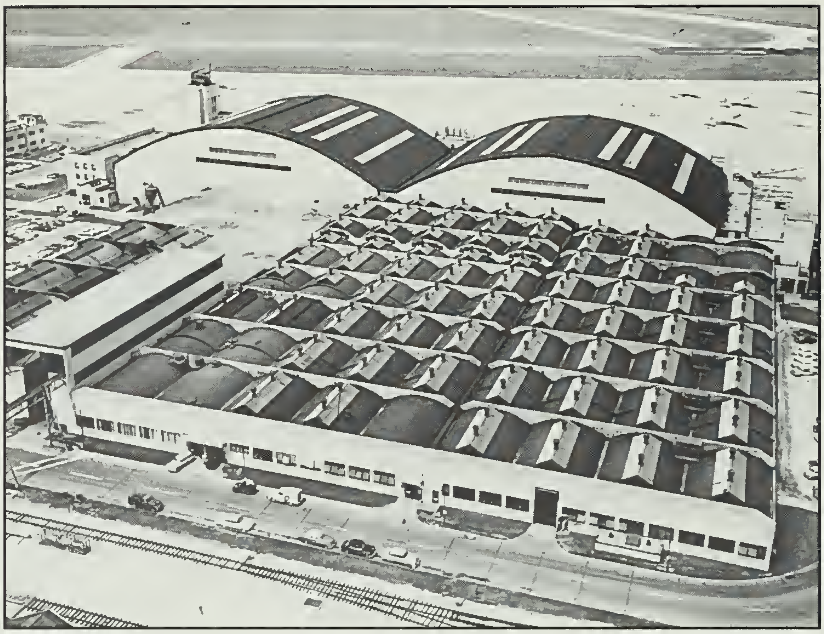


Figure 23: Building 5, c. 1950s (after 1954). (USAF)

Figure 24: Building 5, showing craneway, 1991.

BUILDING 6: SIGNAL CORPS SPECIAL FORCES HANGAR

HAER No. OH-79-M

Construction Date: 1943

DESCRIPTION: The Signal Corps Special Forces Hangar is a steel-frame concrete structure of 55,161 square feet, with a five-section, barrel-vaulted roof and interstitial columns. The north end has two rows of steel-sashed, factory-style, tilt windows across the whole facade. The west side consists of telescoping multi-paned wire-reinforced glass and metal hangar doors, with rectangular concrete towers at each end. A rectangular concrete building is attached to the east side of the hangar, providing 5,302 square feet of office space.

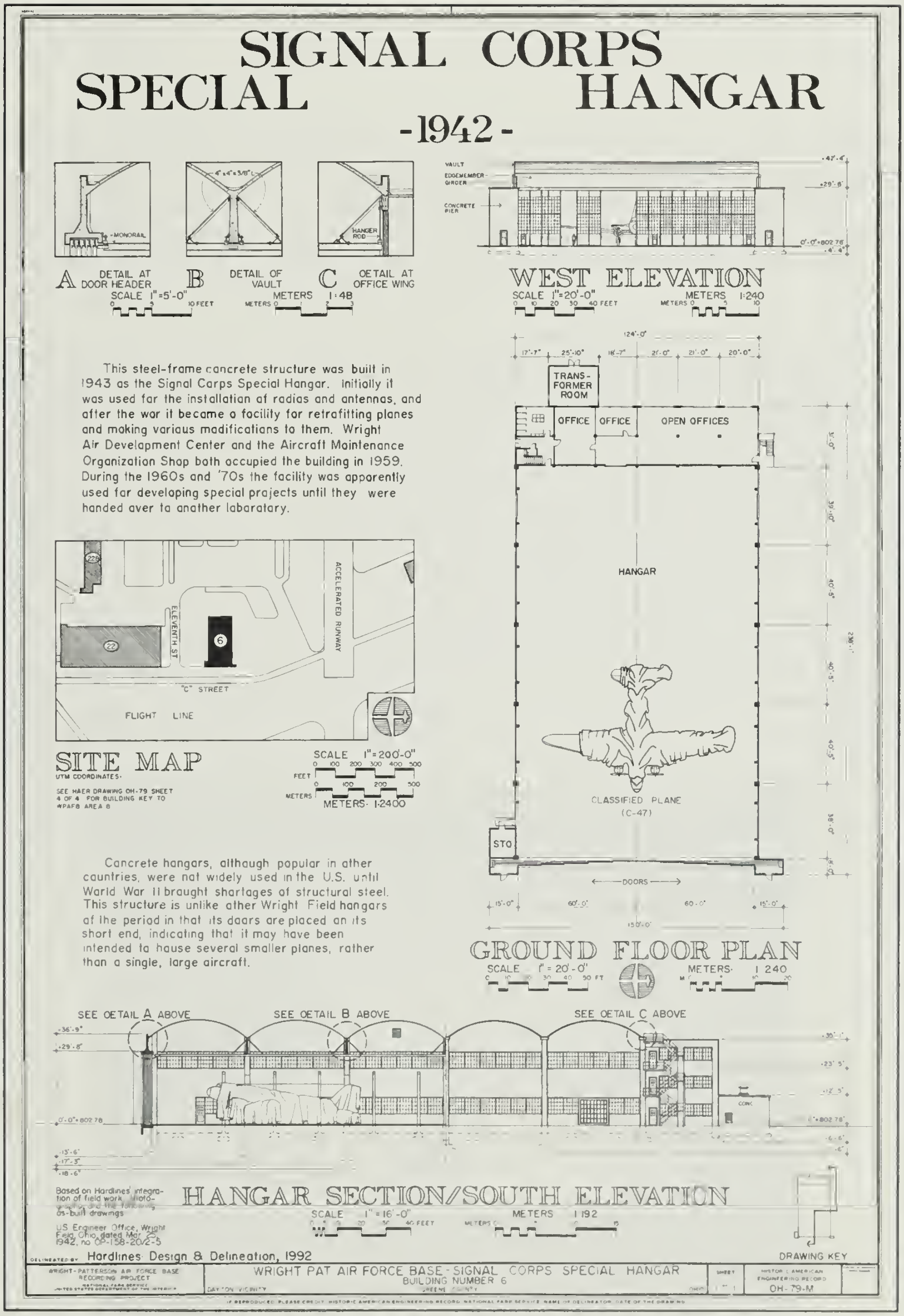
HISTORY: Building 6 was built in 1943 as the Signal Corps Special Forces Hangar. Roberts and Schaefer Co., of Chicago, was consulting engineer, and Simpson Construction Co., of Chicago, was the contractor. Like the Engineering Shops (Building 5) the hangar was designed with a barrel shell roof which meant that the forms employed in the construction of the shops building could be reused here, although they had to be raised on trestles because of the additional height of the hangar.

At first the building was primarily used by the Signal Corps for installing radios and antennas, and after the war it became a facility for retrofitting and modifying planes. In February 1948 a tower and control room were added; these were demolished in 1986. Wright Air Development Center and the Aircraft Maintenance Organization Shop both occupied the building in 1959. During the 1960s and 1970s the facility was apparently used for developing special projects until they were found to be viable and were handed over to another laboratory. From 1964 to 1981 it housed the Air Force Orientation Group. In 1974 a sound studio was constructed in the hangar. Currently the building houses the Wright Field Fitness Center.

For sources, see Bibliography on page 215.

Figure 25: Building 6 under construction, showing reinforcing steel in barrel roof, 1942. (USAF)

Figure 26: Building 6, looking southeast, showing sections and hangar door, 1991.



This steel-frame concrete structure was built in 1943 as the Signal Corps Special Hangar. Initially it was used for the installation of radios and antennas, and after the war it became a facility for retrofitting planes and making various modifications to them. Wright Air Development Center and the Aircraft Maintenance Organization Shop both occupied the building in 1959. During the 1960s and '70s the facility was apparently used for developing special projects until they were handed over to another laboratory.

Concrete hangars, although popular in other countries, were not widely used in the U.S. until World War II brought shortages of structural steel. This structure is unlike other Wright Field hangars of the period in that its doors are placed on its short end, indicating that it may have been intended to house several smaller planes, rather than a single, large aircraft.

Based on Hardlines' integration of field work, photographs, and the following as-built drawings

US Engineer Office, Wright Field, Ohio, dated Mar. 25, 1942, no OP-158-20/2-5

Figure 27: Signal Corps Special Hangar, 1942. (Delineated by Hardlines Design & Delineation, HAER, 1992)

BUILDING 7: ENGINEERING SHOPS OFFICE

HAER No. OH-79-N

Construction Date: 1943

DESCRIPTION: Building 7 is connected to Hangar 9 at the north end of the Hangar 1/9 flightline complex. An Art Deco, three-story, flat-roofed building with a penthouse office, it is similar in appearance to Building 8 at the south end, creating a bookend effect. The main section of the building measures 202' x 75'3" and the penthouse 21'2" x 28'. A stair tower is attached to the northeast corner. Aluminum sash windows replaced the original wood ones in 1979.

HISTORY: Building 7 was built in 1943 to provide office facilities for the Engineering Shops in Building 5, in the midst of Wright Field's World War II construction boom. The penthouse structure is a later addition. Today the building houses research and development contracting offices.

For sources, see Bibliography on page 215.

Figure 28: Building 7, looking southeast, 1991.

BUILDING 8: OPERATIONS AND FLIGHT TEST BUILDING

HAER No. OH-79-O

Construction Date: 1943

DESCRIPTION: Building 8 is a rectangular three-story concrete structure with a flat roof. Built in the Art Deco style, it has a symmetrical south facade of fourteen bays. On the west end of the building, facing the flightline, is a two-story advancing elliptical block with a flat roof and ribbon windows of gold reflective glass in the Art Moderne style. This is the former Wright Field Operations Office. Building 8 is attached to the south side of Hangar 1. The six-story control tower, crowned by a glass control cupola, is situated between the two.

HISTORY: Building 8 was constructed in 1943 as part of the Hangar 1/9 - Buildings 5,7,8 complex, to house Wright Field Operations and the Flight Test Division. Flight testing at Wright Field prior to this time had been conducted by several independent units, each responsible for a different aspect of testing. In 1942 tasks such as the flight testing of experimental aircraft and "accelerated service testing" of models under production were consolidated under the jurisdiction of a single Commanding General. The Flight Test Division, as this new unit was called, did only testing. Such logistical matters as air traffic control and meteorological support at Wright Field's newly busy runways were handled by Post Operations. In 1954 the Pilot Transition Branch transferred to the building from Area C. The control tower remained in use until flight operations at Wright Field closed in the mid-1970s. Aeronautical Systems Division (now Aeronautical Systems Center) Civil Engineering moved into the office section of the building sometime before 1964, and was eventually joined by the U.S. Army Corps of Engineers and Security Information. The building currently houses ASC Security Police and the 645th Civil Engineering Group with planning, programming and program management functions.

For sources, see Bibliography on page 215.

Figure 29: Building 8, looking north, 1992.

Figure 30: West facade of Building 8, 1991.

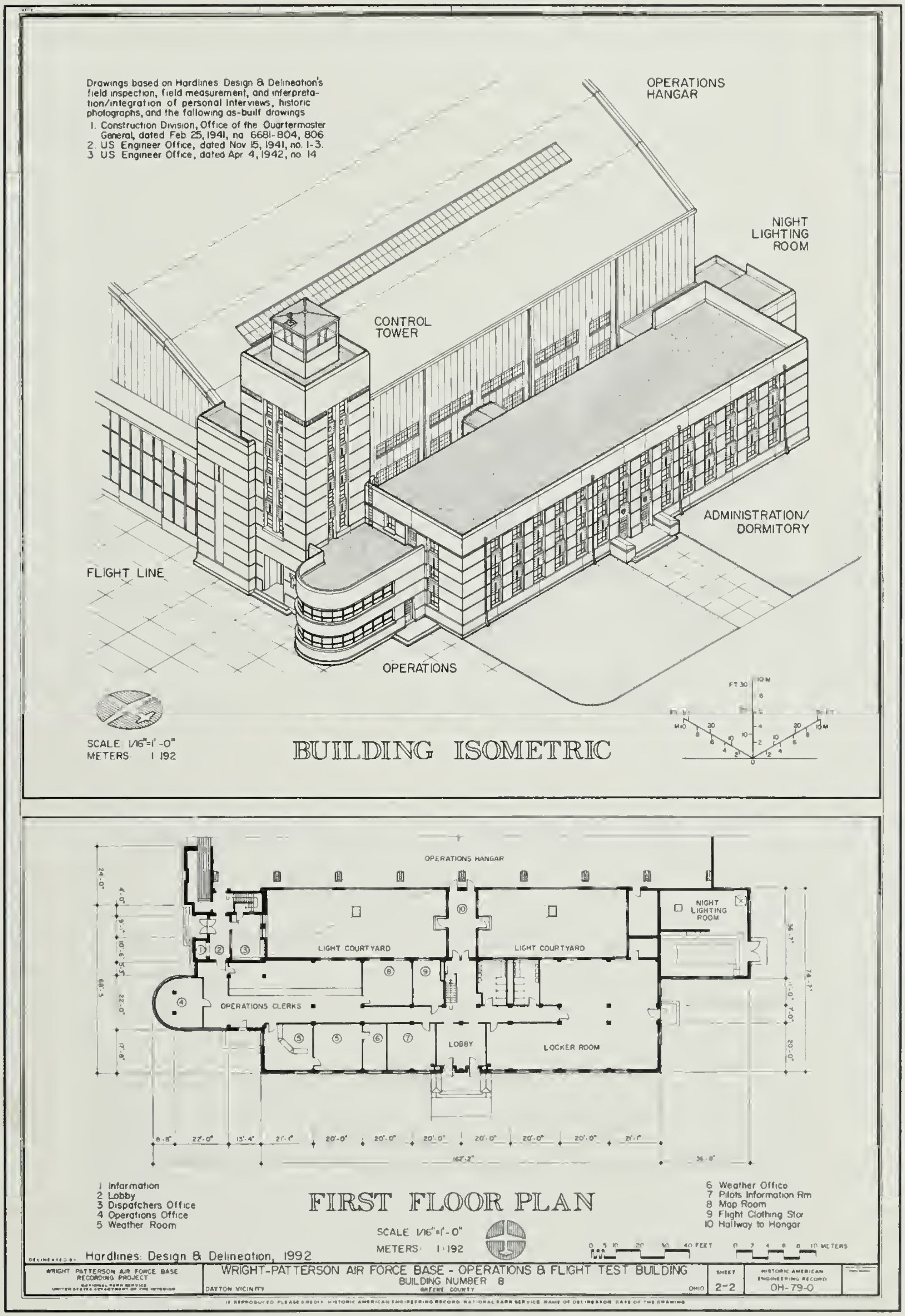


Figure 31: Operations and Flight Test Bldg., 1943. (Delineated by Hardlines: Design & Delineation, HAER, 1992)

BUILDING 11: ADMINISTRATION BUILDING NO. 1

HAER No. OH-79-P

Construction Date: 1926-27

DESCRIPTION: Administration Building No. 1 is a rectangular, two-story, concrete structure measuring 550' x 55', with a textured paint coating (which replaced the original stucco finish) and two rows of symmetrically arranged windows beneath a parapeted roofline. Its designers established its identity as a headquarters by eschewing the industrial brick facades of surrounding buildings in favor of a more refined concrete. The twin main entrances which trisect the prominent western facade are approached by 8' concrete stairs and are flanked by original lampposts, giving the entrances a heightened air of importance. Above the entrances are identical porcelain shields designed by C.P. Johnson of Cincinnati, Ohio. Colored in blue and gold, they feature a likeness of Auguste Rodin's "The Thinker" pondering a winged globe, and are inscribed "Materiel Division, U.S. Army Air Corps."

HISTORY: Building 11 was the first building begun at the new Wright Field when the United States Army Air Corps relocated its Materiel Division from McCook Field in nearby Dayton in the late 1920s.

J.I. Geiger of Dayton laid the foundation shared by Buildings 11 and 16. Excavation began in mid-April of 1926 with a crowd of local notables present. The gathering included Captain E.M. George, Constructing Quartermaster; Frederick B. Patterson, President of National Cash Register Company and the driving force behind Dayton's pursuit of Wright Field; and Orville Wright and his sister Katharine Wright, both Dayton natives. (Their brother Wilbur had died on May 30, 1912.)

E.H. Latham Co. of Columbus, Ohio, built the superstructure, beginning June 30, 1926 and completing it by April 12, 1927. To facilitate the concrete construction, a railroad track was installed along the west side of the building. Gasoline locomotives hauled 1-cubic-yard buckets of concrete on cars from a central mixing plant to a derrick which lifted the buckets to the top of the building. From there the concrete was discharged into smaller buggies to be poured wherever necessary.

As headquarters of the Air Corps Materiel Division (ACMD), Building 11 personnel oversaw all aircraft procurement for the Army Air Corps (known as the Air Service prior to July 2, 1926). The Materiel Division's responsibilities included research and development, engineering, flight testing, procurement, field service (overseeing the Air Corps depot system), industrial war plans, and repair and maintenance. The Air Corps Engineering School and Army Aeronautical Museum also fell under the Division's aegis. Through the modern-day Air Force Materiel Command (AFMC), research and development, procurement and logistics are functions that have remained headquartered at Wright-Patterson Air Force Base, although not in Building 11.

Building 11 hosted the office of the Chief of the Materiel Division (renamed the Materiel Command in 1943) until 1943 when the unit moved to the larger headquarters facilities in newly completed Buildings 14 and 15. In 1935 the building's other major occupant, the Air Corps Engineering School, moved next door to the freshly finished Technical Data Building (Building 12), then home of the Army Aeronautical Museum, where it remained until the outbreak of World War II in Europe. A third-floor addition, known as the "penthouse," was added during World War II, although this was later removed.

Since 1944, Building 11 has been the home of many other administrative offices, including agencies of the Materiel Command, Wright Air Development Center/Division, and Aeronautical

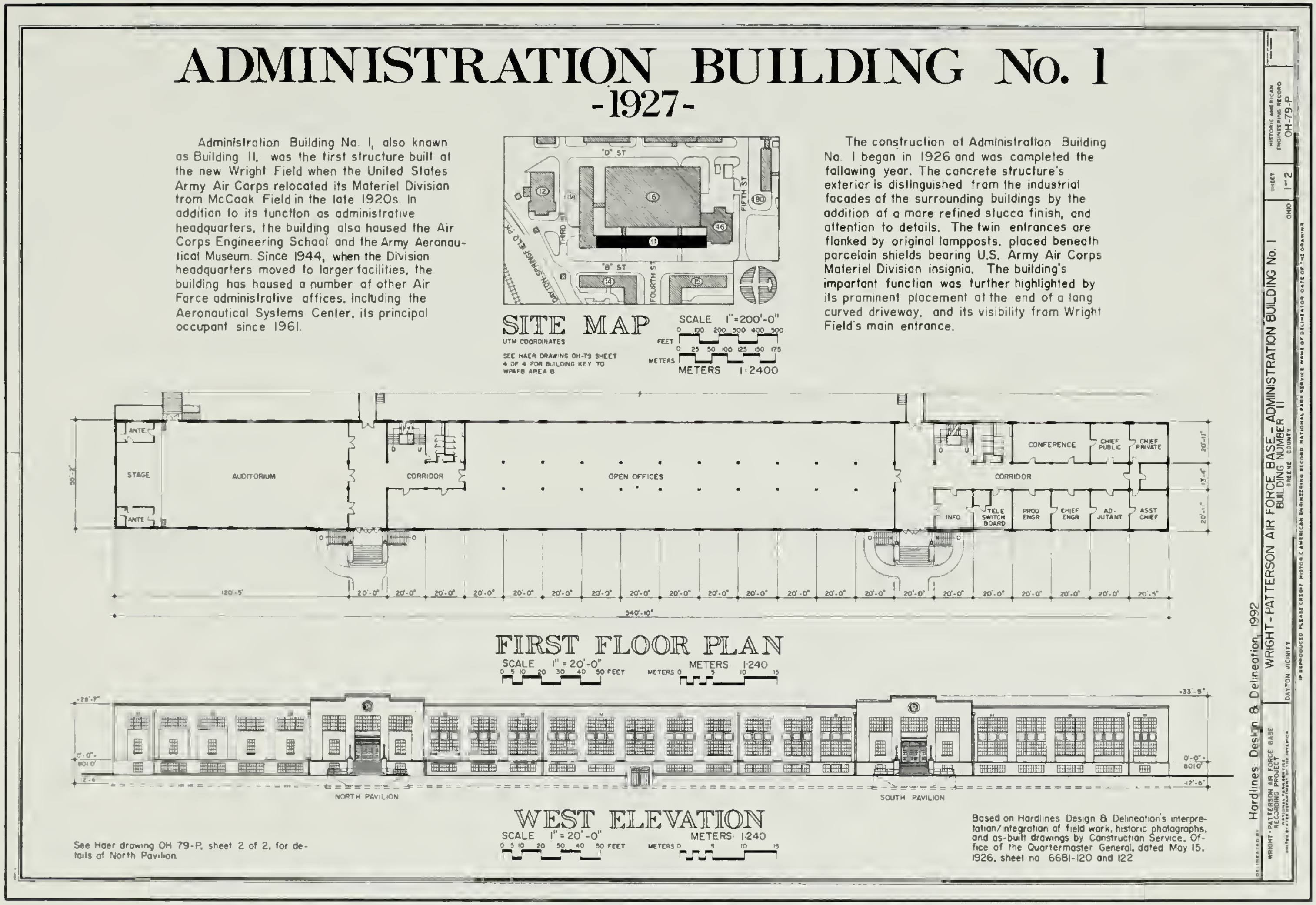
Systems Center. Two months after the Air Research and Development Command was created in September 1950, its headquarters moved to the penthouse of Building 11 until transferring to Baltimore, Maryland, in June 1951. Since 1961 the Aeronautical Systems Division (now Aeronautical Systems Center) has been the principal occupant, joined by the ASC Training Systems SPO (System Program Office) and numerous other offices during the 1980s and 1990s.

For sources, see Bibliography on page 215.

Figure 32: Building 11, ca. late 1920s. (USAF)

Figure 33: Entrance, west side of Building 11, 1992.

Figure 34: Building 11, looking southwest, 1992.



Administration Building No. 1, also known as Building 11, was the first structure built at the new Wright Field when the United States Army Air Corps relocated its Materiel Division from McCook Field in the late 1920s. In addition to its function as administrative headquarters, the building also housed the Air Corps Engineering School and the Army Aeronautical Museum. Since 1944, when the Division headquarters moved to larger facilities, the building has housed a number of other Air Force administrative offices, including the Aeronautical Systems Center, its principal occupant since 1961.

The construction at Administration Building No. 1 began in 1926 and was completed the following year. The concrete structure's exterior is distinguished from the industrial facades of the surrounding buildings by the addition of a more refined stucco finish, and attention to details. The twin entrances are flanked by original lampposts, placed beneath porcelain shields bearing U.S. Army Air Corps Materiel Division insignia. The building's important function was further highlighted by its prominent placement at the end of a long curved driveway, and its visibility from Wright Field's main entrance.

See Haer drawing OH 79-P, sheet 2 of 2, for details of North Pavilion.

Based on Hardlines Design & Delineation's interpretation/integration of field work, historic photographs, and as-built drawings by Construction Service, Office of the Quartermaster General, dated May 15, 1926, sheet no 6681-120 and 122

Figure 35: Administration Building No. 1, Building 11, 1927. (Delineated by Hardlines: Design & Delineation, HAER, 1992)

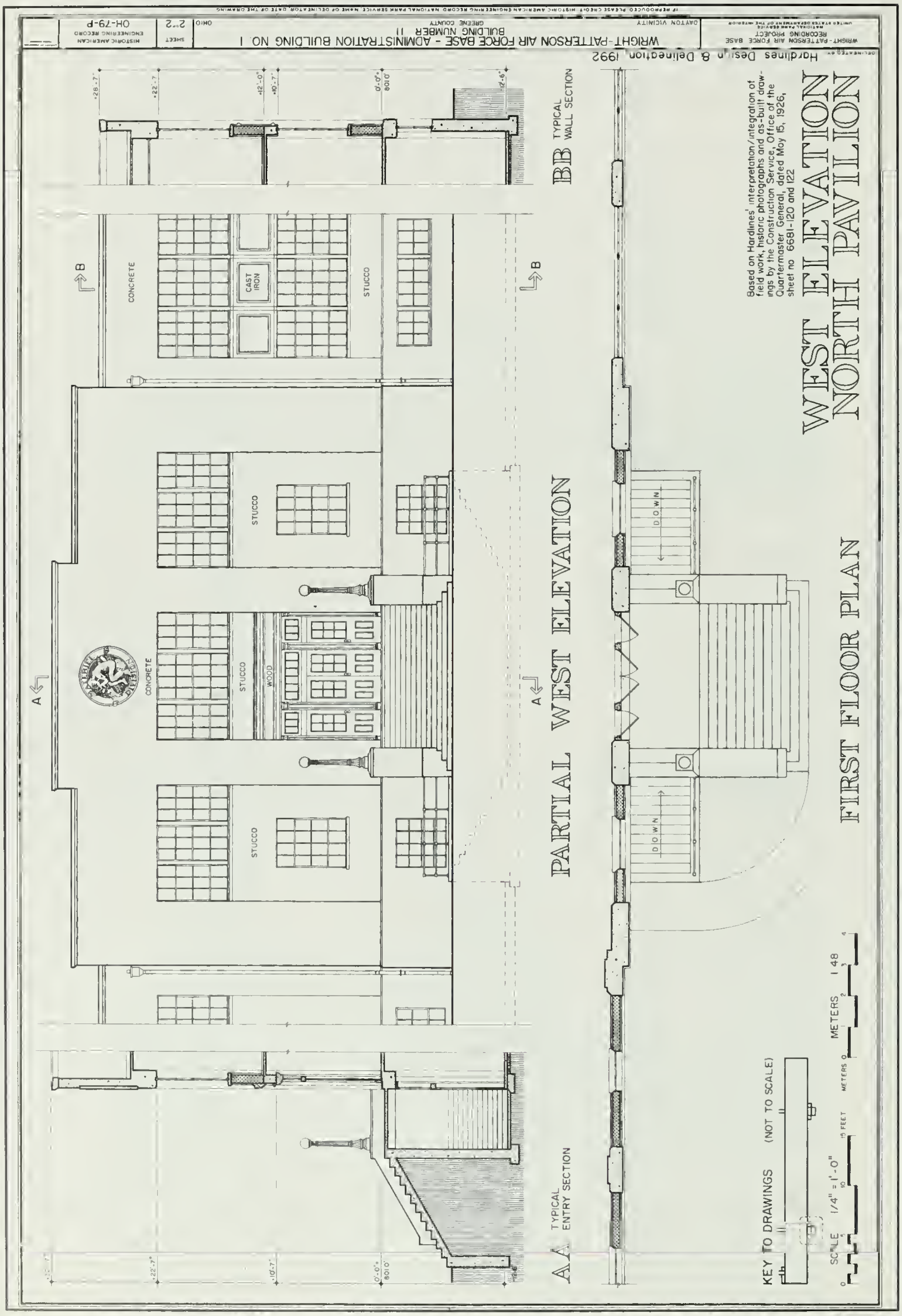


Figure 36: Administration Building No. 1, Building 11, 1927. (Delineated by Hardlines: Design & Delineation, HAER, 1992)

BUILDING 12: TECHNICAL DATA BUILDING

HAER No. OH-79-D

Construction Date: 1934-35

DESCRIPTION: The Technical Data Building (Building 12) is the most elaborate example of 1930s Art Deco architecture in Area B. It is a limestone and brick structure, 228' long and 146' across at its widest section. The long central section contains twelve bays with tall windows that extend to the top of the wall. The building has a gabled roof with a row of skylights, which originally lit the museum display area. The rear entrance has a long ramp that originally led to a hangar-style door, which has since been bricked over and replaced with a pedestrian door. The side wings each have a flat roof, four front bays and four side bays.

Two Art Deco bronze and frosted glass lamps flank the wide steps leading to the building's entrance. The square fluted columns of the portico are topped with carved, Egyptian-style, spread-winged eagles above a chevron imprint. Within the portico, three Art Deco lamps, similar to the ones that attend the stairway, hang in three bays. The outer bays feature large, aluminum-trimmed windows. In the central bay, ribboned pilasters of stone flank the recessed entry. Above the portal, a metal winged shield overlooks the entryway.

The U.S. Air Corps insignia, a winged propeller, wraps around the outside corners of the portico. While the wings are stylized, the propeller retains an authentic shape, making it virtually the only curvilinear element of the exterior. Numerous buttresses and corner towers envelop the building. Many segments of grooves and fluting decorate the caps of the buttresses and towers, the space between the first and second story windows, and the top band of brick just below the stone coping.

The two massive aluminum doors each display an imposing, stylized eagle with a large chevron emblazoned upon its chest. The chevron motif, prominent throughout the building, also adorns vertical bands below the eagles. Above the doors, a wrought-iron transom forms a winged propeller. In keeping with the chevron motif, a zigzag pattern decorates the strip surrounding the doors, and the band across the top of the recessed entryway.

The interior rotunda features a marble floor with inlaid points of the compass, and a dark green marble baseboard. Currently, a scale model of an F-16 aircraft is on display in the center of the rotunda. A large octagonal skylight with zinc and lead tracery rests overhead, and from it hangs an ornate lamp. Additional lighting is provided by elongated frosted-glass sconces mounted on fourteen of the twenty-two fluted wood pilasters with decorated capitols that line the rotunda. Two large aluminum open-work design heat registers are set in the walls facing the entrance. An aluminum shield-clock with wings hangs above the entrance to the main hallway. Seven aluminum doors lead to offices, with one false door added for symmetry. The mezzanine balcony features an intricate aluminum rail supporting a display of eighteen international flags.

The original triangular lot where Building 12 now stands was squared on the west end to conform to the building's facade. As a result, the building overlooks a triangular lawn, with a small triangular cement pool near its entrance. Inside the pool rest two cement frogs and a cement turtle. Also in the pond, a pedestal supports a copper globe with two circling airplanes mounted on its surface, symbolizing Wright Field's contributions to aviation.

Except for a large sheet metal structure on the north side of the building added in 1966 (to house climate control equipment) and replacement windows, Building 12's exterior has not been significantly altered, and it remains in excellent condition. The interior is equally well maintained but has undergone several alterations. Originally, all the space in the central section beyond the rotunda area was an open museum display area. The shift to office space, however, has added permanent walls, a second floor, and a dropped ceiling which hides the original skylights. The most ornamental spaces in the building, the foyer and the rotunda, have remained unaltered.

HISTORY: The expansion of Wright Field was slowed in the 1930s by the decrease in funding for military construction due to the Depression. However, the Works Progress Administration provided manpower for construction of several new buildings, including the Technical Data Building in 1934-1935. Designed by Albert Pretzinger and Freeman A. Pretzinger to house and display documents and artifacts, it was originally occupied by the Technical Data Branch and the Wright Field Technical Library. These units were service organizations to the other personnel of Wright Field, responsible for assembling and disseminating aeronautical information, recording on still and motion pictures the experiments and test procedures of the Engineering Division, and producing training films for the Field. Filmmakers, script-writers, researchers, artists, translators, librarians, and experts on foreign aviation were employed in the Technical Data Building for this task. The Wright Field Technical Library was a section of the Air Documents Division of the Air Technical Service Command, which at the end of the war was responsible for translating and indexing captured documents detailing German aeronautical research and development. Some 55,000 documents were stored and researched here. The building also housed the Army Aeronautical Museum, the first military aviation museum in the country (originally set up at McCook Field in 1923 and later established in Building 11, Wright Field, in 1932). During World War II, however, the museum's collections were placed in storage to make room for the Engineering Division, the principal occupant of Building 12 from 1940-48.

Numerous offices and divisions have occupied Building 12 since World War II (see Appendix 1). The Deputy for the F-16 program has been there since 1976.

Appendix 1

Organizations Residing in Building 12

I. Major Tenants	
Army Air Corps Museum	1935-1940
Engineering Division	1940-1948
Intelligence Office	1944-1948
Central Air Documents Office	1949-1950
Materiel Division	1951
Director of Procurement & Production	1952
Weapons System Division	1952
Deputy Chief of Staff, Operations	1953-1954
Deputy Chief of Staff, Personnel	1955-1976
Deputy for F-16	1976-present

II. Other Organizations	
Personnel Section	1940-1944
Wright Field Reference Library Section	1947
Distribution Section	1947
Materiel Division	1952
Personnel Services Section	1952
Holloman Air Defense Center Liaison	1957-1960
Air Proving Ground Liaison Office	1957-1960
National Advisory Committee of Aeronautics Liaison Office	1957-1960
Continental Army Command Liaison Office	1957-1961
Army Quartermaster Corps Liaison Office	1957-1961
Staff (WADD) Weather Office	1958-1960
Office of Information Services, Historical Office	1959
Deputy Chief of Staff, Plans and Operations	1959
Office of Administrative Services	1960-1968
Plans and Operations Office	1962
SAC Systems Office	
ALCM	1974-1975
SRAM	1975

For sources, see Bibliography on page 215.

Figure 37: Building 12, ca. 1930s, and ornamental pond. (USAF)

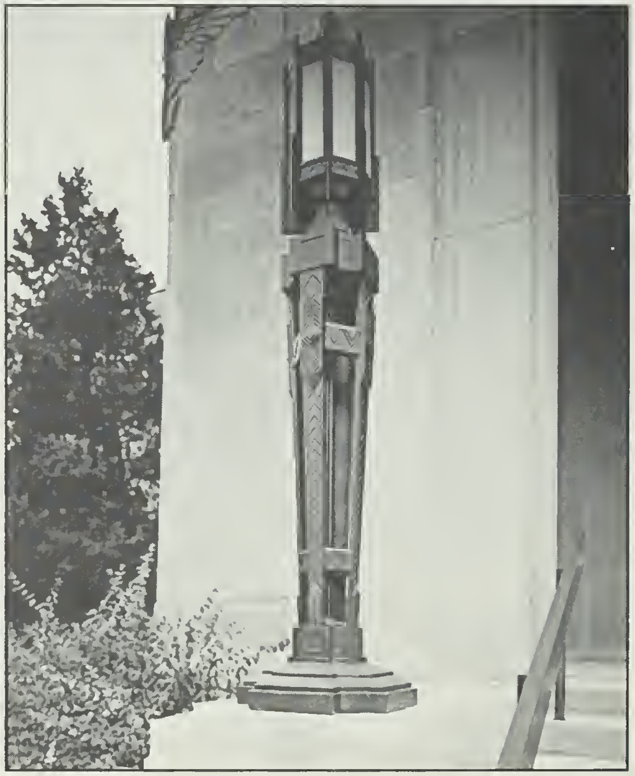


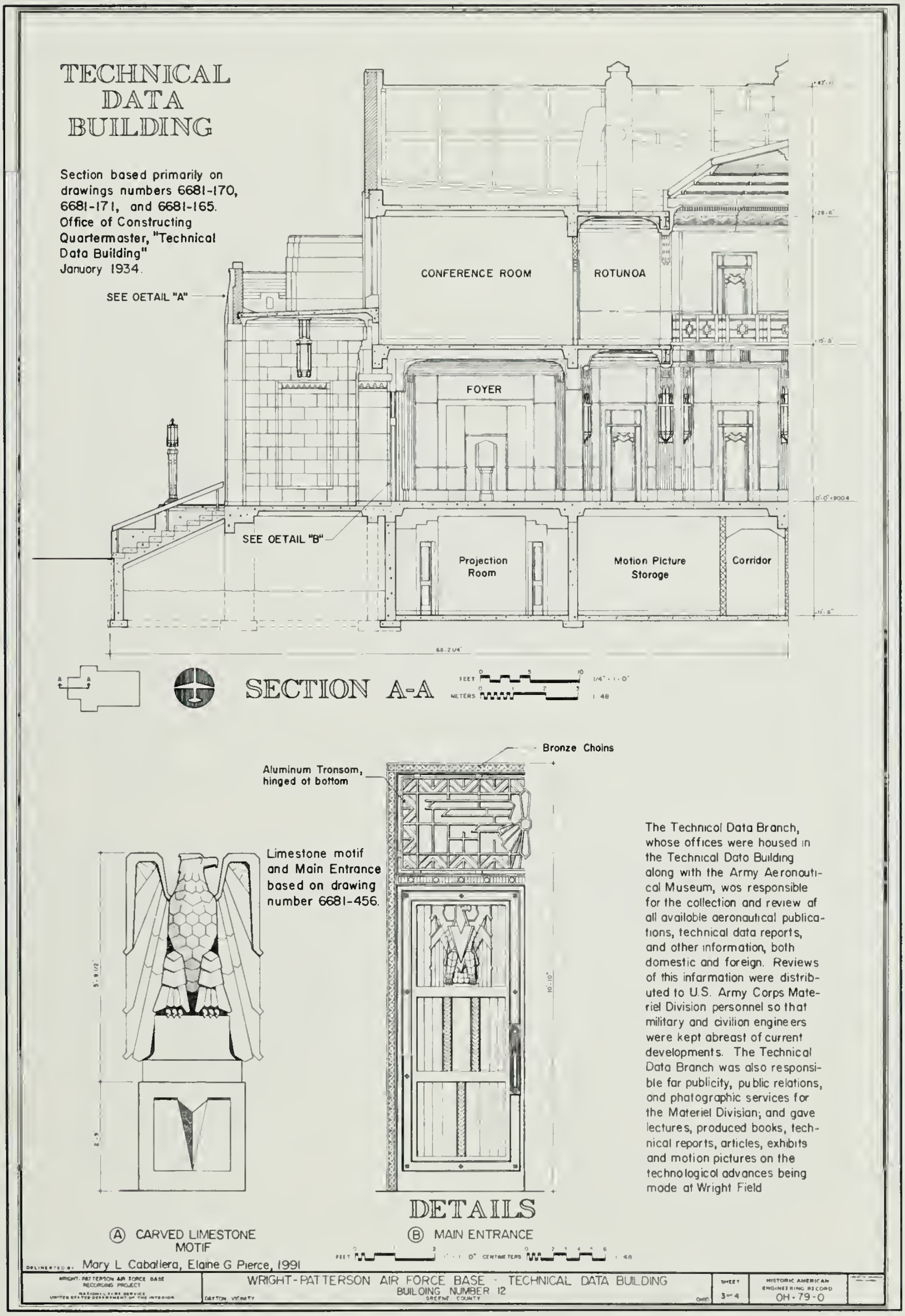
Figure 38: Exterior Art Deco lamp, Building 12, 1991.

Figure 39: Building 12, west facade, 1991.

Figure 40: Exterior door detail, main entrance, Building 12, 1991.

Figure 41: Skylight, foyer, Building 12, 1991.

Figure 42: Exterior detail, U.S. Army Air Corps insignia, Building 12, 1991.



The Technical Data Branch, whose offices were housed in the Technical Data Building along with the Army Aeronautical Museum, was responsible for the collection and review of all available aeronautical publications, technical data reports, and other information, both domestic and foreign. Reviews of this information were distributed to U.S. Army Corps Materiel Division personnel so that military and civilian engineers were kept abreast of current developments. The Technical Data Branch was also responsible for publicity, public relations, and photographic services for the Materiel Division; and gave lectures, produced books, technical reports, articles, exhibits and motion pictures on the technological advances being made at Wright Field

Figure 43: Technical Data Building, 1934. (Delineated by Mary L. Caballero and Elaine G. Pierce, HAER, 1991)

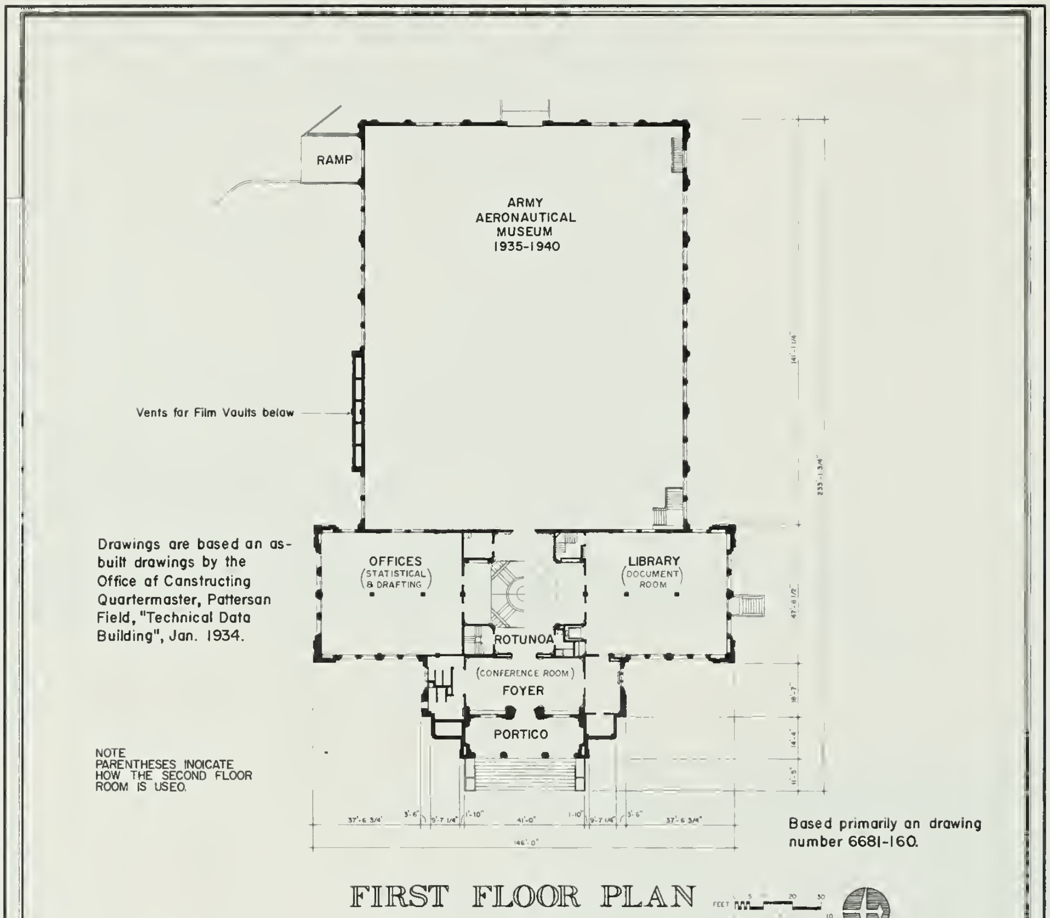


Figure 44: Technical Data Building, 1934. (Delineated by Elaine G. Pierce, HAER, 1991)

BUILDINGS 14 & 15: MATERIEL COMMAND ADMINISTRATION BUILDINGS NO. 1 AND NO. 2

HAER No. OH-79-AL (Bldg. 14)
OH-79-AM (Bldg. 15)

Construction Date: 1943

DESCRIPTION: The twin administrative buildings (Buildings 14 and 15), located between the old main gate and the original administration building (Building 11), are L-shaped, flat-roofed, cast-in-place concrete buildings, consisting of two stories and a full basement, with the main floor level raised above grade to allow light to the basement areas. The exterior walls are 10" thick and were formed against rough-sawed boards that give a textured effect. In the center of each arm of the L, an articulated entry block rises above the rest of the superstructure. Wide steps lead to the recessed main entrances, which face each other across 4th Street, flanked by two large cubical planters with vertical ornaments. Each entrance has four replacement aluminum doors--double doors flanked by two single doors--and three Art Deco cylindrical brass lamps with frosted glass.

A concrete frieze band, incised with vertical grooves in groups of four, crowns the wall around the entire building, and a wide reeded ribbon of molded concrete spans the gap between the first and second floor windows. Originally unpainted and monochromatic, the buildings were for some time painted cream with brown to accent the ten-bay replacement windows, the recessed entrances, the central pilasters above the main entrances, and the building trim. This coloring has been removed, and the buildings returned to their original appearance. Concrete monoliths have been placed at sidewalk level in front of each building to identify the building occupants.

Both buildings (each 107,269 square feet) are equipped with central heating and air conditioning. Several alterations have taken place in the basements and office spaces, and Building 14's north wing has had its lower level basement and upper story windows blocked in. No major structural or exterior modifications have been performed, and the original integrity of the site survives.

HISTORY: Buildings 14 and 15 were constructed in 1943 specifically to house the headquarters of Materiel Command which were moving from Washington, D.C. to Wright Field. The architects were Swerdruk, Parcel, and J. Gordon Turnbull, and the construction contractor was Charles H. Shook of Dayton. Due to the pressing shortage of space, the two L-shaped structures were constructed simultaneously, even though this meant that almost identical sets of forms had to be fabricated.

The buildings severely altered the appearance and character of Area B. Previously, traffic entered Wright Field through the main gate (Buildings 81 and 82), with its stately brick guard houses and wrought iron gate. The entrance road curved gently around, and the visitor entered a semicircular drive facing the imposing Building 11. Within the semicircular drive stood a solitary flag pole and a ceremonial cannon. The construction of Buildings 14 and 15, however, directly in front of Building 11, eliminated the elegant courtyard and the semicircular drive. Moreover, the new buildings extended all the way to the main gate, crowding the entrance and sacrificing the clean, uncluttered approach to the area. A new, strictly utilitarian gate (1B) was built, directing the majority of base traffic around the main cluster of buildings and toward the parking lot.

Originally, both buildings provided space for the Materiel Command Headquarters. Numerous organizations and divisions have occupied Building 14 since the 1940s, including the Wright Air Development Center/Division from 1951 to 1961, followed by the Aeronautical Systems Division from 1961 to 1992. For many years, Building 15 housed the Acquisition Logistics

Division/Center. In 1992, Building 14 housed the Headquarters for the Aeronautical Systems Center, while Building 15 accommodated the Joint Logistics Systems Center.

For sources, see Bibliography on page 215.

Figure 45: Building 14, with corner of Building 15 in foreground, ca. 1950s. (USAF)

Figure 46: Main entrance to Building 14, ca. 1945. (USAF)

Figure 47: Building 14, looking northwest, 1991.

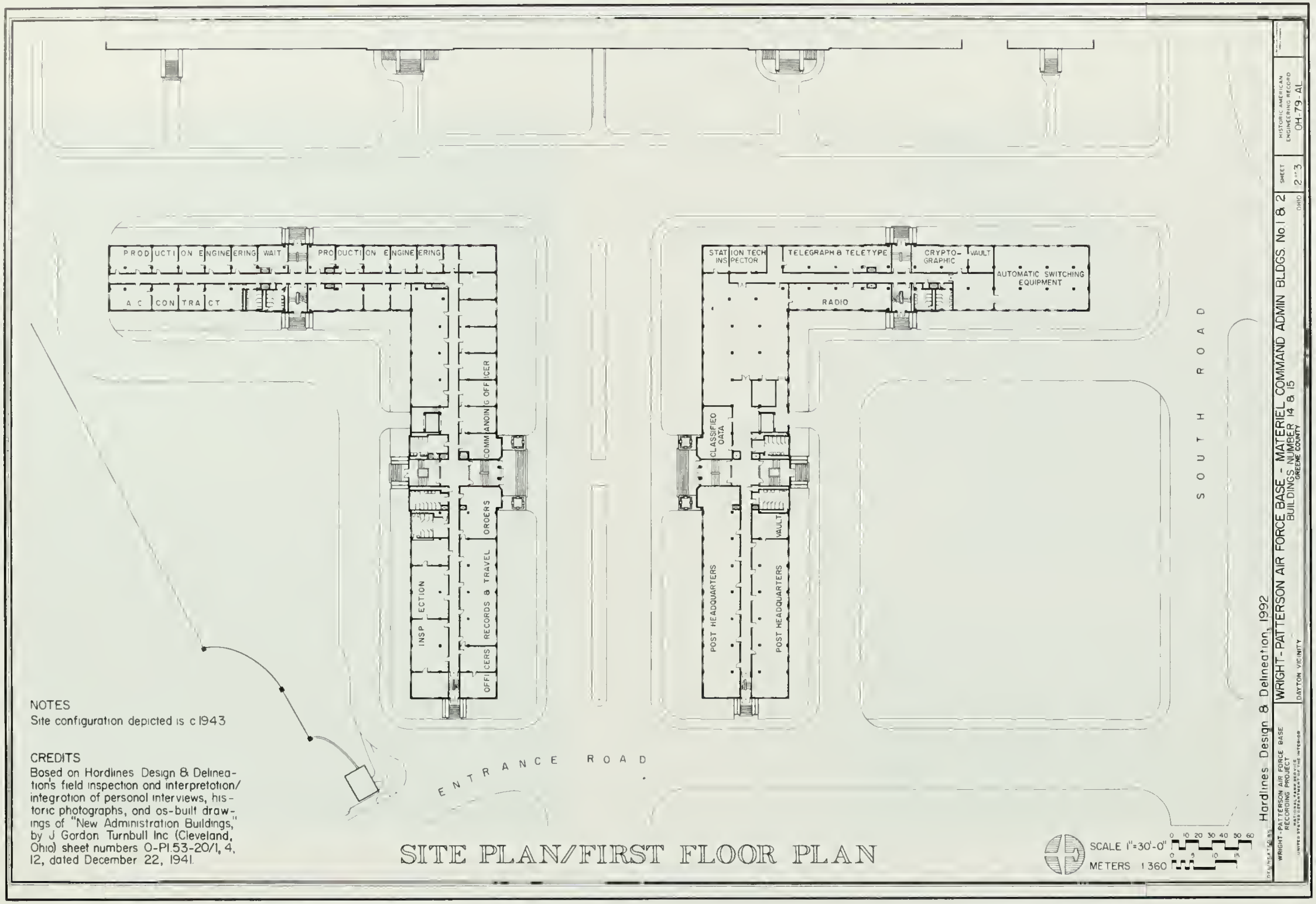


Figure 48: Administration Buildings No.1 and No. 2, Buildings 14 and 15, 1943. (Delineated by Hardlines: Design & Delineation, HAER, 1992)

BUILDING 16: WRIGHT FIELD LABORATORY

HAER No. OH-79-Q

Construction Date: 1927

DESCRIPTION: The Wright Field Laboratory Building is an industrial-style, rectangular, one-story, concrete building covered by a sawtooth roof with encapsulated skylights. The stucco facade has fourteen bays with replacement windows. The building also has a basement which was added in 1934. A tunnel links the Wright Field Laboratory Building with Wright Field Administration Building No. 1 (Building 11), Materiel Command Administration Building No. 1 (Building 14) and Materiel Command Administration Building No. 2 (Building 15).

HISTORY: In 1927 Building 16, the original laboratory facility, became the first building to be completed at the new Wright Field when the United States Army Air Corps relocated its Materiel Division from McCook Field in nearby Dayton. The foundation contractor was J.I. Geiger of Dayton, and the Danis-Hunt Co. of Dayton built the superstructure. Even though Building 16's superstructure construction began two weeks after Building 11's, delays on that project allowed Building 16 to be completed three months earlier than the Administration Building.

In its original form, the building had one floor, approximately 500' long and 250' wide, with a sawtooth roof providing skylight illumination for the work areas. During the 1930s, the Works Progress Administration (WPA) excavated and built a basement among the concrete pillars of the building's foundation. Dug entirely by hand, the underfill was removed in nineteen sections. As each section was removed workers erected steel girders and poured concrete for the basement walls and floor. The WPA completed this project late in 1939, providing desperately needed space for an expanding number and variety of laboratory projects, undertaken in response to the recent outbreak of World War II in Europe.

One of the first tenants of Building 16 was the Materials Laboratory of the Experimental Engineering Section of the Materiel Division. All of the Materials Branch, except the foundry and other heat-related projects, was located in Building 16, and the construction of the basement doubled its available laboratory space. However, the space was still inadequate to support all of the Materials Laboratory's activities, which included a rubber and textile unit, metallurgy, machine shop, physical testing unit, and chemical laboratory. The physical testing area, in particular, was packed with fatigue machines, torsion machines, impact machines, and universal testing machines, all powered by line shafts. The Materials Laboratory was a busy place in the 1930s as aircraft performance vastly improved, and metal surpassed wood as the principal construction medium.

The basement of Building 16 witnessed investigations in yet another cutting-edge aeronautical field. This work was performed by the Physiological Research Laboratory (which underwent several name changes before moving to new facilities in Buildings 29 and 55 on January 1, 1943, as the Aero Medical Laboratory). Founded by Captain Harry Armstrong in 1935, this unit descended from the Medical Branch of the Administration Section of the Materiel Division, which was principally a dispensary, but had also assisted the Engineering Branch in Building 16 when asked. As established in 1935, the Physiological Research Laboratory worked under the Equipment Branch of the Engineering Section of the Materiel Division and was responsible both for investigating the physiological effects of high-altitude and combat flight and for developing protective and emergency equipment to deal with associated medical problems.

While located in Building 16, the Physiological Research Laboratory participated in several notable projects. On November 11, 1935, Captain Armstrong and his medical technician, Captain Al Stevens, ascended to a record altitude of 72,000 feet in the National Geographic-sponsored balloon "Explorer II." The pressurized, sealed gondola for the craft was manufactured in Building 16. World-famous pilot Wiley Post tested his pressure suits in the altitude chambers of Building 16. Captain Armstrong specified the physiological requirements for the cabin atmosphere of the XC-35, the first successful pressurized sealed-cabin aircraft. Laboratory personnel also developed the world's first practical high-altitude breathing apparatus. Captain Francis Randall and William Widbock designed a system which provided pure oxygen at pressures of 15-25 torr above the ambient pressure. In November 1942 Lieutenant Colonel Randolph Lovelace, piloting a B-17, successfully tested the equipment at an altitude of 42,000 feet.

Building 16 also housed other facilities of the Equipment Branch: aircraft instruments such as artificial horizons, altimeters, directional gyroscopes, drift sights, and airspeed indicators were developed here, as well as improved aerial cameras and in-flight film processing equipment, parachutes, and lighting equipment for both aircraft and airfields.

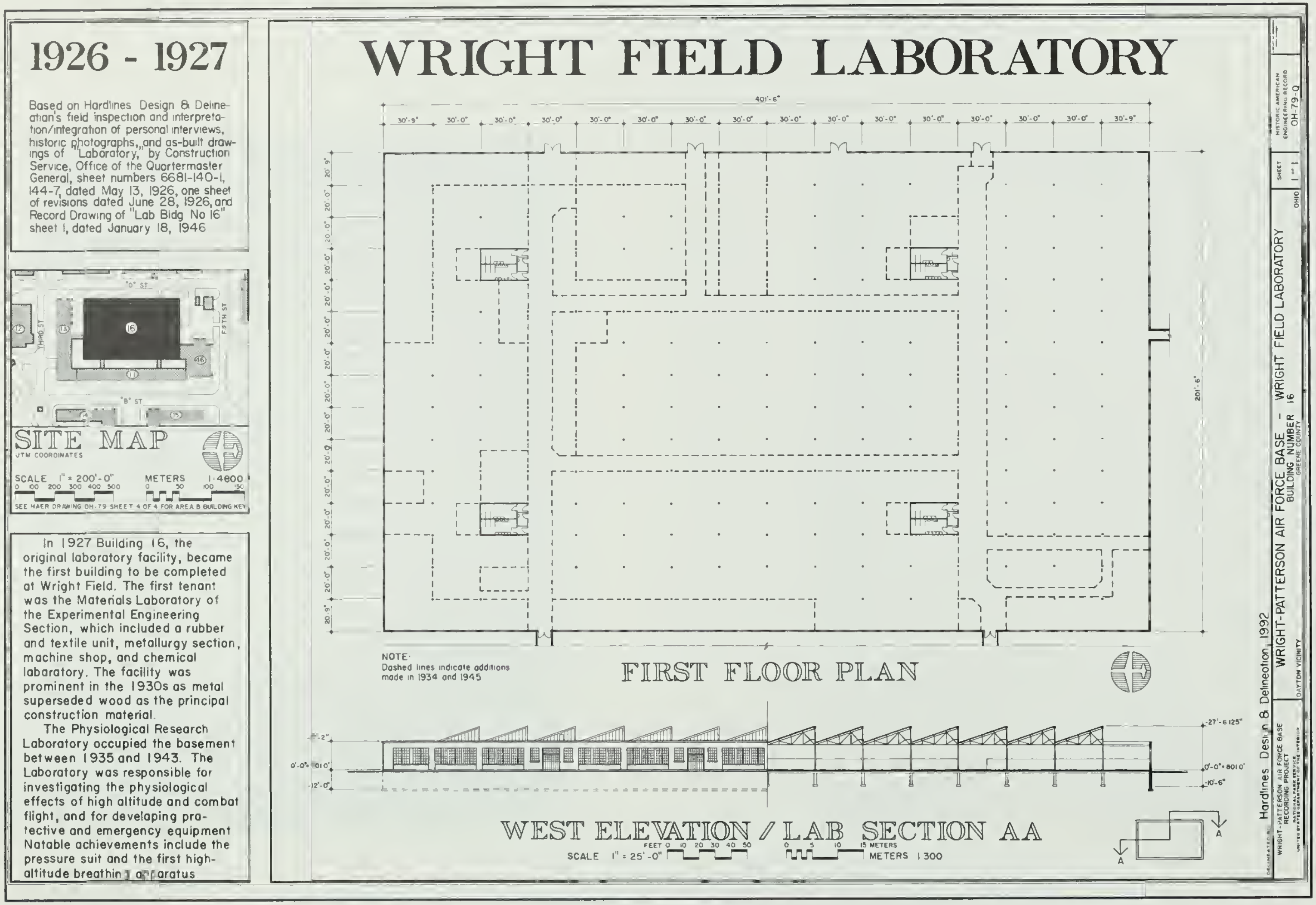
With the construction boom at Wright Field during World War II, Building 16 gradually shifted from an increasingly inadequate laboratory to an office and service building. The Aeronautical Systems Center (ASC) has utilized much of the office space in Building 16.

In the 1980s the building underwent significant exterior and interior renovation, during which the original skylights, roof and steel truss were exposed in the main entryway area. In 1992 administrative support offices such as Resource Management, Contracting, and the ASC History Office resided in Building 16, along with three System Program Offices (SPOs): Flight Training SPO, Systems SPO, and the B-2 SPO. A large community center area in the southeast corner of the floor includes a post office, dry cleaners, snack bar, travel desk, PX Annex, bank, and credit union.

For sources, see Bibliography on page 215.

Figure 49: Interior of Building 16, ca. 1927. (USAF)

Figure 50: Building 16, looking northwest, 1992.



1926 - 1927

Based on Hardlines Design & Delineation's field inspection and interpretation/integration of personal interviews, historic photographs, and as-built drawings of "Laboratory," by Construction Service, Office of the Quartermaster General, sheet numbers 6681-140-1, 144-7, dated May 13, 1926, one sheet of revisions dated June 28, 1926, and Record Drawing of "Lab Bldg No 16" sheet 1, dated January 18, 1946

In 1927 Building 16, the original laboratory facility, became the first building to be completed at Wright Field. The first tenant was the Materials Laboratory of the Experimental Engineering Section, which included a rubber and textile unit, metallurgy section, machine shop, and chemical laboratory. The facility was prominent in the 1930s as metal superseded wood as the principal construction material.

The Physiological Research Laboratory occupied the basement between 1935 and 1943. The Laboratory was responsible for investigating the physiological effects of high altitude and combat flight, and for developing protective and emergency equipment. Notable achievements include the pressure suit and the first high-altitude breathing apparatus

NOTE: Dashed lines indicate additions made in 1934 and 1945

Figure 51: Wright Field Laboratory, Building 16, 1926-1927. (Delineated by Hardlines: Design & Delineation, HAER, 1992)

BUILDING 17: AIRCRAFT RADIO LABORATORY

HAER No. OH-79-AB

Construction Date: 1929

DESCRIPTION: Building 17 is a two-story, six-course American bond brick structure with elements typical of early Wright Field architecture. These include a low-pitched gabled roof, wide copper entablature, and rectangular columns with concrete capitals. The east and west sides of the building, including the west addition, have two courses of corbeled brick at the top, underneath the gutter. The original large windows have been partially bricked up and replaced with smaller, modern windows. There have also been four major additions to the original building: in 1935 a south wing was added, doubling the structure's size and changing the plan from a square to a long rectangle; in 1939 a one-story wing was built along most of the west side; in 1942 a one-story east wing was added; and in 1944 the wing was extended the entire length of the building.

HISTORY: The Aircraft Radio Laboratory was designed by the Office of the Constructing Quartermaster, the foundation was laid by J.I. Geiger of Dayton, and the superstructure was built by the Danis-Hunt Co., also of Dayton. The building was completed in 1929.

Signal Corps officers, working in cooperation with Air Corps officers, operated the Aircraft Radio Laboratory. In addition to addressing the problems of air-to-air and air-to-surface communication over extended distances, they also developed interphone systems for two-seat (or two-place) and multi-place airplanes. Other radio research produced radio trucks for landing fields, improved airplane antennas, and radio compasses.

The radio compass was a particularly beneficial instrument when linked with a gyro compass via a directional (one-way) relay. In such an arrangement, the radio compass tracked a radio signal from the ground, constantly feeding the information to the gyro compass, which kept the airplane on a constant course towards it. This way, an airplane could be automatically steered in a straight line or through a cross wind to any radio station within sight of an airfield and then to the field itself. This technology represented the most advanced avionics of the age.

In 1942 the Aircraft Radio Laboratory moved to a new facility (Building 28), and the Aerial Photographic Reconnaissance Laboratory succeeded the Radio Laboratory in Building 17, remaining there until 1960, when it combined with the Electronic Technology Laboratory. For many years a bronze plaque (dedicated in 1952 and since removed) at the main north entrance commemorated four laboratory personnel who died in reconnaissance airplane accidents.

In 1960, the Materials Laboratory obtained Building 17. The Applications Laboratory and its offices moved in first, and in 1961 the offices of Materials Central joined them. These remained for twenty years, when the building's laboratories were eliminated in a renovation to convert the building into offices for the Aeronautical Systems Division. Upon completion in 1983, the CX SPO (Cargo Aircraft-Experimental System Program Office), later known as the C-17 SPO, established its offices there, remaining until 1992. The C-17 is a state-of-the-art Short Take-Off and Landing (STOL) cargo aircraft capable of carrying loads of 172,200 pounds in a 20,900 cubic foot volume. In 1992 the building became temporary office space.

For sources, see Bibliography on page 215.

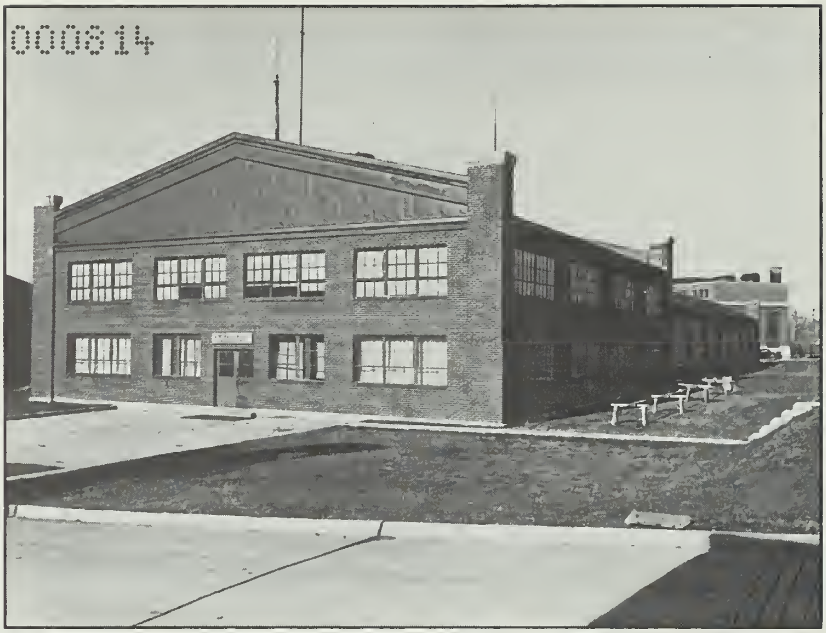


Figure 52: Building 17, ca. 1929. (USAF)

Figure 53: Building 17, east facade, 1991.

BUILDING 18 COMPLEX: POWER PLANT LABORATORY

HAER No. OH-79-AN

Construction Dates:

18 (Power Plant Research Laboratory): 1928
18A (Power Plant Laboratory Office): 1940
18B (Dynamometer Laboratory): 1942
18C (Addition to Dynamometer Laboratory): 1943
18D (Power Plant Administration): 1943
18E (Unconventional Power Plant): 1944
18F (Power Plant Cold Rooms): 1945
18G (Engine Overhaul Shops): 1928

DESCRIPTION: The Power Plant Research Laboratory (Building 18) is a T-shaped single-story, six-course American bond brick building. It has a low-pitched, concrete-filled, front-gabled roof with a wide copper entablature and tall rectangular towers on the corners. At one end there is an opening covered by bifolding steel doors with steel-sashed windows. Many of the windows along the sides have been bricked up, although some concrete sills remain.

The Power Plant Laboratory Office (Building 18A) is a two-story rectangular brick building with a concrete basement. It consists of twelve bays with glass blocks between replacement windows, brick corner pilasters, and a low-parapeted flat roof.

The Dynamometer Laboratory No. 2 (Building 18B) is a square two-story brick building with square corner towers, a wide concrete entablature, a flat roof and bricked up windows.

The Power Plant Dynamometer Laboratory addition (Building 18C) is a slightly U-shaped building with a concrete basement and first floor. The flat roof has a wide concrete entablature. The window bays have been bricked up. Each of the four test cells has large steel bedplates mounted on concrete pillars. The four brick enclosures on the west end of the test cells contained roll-up deflector shields with sliding doors.

Just to the west of Building 18A, and connected to it by a common entrance structure is Building 18D, the Power Plant Administration Building. Similar in style and layout to Building 18A, Building 18D features a concrete basement and foundation, with a second and third floor of American bond brick, and a low-parapeted flat roof.

Building 18E housed the Unconventional Power Plant Laboratory. This three-story, common bond brick building has a wide concrete band at the top of a low-parapeted roof. On the sides of the building the windows have been bricked up, but the concrete lintels and sills remain.

The Power Plant cold rooms are located in a two-story, common bond brick building (Building 18F). On the north side there are three large doors and six windows on the first floor. There are no windows on the second story.

Building 18G, the Engine Overhaul Shops, is attached to Building 18A and connected to Buildings 18A and 18D by passageways. It is built in the style of the early Wright Field buildings--a long, rectangular, one-story, common bond brick building with a low-pitched gabled roof and square towers at the corners. It still has the original front double doors and the original steel-sashed factory windows in the gable, but the others are bricked up.

HISTORY: Built in 1928, Building 18 is one of the earliest Wright Field structures. It served as the main facility for the Materiel Division's Power Plant Laboratory, which had moved from McCook Field, and initially housed the Laboratory's dynamometers--instruments used to measure the thrust or power of engines--and two concrete wind tunnels in the basement. Today, Building 18 is the central structure of a greatly expanded complex of buildings that belong to the Power Plant Laboratory's successor, the Aero Propulsion and Power Directorate of the Wright Laboratory. Building 18G was originally an extension to the north bay of Building 18, and was designed to accommodate the engine overhaul shops. Battery laboratory research facilities, the Computer Technology Group, conference rooms and a display area for the Directorate currently occupy the space.

The remaining buildings of the Power Plant Laboratory Complex were built between 1940 and 1945. Building 18A was built in 1940 to house the Power Plant engineering office, and continues in that role for the Aero Propulsion and Power Directorate. In 1943, Building 18D was built just west of, and in similar style to, Building 18A. A connecting entrance structure was also added between the buildings, making them essentially one building. Like Building 18A, Building 18D also housed offices for the Aero Propulsion and Power Directorate. Building 18B was constructed in 1942 as the Dynamometer Laboratory. The two engine dynamometer test cells had large steel bedplates supported on massive concrete pillars sitting on rock. In 1989 it became the Propulsion Research and Development Facilities and Equipment Building. Building 18C was built in 1943 as an addition to the Dynamometer Laboratory to support the expanding Power Plant Laboratory activities during World War II. Today it houses the Propulsion Research and Development Test Cells. Built in 1944 as the Unconventional Power Plant Laboratory, Building 18E housed two test cells equipped with floating thrust measuring bedplates and altitude exhauster capability. In the 1950s and 1960s the building was used for turbojet and ramjet research testing, while in 1992 Building 18E's test cells were used for Advanced Propulsion Research, and Turbine Engine Division Airfoil Research. Building 18F was built in 1945 to house the Power Plant Cold Rooms. The facility had four cold test rooms, for low temperature testing of engines and accessory equipment. The cold rooms exhausted into a common plenum chamber on the west side. The eastern half of the building contained the refrigeration equipment, transformer vault, offices, and storage areas. A cooling tower was located in the northeast corner. Today, the Avionics Directorate Test Particle Preparation and Storage Unit (part of Wright Laboratory) occupies the building.

For sources, see Bibliography on page 215.

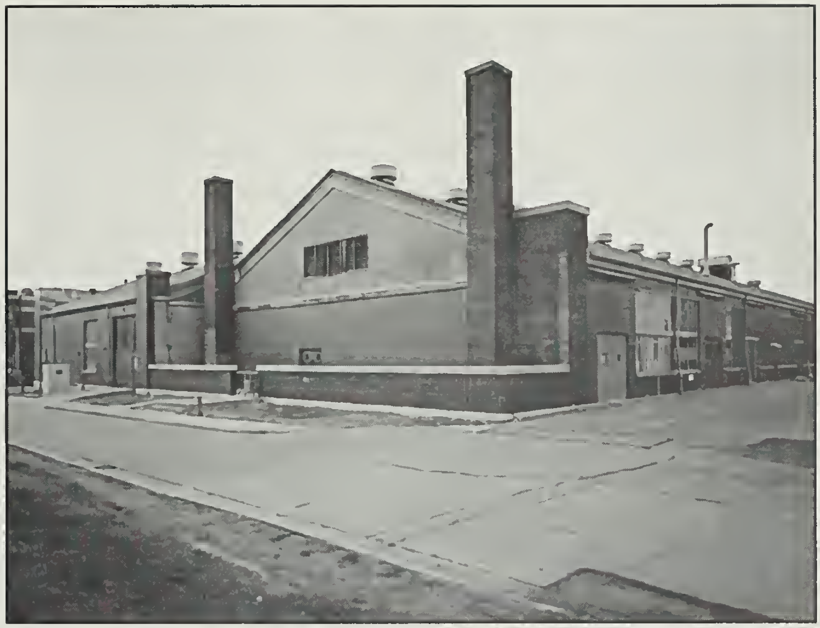


Figure 54: Building 18 (Power Plant Research Laboratory), looking northwest, 1991.

Figure 55: North facade, Buildings 18A-D, 1992.

BUILDING 19: 5-FOOT WIND TUNNEL

HAER No. OH-79-B

Construction Dates: 1927-1929

DESCRIPTION: This two-story, six-course American bond brick building has a low-pitched, front-gabled roof with a copper entablature. Exhibiting elements of the Greek Revival style, rectangular columns with concrete capitals decorate the corners. Below the concrete stucco gables of the east and west ends, fifteen bays of twelve-pane windows with concrete sills run the entire width of the building. The second story of the north side contains twelve window bays, with two nine-pane and two twelve-pane windows in each bay. The ground floor contains similar bays with large, steel, double doors leading to the generator room. The south side, now obscured by Building 20, has eleven window bays. At the west end, large metal double doors are flanked by single doors, themselves flanked by nine-pane windows. Other single doors are located on the north and east sides of the building. The original copper downspouts have been painted over, and several original awning hooks remain over the windows.

The tunnel itself retains most of its original components. The motor generators, drive motors and electrical equipment are all original. This equipment (built by Sprague Electric between 1908-1910) has only been overhauled once, and that was not until the early 1960s. Four original humidifiers, manufactured by the Bannson Company, remain near the ceiling of the building.

HISTORY: One of the original Wright Field structures, Building 19 remains virtually unchanged from its 1929 state and is one of the most historically significant buildings on Wright-Patterson Air Force Base. Although designed specifically to house the 5-Foot Wind Tunnel, Building 19 was built in 1927 as a temporary structure, with steel corrugated sheet metal siding and roofing. When the 5-Foot Wind Tunnel was actually moved from McCook Field in 1929, funds became available to make the building permanent with brick walls, steel-sashed windows, and a permanent roof.

The Air Service's Engineering Division began planning the construction of a wind tunnel after World War I. Wind tunnels had been an increasingly popular tool for aircraft engineering since the Wright brothers successfully used data from their homemade tunnel (22"-square and 5'-long) in 1902. By subjecting small scale models to artificial winds, tunnels allow engineers to test the effect of design changes on such characteristics as airplane drag, stability and maneuverability at far lower cost than would the building of full-size prototype airplanes. By 1920, the Air Service was issuing outside contracts for aerodynamic testing in the amount of $30,000 per year. The construction of an in-house wind tunnel seemed an economic and practical necessity.

Refinements to tunnel technology have been constant in this century, but engineers have identified five elements that constitute any wind tunnel: an enclosed passage through which a *drive system* sends moving air; a *test section*, in which a scale *model* is suspended in a *controlled airstream*; and associated *test instrumentation*. Originally, the Air Service Engineering Division desired an 8-foot diameter test section for its research at McCook Field. At the time, however, no building at McCook was large enough to contain a tunnel of that size. Moreover, since it was known that the tunnel might be moved in the near future, portability was a significant concern. Consequently, the Army Air Service settled on a 5-foot version, with provisions for increasing the size at a later date. The McCook Field Wood Shops built the tunnel under the supervision of R.J. Myers, most probably without special design drawings or specifications. It is likely, however, that engineers at the Massachusetts Institute of Technology contributed the basic plans for the tunnel. Upon completion it was the most powerful and efficient tunnel in the world, and was extolled as a remarkable wood working job. When the tunnel was completed in 1922, the final inspection team included Orville Wright.

The Wood Shops at McCook fashioned the tunnel's main chamber by cutting narrow staves of seasoned Port Arthur cedar in a four-side molder. These were fitted together with the tongue-and-groove method inside circumferential rings, and then glued and screwed, thus making each segment of the tunnel a rigid unit. Cradles under alternate rings supported the tunnel. The cradles for the test section segments were mounted on wheels that rode on rails, which allowed the tunnel to accommodate tests of maximum range and make use of the two original model support systems, or balances.

The tunnel's test section has employed three types of balances in its lifetime. It originally came equipped with a National Physics Laboratory (NPL) mass balance (manufactured by Wm. Gaertner & Co. in Chicago), embedded in 8 feet of concrete. Although not used for many years, all the components survive. The other original model support is the tunnel's wire balance (sometimes referred to as a "Wright balance"), which also remains in Building 19 and is still used periodically. The primary means of model support and data collection today is a string gauge balance which features a full 6° of freedom and--sacrificing sensitivity for quantity--can issue about 400 data points per second. Instrumentation used in the tunnel included a water and kerosene micrometer (original), which was very accurate in boundary layer testing, but very slow and tedious to operate; several manometers (used to measure the pressure of air around a surface); and an inclinometer dating from the 1920s.

Air was driven through the experimental section by two fans of 900 horsepower each. Wind speeds could reach 260 miles per hour, although the usual test conditions involved winds of 40-100 miles per hour. According to Harold Larsen, Professor Emeritus at the Air Force Institute of Technology and long-time operator of the 5-Foot Wind Tunnel, the fabrication of the two twelve-blade fans for the tunnel was delayed due to the difficulty of procuring wood of the proper hardness. Tunnel engineers did not find an adequate source for the wood until they learned of a frozen cherry orchard in Michigan. Sometime during the 1940s, a model accidentally escaped the test section, flying through the fan section where it shattered one fan blade. As a result, the damaged blade--as well as the one directly opposite it--had to be removed, leaving only ten blades on the front fan. Almost seventy years old, the fans have developed hairline cracks in their hubs. Consequently, Professor Larsen is currently designing replacement fans which will make use of a composite material and a new, more efficient design. One of the last pieces of equipment moved to the new installation at Wright Field, the tunnel was disassembled at McCook during February of 1928 and reassembled in Building 19 by February of the next year. The tunnel itself was unaltered, except for the addition of an experimental cabin built around the tunnel near the test section, and the removal of wheels from the support cradles. Building 19's floor does have permanent rails installed, but the straightening vane assembly (which directs air flow in the tunnel) is now the only maneuverable component of the wind tunnel. The straightening vane assembly and the straightening vanes in the fan section both consist of an even number of vanes arranged symmetrically. Aerodynamics engineers have since discovered that an asymmetrical arrangement of a prime number of vanes is more efficient.

One of the first assignments for the new tunnel (while still at McCook Field) was to test models of the XNBL-1 Barling Bomber of 1923. The tunnel provided critical data on performance and stability on what was at that time the world's largest airplane. The highly successful tests demonstrated that a wind tunnel could save tremendous amounts of time and money by increasing the predictability of prototypes. At the time of the Barling Bomber project, a test represented about 1 percent of the total cost of a new experimental airplane. Consequently, if a proposed aircraft turned out to be of a faulty design, 99 percent of the project cost, and possibly the pilot's life, was saved.

At Wright Field, the 5-Foot Wind Tunnel became a critical component in the development of aircraft technology. The tunnel tested nearly every aircraft, both whole models and components, developed by the military during the 1930s. The 5-Foot Wind Tunnel provided critical data on the problems of "flutter"--an instability of the aircraft which eventually leads to failure. Tunnel engineers conducted control surface flutter, flight flutter, and flutter model tests on many aircraft and components prior to World War II. In 1939, the Aircraft Lab created a Flutter and Vibration Section, which took over most flutter testing. They conducted most tests in flight, since wind-tunnel engineers were reluctant to test models which might break up and damage the tunnel. Nonetheless, the 5-Foot tunnel has retained its usefulness for other kinds of researches. In 1958, the Aircraft Laboratory (predecessor of the Flight Dynamics Directorate of Wright Laboratory) gave the 5-Foot Wind Tunnel to the Air Force Institute of Technology for its students' thesis projects, which often concentrate on specific problems for which the Air Force needs data. Furthermore, the Aeromechanics Division still occasionally uses the tunnel for testing, such as recent work on the X-29 project. Since World War II, the long list of aircraft that have benefitted from the experiments in the 5-Foot Wind Tunnel include the F-15, F-4C, C-130, EC-135 (ARIA), and numerous missile systems.

The models used in wind tunnels can be extremely expensive and time-consuming to build, thus reducing a tunnel's efficiency by limiting the amount of work available for it. For example, just prior to World War II, an aluminum wing model for an A-26, accurate to within 1/10,000", cost $100,000. However, in a dramatic cost-cutting move, Harold Larsen contacted the commercial model company Revel in the 1950s. It turned out that their 59 cent plastic models were well within the accuracy tolerances needed to conduct stability, control and aerodynamic testing. Consequently, thousands of dollars could be saved on initial testing of particular prototypes. It was only when the testing relied on mass, or high loads that more expensive models were needed, since plastic deflects easily. Many of the models tested in the tunnel throughout its long history remain on display within the wind tunnel building. Examples range from early triplanes to large-scale missile bodies and early space shuttle prototypes.

The 5-Foot Wind Tunnel enjoys status as the oldest operating wind tunnel in existence anywhere, and is being considered for National Landmark status by the American Society of Mechanical Engineers. Although Wright Field has housed many other, newer wind tunnels, the 5-Foot tunnel still presents an inexpensive and quick means for preliminary testing. About 30 percent of the tunnel's work is for other organizations, such as the Army, Navy, Central Intelligence Agency, and private contractors--essentially anyone with a government contract can arrange a test in the tunnel. In recent years, the tunnel has been the site for such diverse tests as skyscraper aerodynamics, soap box derby models, and bicycle wheels for the U.S. Olympic team. Building 19 is almost exclusively a housing for the 5-Foot Wind Tunnel, although a few support facilities are also in the building. Enclosed office and workshop spaces flank the large bay doors leading out the west end. The motor-generator room at the east end of the building also contains two smaller wind tunnels. One of the tunnels, powered by a B-29 air conditioning motor, is used for tests needing very low turbulence levels (.001%), and produces airspeeds up to 70'/sec. The second, very small and unique, wind tunnel tests cascades and turning vanes. The building also contains a 2-ton overhead crane.

For sources, see Bibliography on page 215.

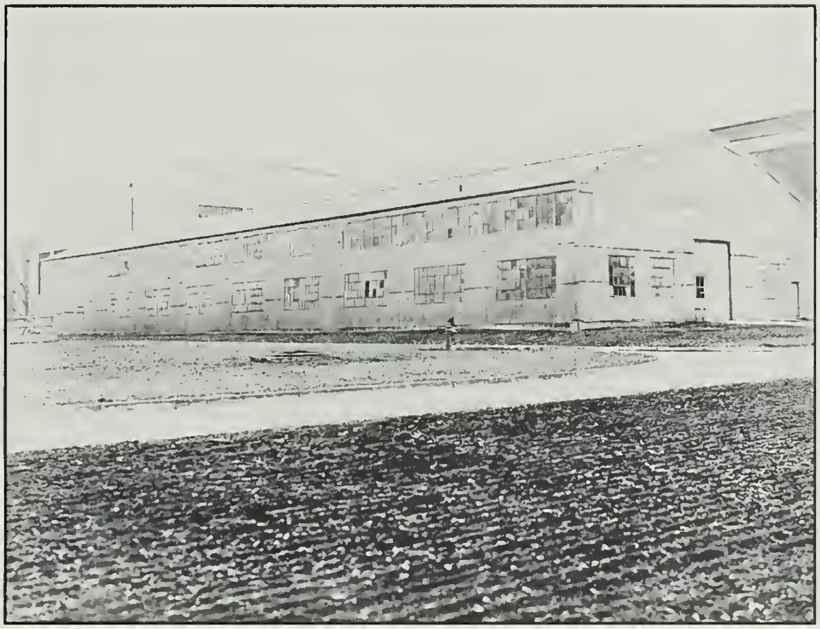


Figure 56: Temporary structure for Building 19, ca. 1927-29. (USAF)

Figure 57: West facade of Building 19, 1991.

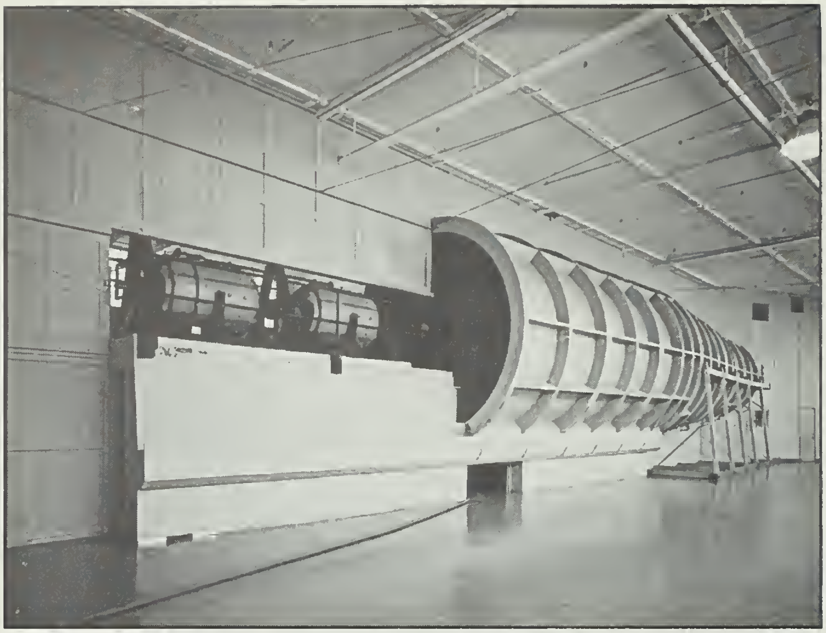


Figure 58: 5-Foot Wind Tunnel with fan motors in foreground, 1991. [See photograph on page 18.]

Figure 59: Detail of exterior of 5-Foot Wind Tunnel, 1991.

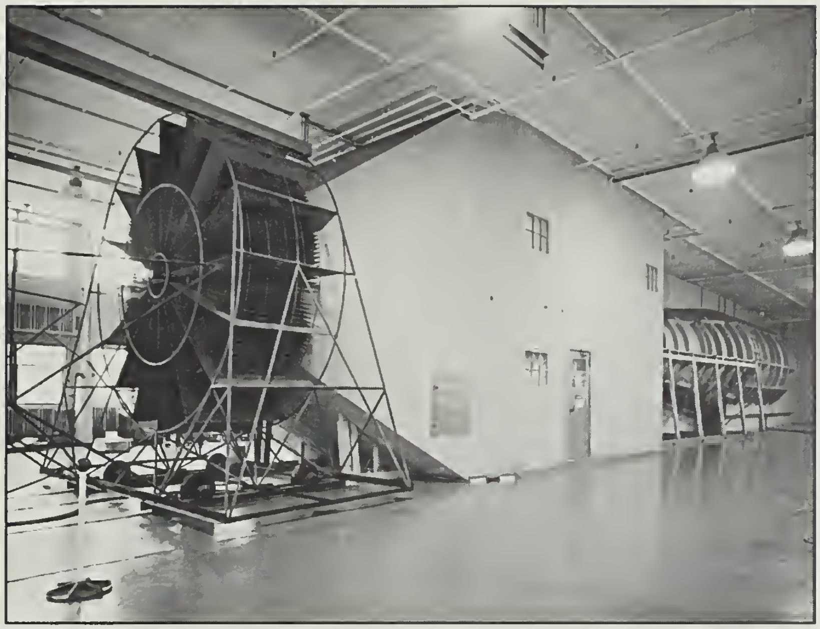


Figure 60: Exterior view of control room, 5-Foot Wind Tunnel, 1991.

Figure 61: One of two generators for 5-Foot Wind Tunnel, 1991.

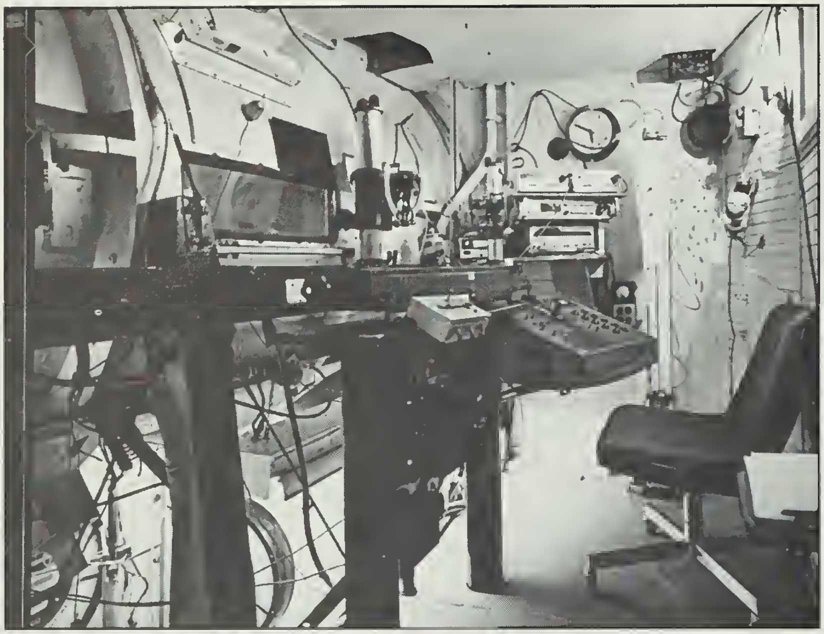
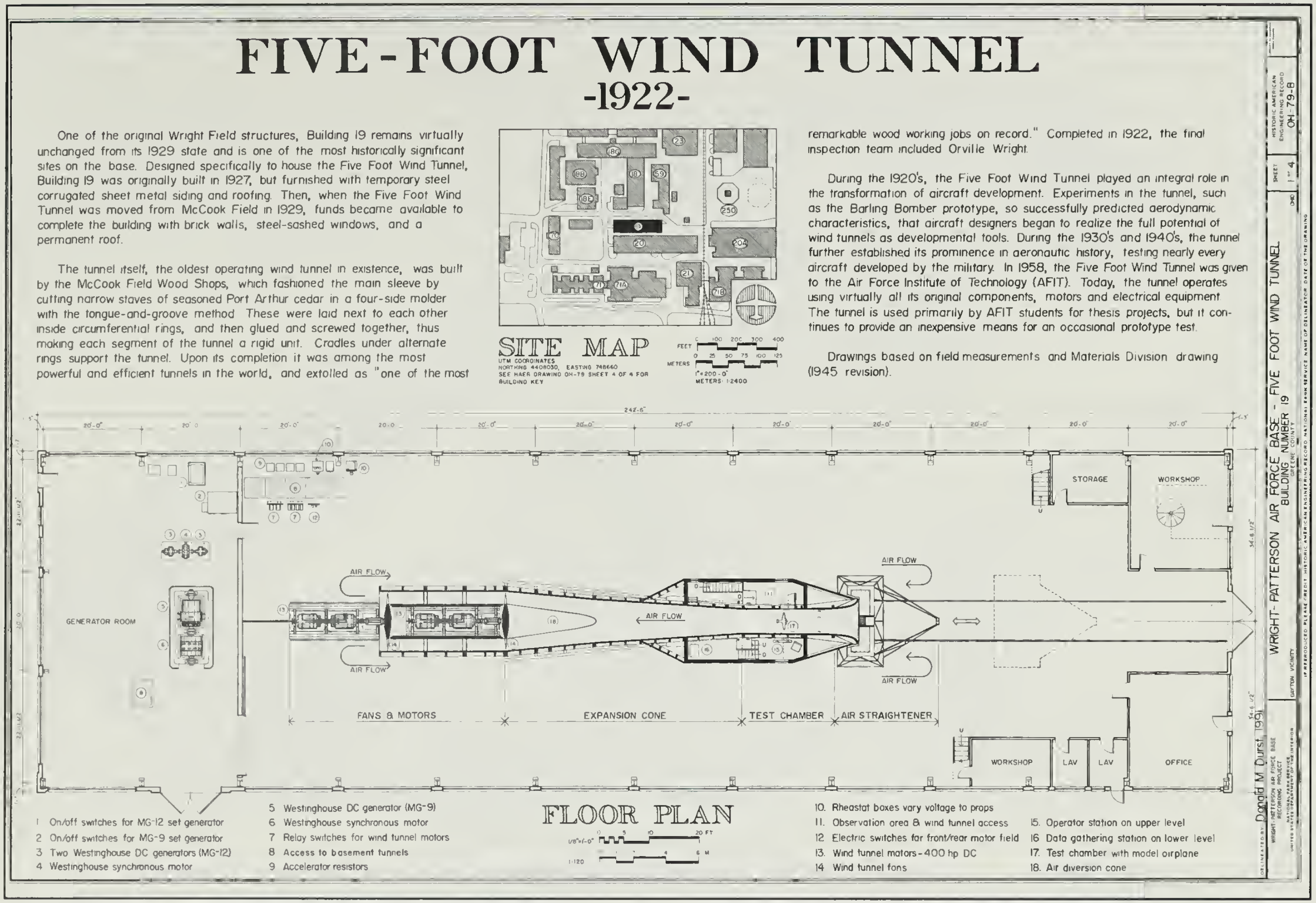


Figure 62: Interior view of control room, 5-Foot Wind Tunnel, 1991.

Figure 63: Test models for 5-Foot Wind Tunnel, 1991.



FIVE-FOOT WIND TUNNEL

-1922-

One of the original Wright Field structures, Building 19 remains virtually unchanged from its 1929 state and is one of the most historically significant sites on the base. Designed specifically to house the Five Foot Wind Tunnel, Building 19 was originally built in 1927, but furnished with temporary steel corrugated sheet metal siding and roofing. Then, when the Five Foot Wind Tunnel was moved from McCook Field in 1929, funds became available to complete the building with brick walls, steel-sashed windows, and a permanent roof.

The tunnel itself, the oldest operating wind tunnel in existence, was built by the McCook Field Wood Shops, which fashioned the main sleeve by cutting narrow staves of seasoned Port Arthur cedar in a four-side molder with the tongue-and-groove method. These were laid next to each other inside circumferential rings, and then glued and screwed together, thus making each segment of the tunnel a rigid unit. Cradles under alternate rings support the tunnel. Upon its completion it was among the most powerful and efficient tunnels in the world, and extolled as "one of the most remarkable wood working jobs on record." Completed in 1922, the final inspection team included Orville Wright.

During the 1920's, the Five Foot Wind Tunnel played an integral role in the transformation of aircraft development. Experiments in the tunnel, such as the Barling Bomber prototype, so successfully predicted aerodynamic characteristics, that aircraft designers began to realize the full potential of wind tunnels as developmental tools. During the 1930's and 1940's, the tunnel further established its prominence in aeronautic history, testing nearly every aircraft developed by the military. In 1958, the Five Foot Wind Tunnel was given to the Air Force Institute of Technology (AFIT). Today, the tunnel operates using virtually all its original components, motors and electrical equipment. The tunnel is used primarily by AFIT students for thesis projects, but it continues to provide an inexpensive means for an occasional prototype test.

Drawings based on field measurements and Materials Division drawing (1945 revision).

SITE MAP

UTM COORDINATES
NORTHING 4408030, EASTING 748660
SEE HAER DRAWING OH-79 SHEET 4 OF 4 FOR BUILDING KEY

FLOOR PLAN

1 On/off switches for MG-12 set generator
2 On/off switches for MG-9 set generator
3 Two Westinghouse DC generators (MG-12)
4 Westinghouse synchronous motor
5 Westinghouse DC generator (MG-9)
6 Westinghouse synchronous motor
7 Relay switches for wind tunnel motors
8 Access to basement tunnels
9 Accelerator resistors
10. Rheostat boxes vary voltage to props
11. Observation area & wind tunnel access
12 Electric switches for front/rear motor field
13. Wind tunnel motors-400 hp DC
14 Wind tunnel fans
15. Operator station on upper level
16 Data gathering station on lower level
17. Test chamber with model airplane
18. Air diversion cone

WRIGHT-PATTERSON AIR FORCE BASE - FIVE FOOT WIND TUNNEL
BUILDING NUMBER 19
GREENE COUNTY
DAYTON VICINITY
OHIO

DELINEATED BY: Donald M Durst 1991

WRIGHT-PATTERSON AIR FORCE BASE RECORDING PROJECT
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

SHEET 1 OF 4

HISTORIC AMERICAN ENGINEERING RECORD
OH-79-B

IF REPRODUCED PLEASE CREDIT: HISTORIC AMERICAN ENGINEERING RECORD, NATIONAL PARK SERVICE, NAME OF DELINEATOR, DATE OF THE DRAWING

Figure 64: 5-Foot Wind Tunnel, Building 19, 1922. (Delineated by Donald M. Durst, HAER, 1991)

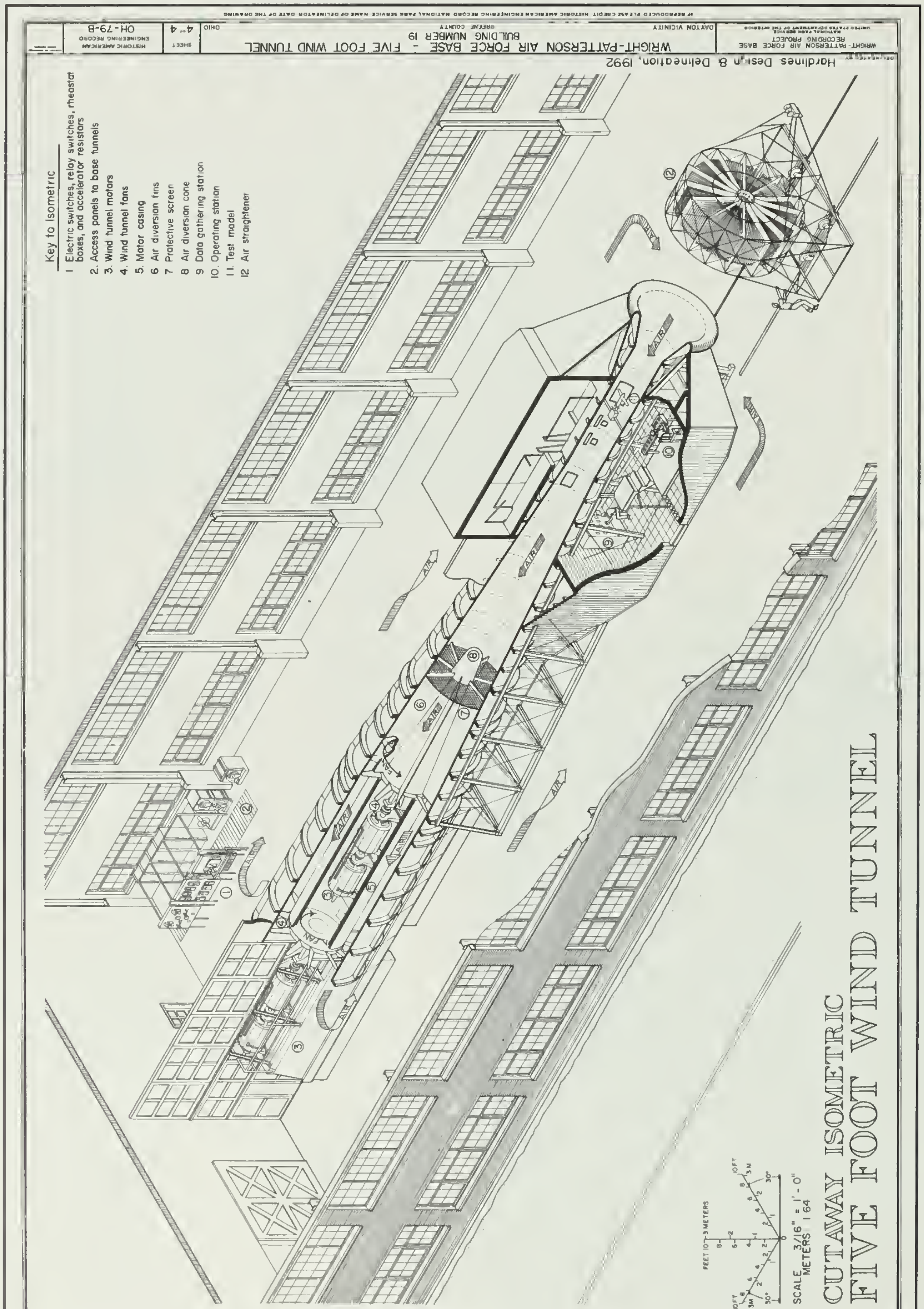


Figure 65: 5-Foot Wind Tunnel, Building 19, 1922. (Delineated by Hardlines: Design & Delineation, HAER, 1992)

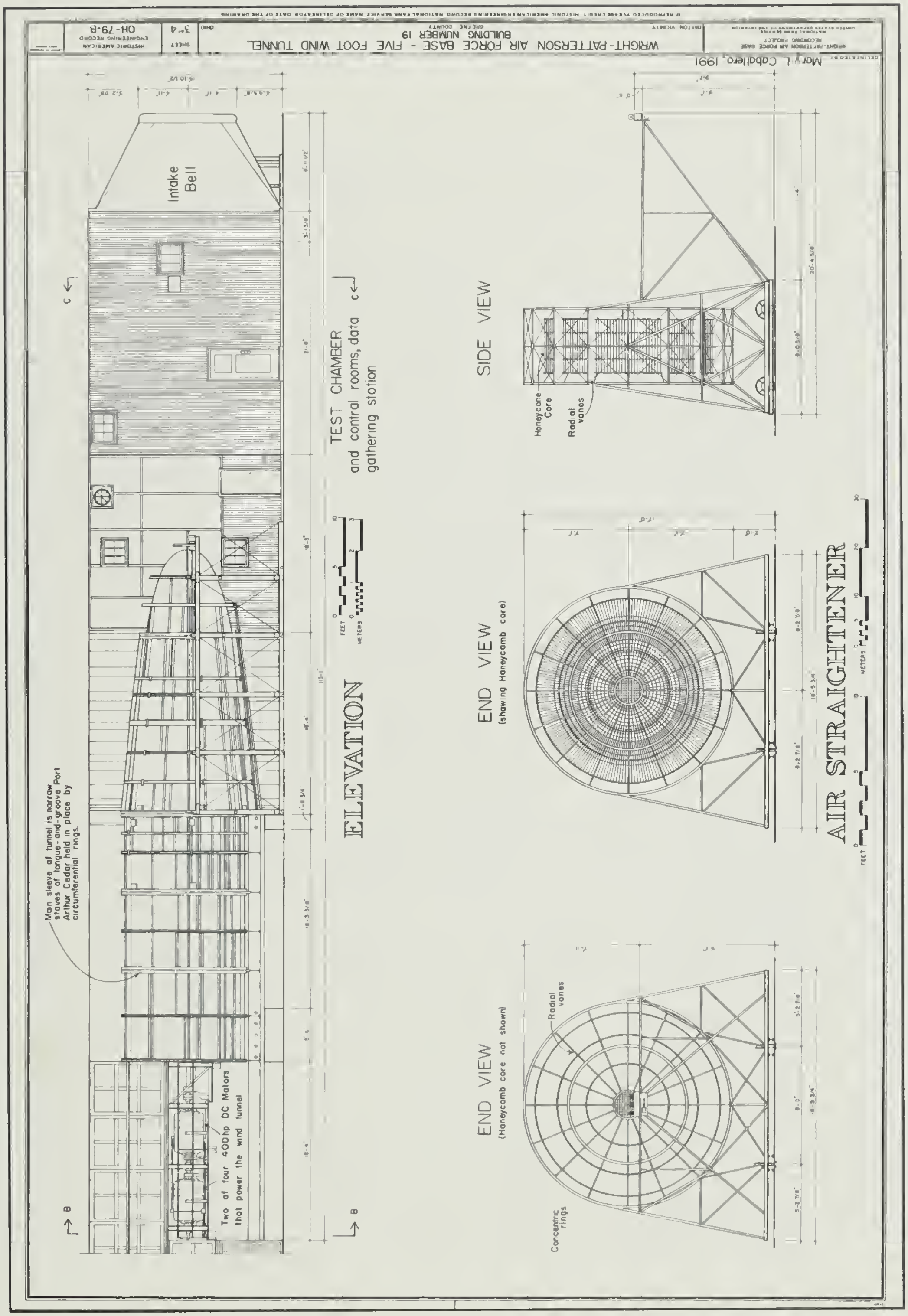
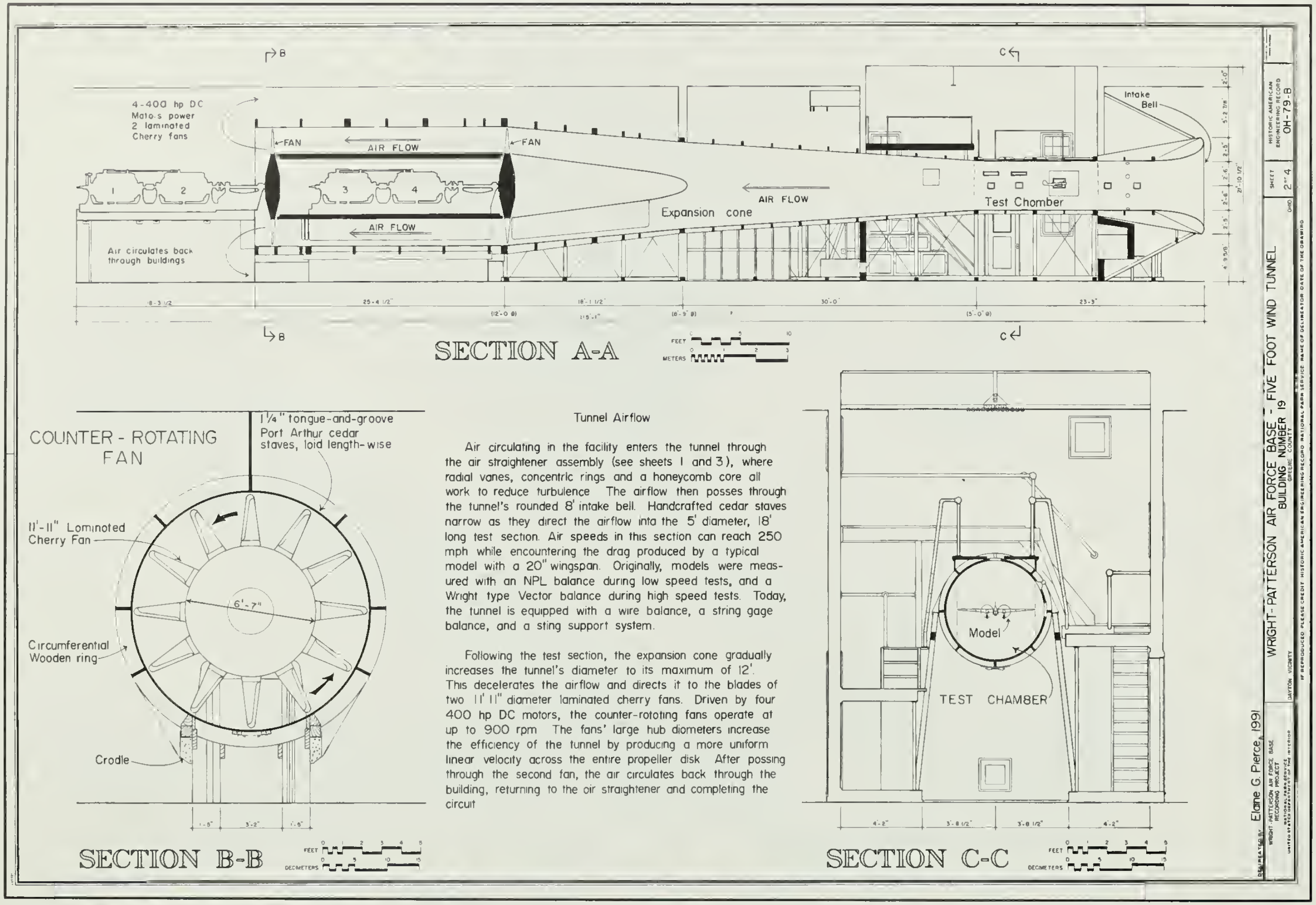


Figure 66: 5-Foot Wind Tunnel, Building 19. (Delineated by Elaine G. Pierce, HAER, 1991)



Tunnel Airflow

Air circulating in the facility enters the tunnel through the air straightener assembly (see sheets 1 and 3), where radial vanes, concentric rings and a honeycomb core all work to reduce turbulence. The airflow then passes through the tunnel's rounded 8' intake bell. Handcrafted cedar staves narrow as they direct the airflow into the 5' diameter, 18' long test section. Air speeds in this section can reach 250 mph while encountering the drag produced by a typical model with a 20" wingspan. Originally, models were measured with an NPL balance during low speed tests, and a Wright type Vector balance during high speed tests. Today, the tunnel is equipped with a wire balance, a string gage balance, and a sting support system.

Following the test section, the expansion cone gradually increases the tunnel's diameter to its maximum of 12'. This decelerates the airflow and directs it to the blades of two 11' 11" diameter laminated cherry fans. Driven by four 400 hp DC motors, the counter-rotating fans operate at up to 900 rpm. The fans' large hub diameters increase the efficiency of the tunnel by producing a more uniform linear velocity across the entire propeller disk. After passing through the second fan, the air circulates back through the building, returning to the air straightener and completing the circuit.

Figure 67: 5-Foot Wind Tunnel, Building 19. (Delineated by Mary L. Caballero, HAER, 1991)

BUILDING 20: PROPELLER LABORATORY

HAER No. OH-79-J

Construction Date: 1927

DESCRIPTION: Building 20 is a two-story, nine-bay, concrete building, measuring 98' x 277', with a basement and a bowstring truss roof. There is a brick entrance structure attached to the east end of the building with steel sash and glass-block windows above and on either side. On the south side there are nine pairs of windows and seven pairs on the north side. The east wall is decorated with Art Moderne detail in the form of three horizontal grooves in the concrete.

HISTORY: In 1927 construction began on the earliest section of what is now Building 20 as the generator-power house for the 2,500 horsepower variable speed drive propeller test stand (later called Rig 3) and bomb pad that were transferred from McCook Field. However, the facility was not completed until May 1929 and, in the meantime, testing continued at McCook Field. The floors were designed for 250 and 500 p.s.f. and the walls were built to a thickness of 18", incorporating ⅝" round bars at 12" centers for reinforcement. The original construction included a tunnel from the power house to the control room located beneath the test stand. The tunnel was used for power cabling and utilities to the test stand and personnel access to the control room. A 40-ton crane and craneway was originally used in the construction of the generators and test rig drive motors, and the installation of test articles. The craneway still supports the maintenance of the generators, drive motor, and movement of test articles.

Two additional test stands (Rigs 1 and 2) and bomb pads were completed in 1931 with 6,000 horsepower and 3,000 horsepower capabilities. In 1942 a two-story shop and engineering building was added to the west end of the power house to support Propeller Laboratory activities. This whole structure is now designated Building 20.

In 1944 an acoustical enclosure was constructed around the three test stands and the original Helicopter Rotor Test Stand located between Rig 1 and the power house. This is now Building 20A (described in the following report).

The Laboratory worked on developing propellers, propeller hubs and controls for aircraft of rapidly increasing size and power, for Army and Navy fighters, bombers, cargo and passenger planes and VTOL aircraft. Among the Laboratory's concerns were such new devices as the dual-rotation propeller (in which two sets of blades turn at the same time but in opposite directions); gearing systems for the control of propeller speed; and technologies to carefully control blade pitch. During World War II the emphasis was on aircraft maneuverability, as needed in combat situations, rather than on speed itself. Jet propulsion, although known to U.S. aeronautical engineers at the time and used on German aircraft and weaponry, did not come to fully occupy U.S. Army Air Corps engineers until after the armistice. Thus, propellers maintained their paramount importance at the Wright Field facilities throughout the war period.

In 1957 the Propeller Laboratory was assimilated into what became known as the Aero Propulsion and Power Directorate of Wright Laboratory. The engineering offices were occupied by the Wright Air Development Center in the following year. In 1964 Tech Photo Services took over the first floor and basement, merging with Avionics Systems Division Graphics in 1990 to become the Aeronautical Systems Division (now Aeronautical Systems Center) Visual Information Center. The Avionics Systems Division's Recon and Defense Office occupies the second floor.

For sources, see Bibliography on page 215.

Figure 68: Building 20, looking northeast, 1991.

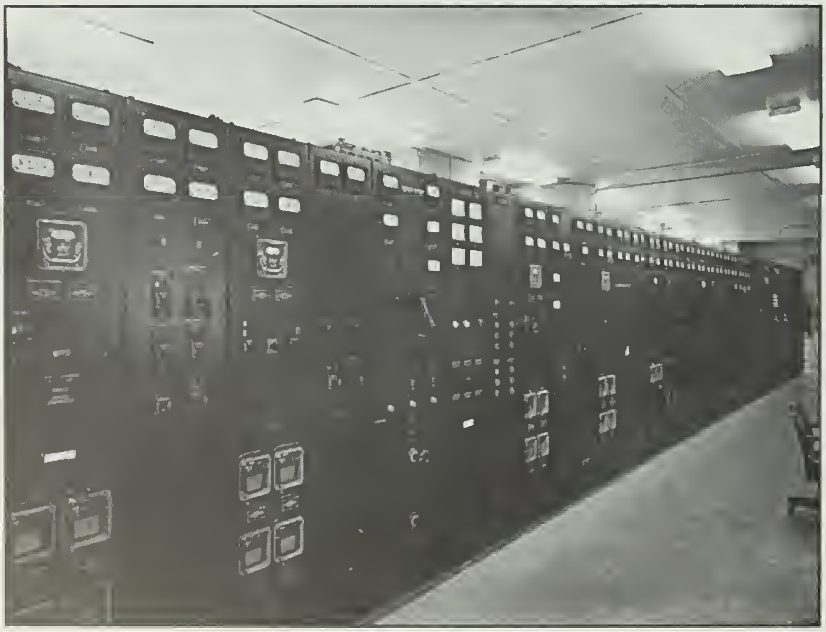


Figure 69: Interior view of control room, Building 20, 1991.

BUILDING 20A: PROPELLER WHIRL RIGS ACOUSTICAL ENCLOSURE

HAER No. OH-79-C

Construction Date: 1927, 1944

DESCRIPTION: The Propeller Test Complex is a rectangular, cast-in-place concrete building with nineteen open-sided bays. The 24' thick walls are a combination of solid concrete and acoustical baffles of honeycomb construction. The baffles are tubes of 3½"-thick pre-cast concrete which is so porous that it allows smoke to blow through the walls of the tube. Four baffles, 6' long and 2' square are laid end to end, angled slightly upward from both sides towards the center of the wall to increase their muffling effect. The baffles are now enclosed with glass. The roof is constructed of 3" planks on wood trusses, covered by a 3" slab of lightweight aggregate concrete. The floor is the original concrete base which supported the rigs before they were enclosed. The interior of the complex contains four propeller test whirl rigs built by Westinghouse Corporation, a craneway, and wooden baffling pads called bombproofs.

HISTORY: The Propeller Test complex is a system of structures designed to test the structural integrity of aircraft propellers. The heart of the complex is the line of three propeller test rigs, built by the Westinghouse Corporation to the specifications of Wright Field personnel M.A. Smith and Adam Dickey. The first was completed in 1929 and the other two in 1931. Operating at 6000, 3000, and 2500 horsepower, these rigs were originally designed to turn propellers at respective speeds of 750, 1800, and 3600 revolutions per minute. (The high horsepower rigs operated large propellers, which revolved at slower speeds than small propellers.) Typically, an endurance test of twenty hours was followed by an overspeed test at 110 per cent of maximum speed to prove the propeller's strength.

Originally the three test stands stood out in the open. A 40-ton overhead crane was built to assist in the construction of the rigs and to lift experimental equipment and propellers into place. Thick wooden structures called bombproofs or bombpads were constructed next to and above the test rigs to restrict the flight of propeller fragments after failure on the rigs.

A concrete acoustical structure surrounding the test area and craneway was constructed during World War II when the continuous testing of propellers created a thunderous drone so powerful that it was considered a health hazard. The architects faced the challenge of designing an enclosure which would muffle the noise of the propellers while still allowing free circulation of air so as not to affect the test results. Such a structure had never been built before and, in addition, war-related shortages limited the diversity of available materials. Engineers solved the problem by building walls of square tubes, 6' long and 2' square, of a concrete sufficiently porous to allow air to pass through. To create the 24'-thick walls, four tubes were laid end-to-end with an upward tilt in the middle, designed to break up and dampen the sonic pulses produced by the whirl rigs. The architecture-engineering firm that devised this arrangement was Allen and Kelley, of Indianapolis, Indiana, under the direction of the Wright Field District Office of U.S. Army Corps of Engineers. A. Farnell Blair, of Decatur, Georgia, was the contractor, and Price Brothers, of Dayton, fabricated and set in place the precast concrete tubes.

In the early 1950s a fourth test rig was constructed, which was capable of a 30,000 horsepower drive output at variable speeds up to 12,000 r.p.m.

From 1929 to 1965 these rigs were used for testing propellers, propeller hubs and controls.

Testing was done on a range of materials, including wood, laminates, composites and stainless steel, and on a range of propellers, including supersonic and turbo-prop aircraft propellers.

The Compressor Research Test Facility was constructed on the site between 1975 and 1981, consisting of a 30,000 horsepower variable speed drive system, that allowed speeds of up to 16,000 r.p.m. at 30,000 horsepower and up to 30,000 r.p.m. at 15,000 horsepower. The facility is designed to provide performance test data on new and existing jet engine compressors. It also includes a test chamber with test air flow straighteners and an altitude controllable inlet system, a test air exhaust system and a computerized data acquisition system.

For sources, see Bibliography on page 215.

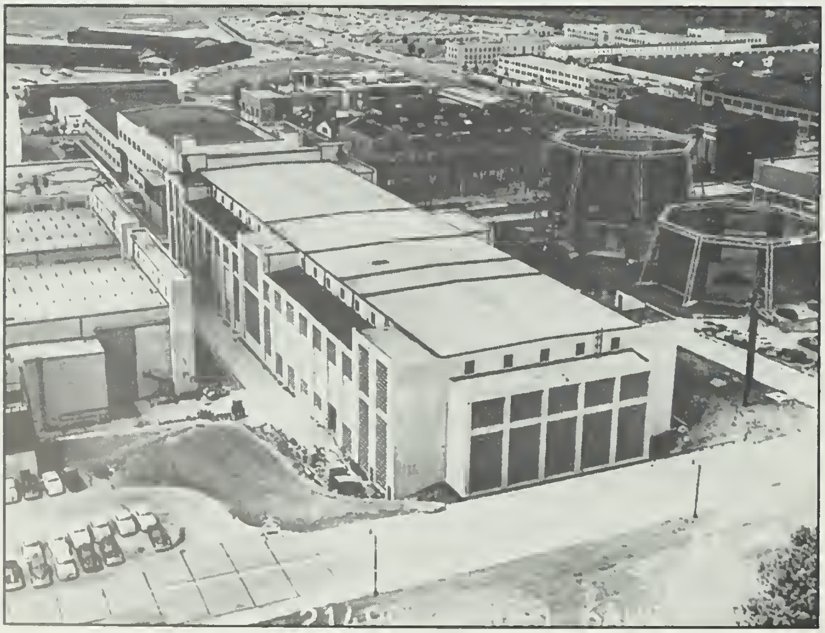


Figure 70: Building 20A, 1953. (USAF)

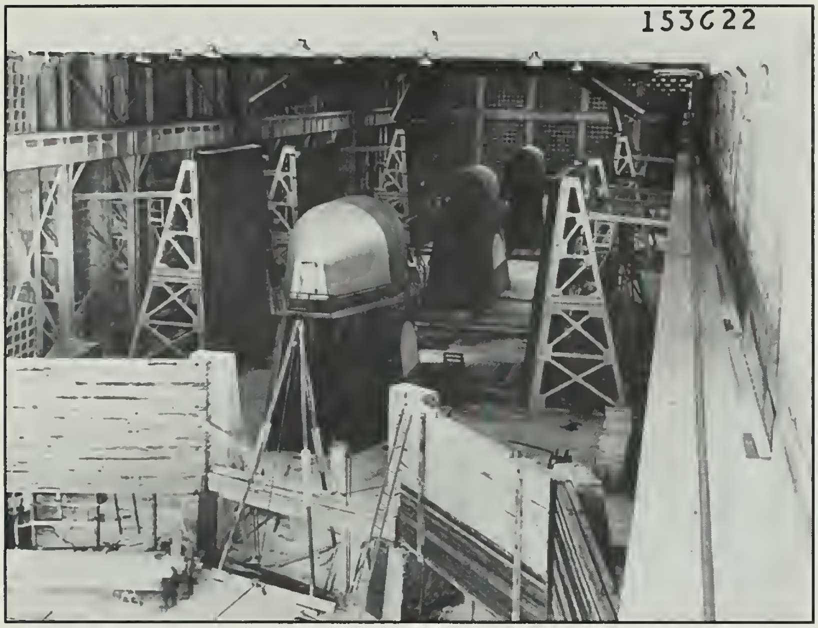


Figure 71: Line of propeller test stands in Building 20A. (USAF)

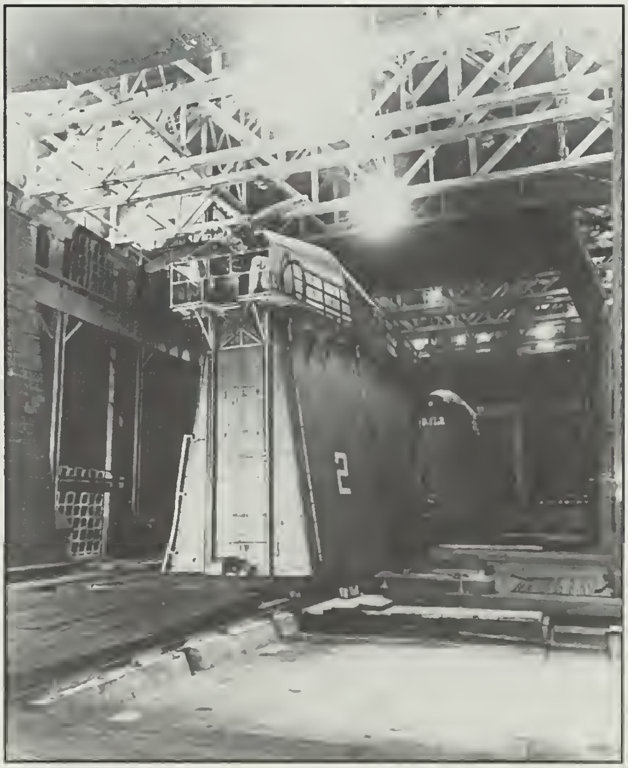


Figure 72: Propeller test stands, Building 20A. (USAF)

Figure 73: Building 20A, looking northwest, 1991.

Figure 74: Interior wall of Building 20A, showing concrete sound baffles, 1991.

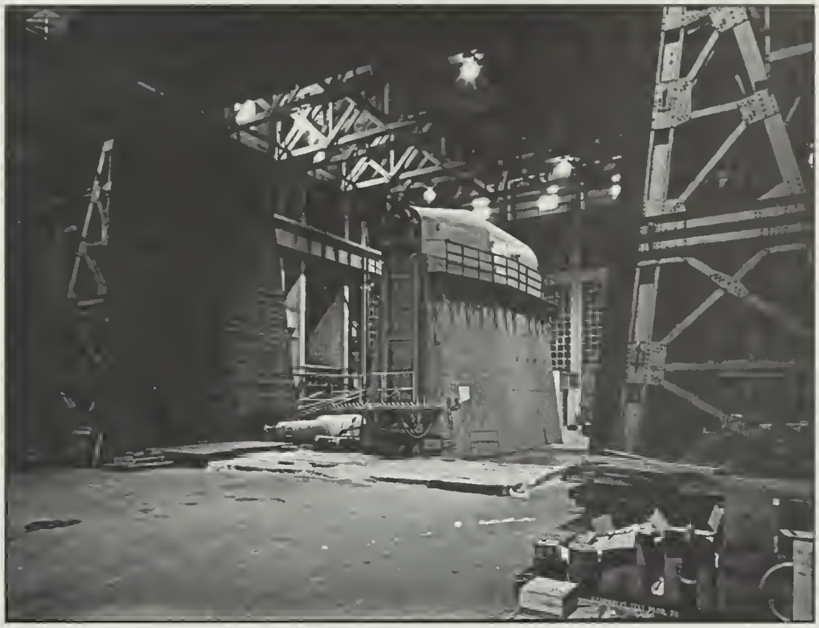


Figure 75: Propeller test stand and bombproofs in Building 20A, 1991.

Figure 76: Bombproof of propeller test stand, Building 20A, 1991.

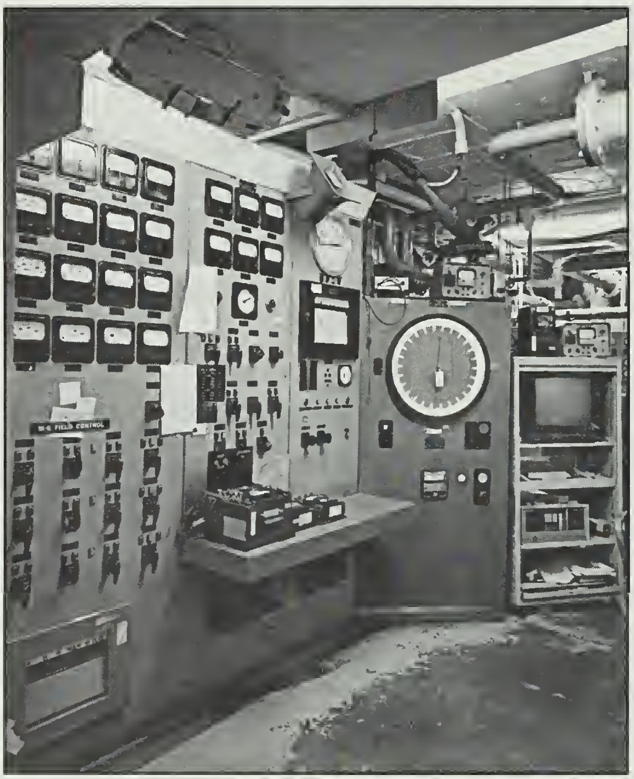
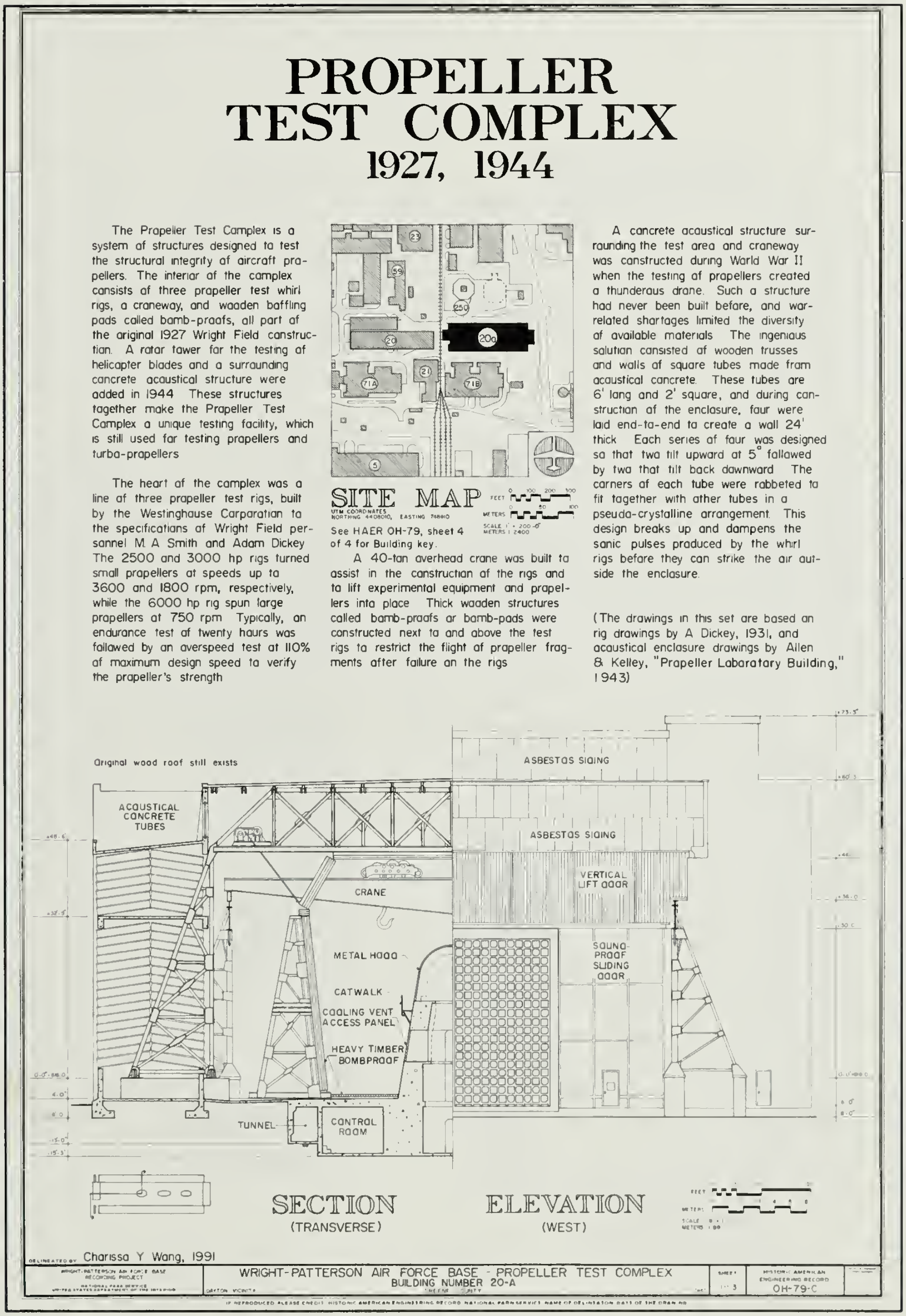


Figure 77: Interior view of propeller test stand control room, Building 20A, 1991.



PROPELLER TEST COMPLEX
1927, 1944

The Propeller Test Complex is a system of structures designed to test the structural integrity of aircraft propellers. The interior of the complex consists of three propeller test whirl rigs, a craneway, and wooden baffling pads called bomb-proofs, all part of the original 1927 Wright Field construction. A rotor tower for the testing of helicopter blades and a surrounding concrete acoustical structure were added in 1944. These structures together make the Propeller Test Complex a unique testing facility, which is still used for testing propellers and turbo-propellers.

The heart of the complex was a line of three propeller test rigs, built by the Westinghouse Corporation to the specifications of Wright Field personnel M. A. Smith and Adam Dickey. The 2500 and 3000 hp rigs turned small propellers at speeds up to 3600 and 1800 rpm, respectively, while the 6000 hp rig spun large propellers at 750 rpm. Typically, an endurance test of twenty hours was followed by an overspeed test at 110% of maximum design speed to verify the propeller's strength.

SITE MAP

UTM COORDINATES
NORTHING 4408010, EASTING 748810

See HAER OH-79, sheet 4 of 4 for Building key.

A 40-ton overhead crane was built to assist in the construction of the rigs and to lift experimental equipment and propellers into place. Thick wooden structures called bomb-proofs or bomb-pads were constructed next to and above the test rigs to restrict the flight of propeller fragments after failure on the rigs.

A concrete acoustical structure surrounding the test area and craneway was constructed during World War II when the testing of propellers created a thunderous drone. Such a structure had never been built before, and war-related shortages limited the diversity of available materials. The ingenious solution consisted of wooden trusses and walls of square tubes made from acoustical concrete. These tubes are 6' long and 2' square, and during construction of the enclosure, four were laid end-to-end to create a wall 24' thick. Each series of four was designed so that two tilt upward at 5° followed by two that tilt back downward. The corners of each tube were rabbeted to fit together with other tubes in a pseudo-crystalline arrangement. This design breaks up and dampens the sonic pulses produced by the whirl rigs before they can strike the air outside the enclosure.

(The drawings in this set are based on rig drawings by A. Dickey, 1931, and acoustical enclosure drawings by Allen & Kelley, "Propeller Laboratory Building," 1943)

SECTION
(TRANSVERSE)

ELEVATION
(WEST)

DELINEATED BY Charissa Y Wang, 1991

WRIGHT-PATTERSON AIR FORCE BASE - PROPELLER TEST COMPLEX
BUILDING NUMBER 20-A

Figure 78: Propeller Test Complex, 1944. (Delin. by Charissa Y. Wang, HAER, 1991) [See also drawing on page 16.]

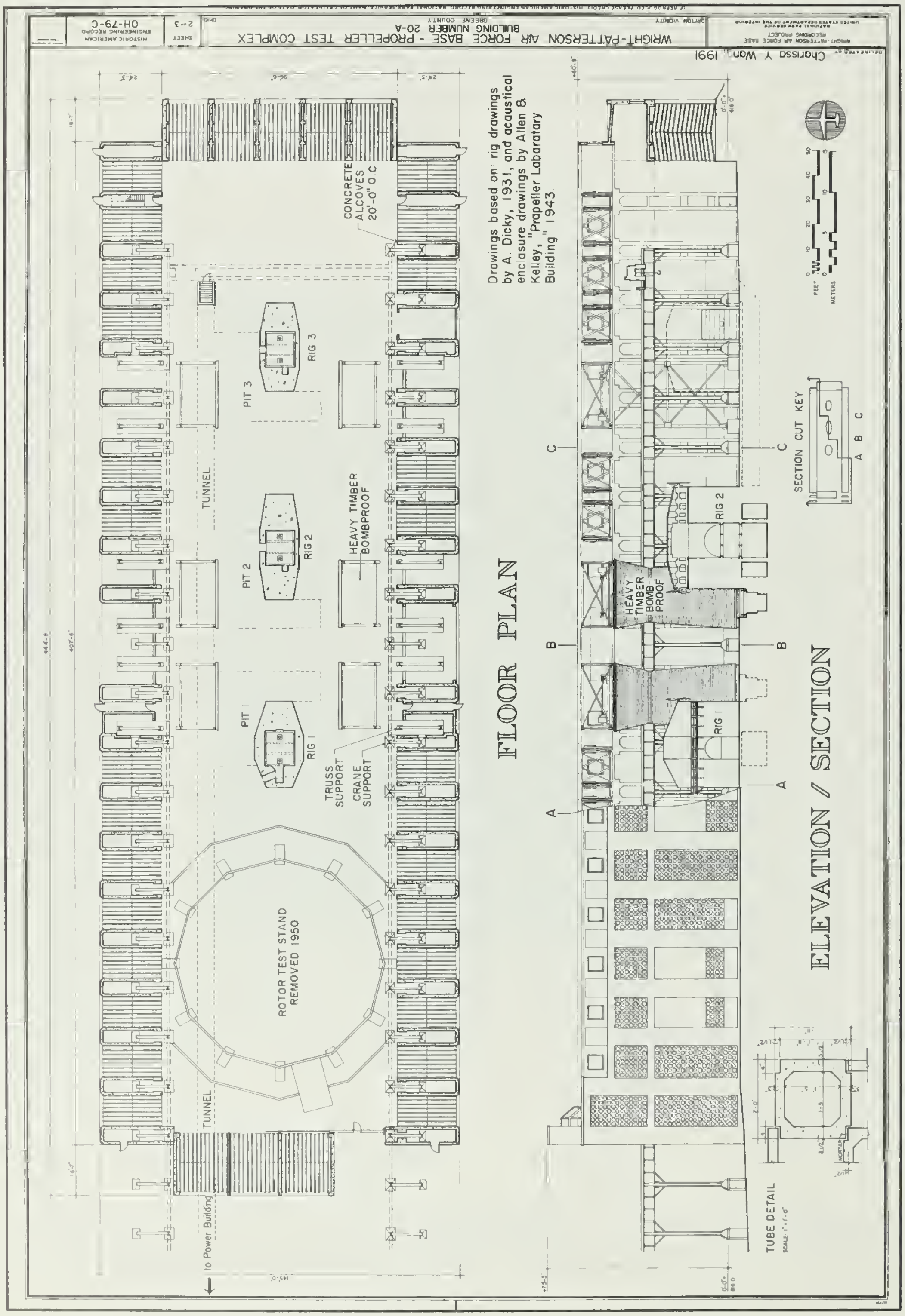


Figure 79: Propeller Test Complex, 1944. (Delineated by Charissa Y. Wang, HAER, 1991)

BUILDING 21: OLD ARMAMENT BUILDING

HAER No. OH-79-R

Construction Date: 1929

DESCRIPTION: The Old Armament Building is a six-course, American bond brick building with a low-pitched roof and copper entablature in the Greek Revival style. There are two bays, one facing east and the other south, each with concrete capitals on rectangular columns at the corners. Originally the building consisted of two adjacent, but perpendicular, gabled bays in the typical Wright Field style--a north section that faced north and a slightly larger southern section with gables facing east and west. In 1938 an east-facing bay was added to match the north-facing bay. The north-facing bay was demolished in 1953. In its place a large concrete addition now towers above the original portion and its slightly newer neighbor to the south. Of the present structure's 28,818 square feet, only 3566 square feet is original.

HISTORY: In 1929, two years after the dedication of Wright Field, the Air Corps Materiel Division constructed Building 21 as its Armament Laboratory. At this facility and the gun range which extended to the east, personnel developed and tested many of the weapons utilized by the Allied forces during the first half of World War II. The Armament Laboratory designed equipment to increase both the firepower and bombing capabilities of aircraft. Wright Field engineers modernized the .30 and .50 caliber machine gun systems that were most common on American aircraft during World War II. They designed cooling systems which allowed gunners to safely increase the rate of fire. This was especially important in attacks against ground targets, since the swift aircraft of World War II spent less time over their targets than previous aircraft. Gun sights and synchronizers were also improved and tested at the Armament Laboratory.

The most important advance in aircraft gunnery was the development of flexibly-mounted machine guns. The heavy .50 caliber guns also required power-mechanisms to operate their turrets effectively. With these systems, gunnery specialists on large bombers could adequately defend themselves even in the absence of fighter protection. The B-17G bomber possessed twelve .50 caliber machine guns, gaining it the nickname "Flying Fortress."

The Armament Laboratory fairly revolutionized bombing tactics with the development of improved bombsights. These specially designed devices adjusted for air speed, wind speed, altitude, bomb trajectory, and aircraft pitch and yaw. This allowed a timed release of bombs at pre-selected intervals. While such systems cannot compare with the laser-guided systems of today, they did increase the deadly effects of medium and high-altitude bombing, which were safer for pilots than the low-altitude bombing runs formerly necessary to ensure accurate bomb delivery.

An east-facing bay was added to Building 21 in 1938. However, as with other original Wright Field laboratories, Building 21 was superseded by new buildings constructed during World War II, in this case the much larger facility of Building 22, the Armament Laboratory Hangar. In 1953 the north bay was demolished and a 21,000-square-foot concrete addition was constructed on the site. Building 21 was assigned to the Propulsion Laboratory and became the engine set-up facility, assembling and preparing engines for tests in the Building 71 complex, which extends both east and west of Building 21. The addition was equipped with a ten-ton bridge crane in each of its high bays (34') and a two-ton bridge crane in each of its low bays (20'). These cranes were used to lift and carry engines and components and were retained later in the 1950s when Building 21 became known as the Fabrication Services Building. Still supporting the Propulsion Laboratory, it was used for the fabrication and assembly of test equipment and also contained four small vibration tables to test small engine components under vibrational stress. Two of the tables were mechanical, and two were electromagnetic.

Over the last several decades, Building 21 has continued its history as a general purpose maintenance shop for the Propulsion Laboratory. Today it contains maintenance support facilities for the Fuel Farm, which is adjacent to the south, and the Compressor Research Facility, located in Building 20A, which tests new compressors and fans for jet engines.

For sources, see Bibliography on page 215.

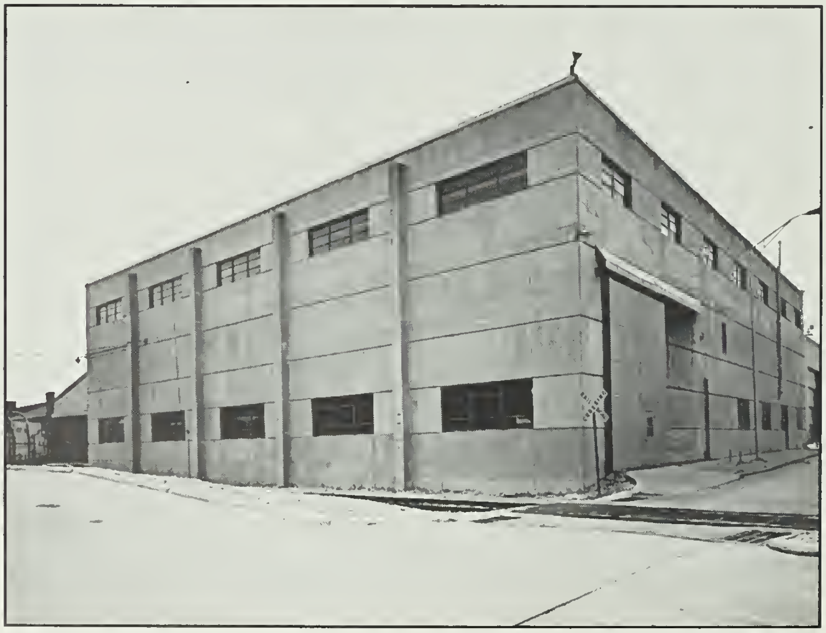


Figure 80: 1953 addition to Building 21, 1991.

BUILDING 22 COMPLEX: ARMAMENT LABORATORY HAER No. OH-79-S (Bldg. 22)
Construction Date: 22: 1942 HAER No. OH-79-T (Bldg. 22B)
22B: 1944

DESCRIPTION: The Armament Laboratory incorporates three interconnected sections. The main portion of the structure is a large steel-framed central hangar with barrel-vaulted roof measuring 284' x 248'. The hangar faces east toward the gun range and has large doors consisting of metal-framed windows suspended on rollers. There are tall concrete towers at all four corners. Two smaller concrete wings are attached to the north and south ends. These are rectangular cast-in-place concrete structures, each with a ten-bay front. Originally, these sections were both 51' wide, and 202' and 233' long, respectively, but in 1952 a two-story addition increased the south wing to twice its original size. Building 22B (the 200 Yard Gun Range Structure) stands to the east of Building 22, on the north side of the Gun Range.

HISTORY:

Building 22: Armament Laboratory

Wright Field's construction boom of World War II increased the number of buildings at the installation almost eight-fold. Building 22 was the first new structure to be completed along the flightline, built in 1942 to accommodate the expanded wartime activities of the Materiel Command Armament Laboratory. Building 22 was several times larger than Building 21, the Old Armament Laboratory (as it became known) and the hangar's personnel also administered three nearby gun ranges. These included a 25-yard range adjacent to the hangar, an enormous 500-yard gun range which extended to the east of the hangar, and a 200-yard indoor gun range also to the east and listed separately as Building 22B.

The two wings were used to house offices and support facilities for the Armament Laboratory, while the hangar itself contained laboratories for the testing and development of weapons guidance systems. The main object of these efforts was a guidance system that would function in a variety of environments. A 1960 report on research and development facilities of the Wright Air Development Center (WADC) stated that Building 22 "contained the most complete environmental equipment in the Air Force." The facility included ten test chambers:

Chamber	Operational Date
Heat and Cold	1942
Systems Altitude	1943
Firing, Cold, Heat, Humidity, and Temperature Shock (Contained a Firing Range)	1943
Stratosphere	1947
Heat	1948
Arctic Altitude	1954
Systems Humidity	1954
Heat, Cold, and Altitude	1955
Systems and Components Climatic Humidity	1956
Climatic Humidity	1958

At the founding of the Air Force as a separate military branch in 1947, this facility was responsible for research and development on weapons guidance and control systems only, while the Army and Navy developed guns, bombs, and rockets. In 1951 the Air Force Armament Center at Eglin Air Force Base took over these responsibilities, while the Armament Laboratory at Wright-Patterson continued its same mission. In 1959 the Navigation and Guidance Laboratory in Building 22 became part of the Avionics Division of the Wright Air Development Division (WADD), and in 1971 it became the Navigation and Weapon Delivery Division of the Air Force Avionics Laboratory. Prior to 1967, Building 22 also contained the Electromagnetic Warfare and Electromagnetic Warfare Applications Branches of the Avionics Laboratory.

Building 22 currently houses offices of the Avionics Directorate of Wright Laboratory, but the laboratories themselves have moved to more modern facilities on base. Two major Air Force technology programs also have their headquarters in the former Armament Hangar. These are PRAM (Productivity, Reliability, Availability, and Maintainability) and RAMTIP (Reliability And Maintainability Technology Insertion Program). PRAM is responsible for directing the development and improvement of various generic aircraft systems, while RAMTIP explores methods to enhance present and future aircraft systems by inserting new technologies into them. Finally, the Wright Laboratories Technical Library is located in a free standing structure inside the hangar which was constructed for the library in 1976. In 1987 a mural of the Wright Flyer (the Wright Brothers' first airplane) was painted on the front facade of the hangar to commemorate the fortieth anniversary of the Air Force.

Outdoor Gun Ranges

Like most engineering facilities, the Army Air Force Materiel Command Armament Laboratory at Wright Field required a test area for the products of its research. In this case it was a complex of three gun ranges to the east of Building 22, the Armament Laboratory Hangar.

A 25-yard gun range, completed in 1942, was located immediately to the east of the north wing of the building. It had a timber and sand backstop enclosed with concrete walls and was used as a bullet stop for the projectiles from guns being tested at low temperatures in the firing cold chamber. The 37mm aircraft cannon was the largest gun fired on this range.

A 500-yard gun range, also built in 1942, was surrounded on three sides by an earthen embankment in the form of a hairpin. A sand and timber backstop at the closed end of the range protected the earthworks from erosion by the projectiles. On both sides of the backstop, 69'-high reinforced concrete walls supported a reinforced concrete ceiling 90' high at its center. The walls and ceilings served to catch projectiles which ricocheted off the backstop, and a timber covering on the underside of the ceiling protected the concrete from damage.

Although the range was 500 yards long, test specimens were seldom fired or fired at from this distance. The gun was usually brought up and anchored quite close to the backstop whether the gun or the target was the test specimen. Airborne fire control equipment such as rocket guns, all sizes of machine guns and cannon, gun turrets, and the like were tested for mechanical operation and performance on this range. The range was used to fire shells of up to 75mm at airplanes, running aircraft engines, oxygen tanks, leak-proof fuel tanks, and other aircraft components. The Wright Field fire department stood by with carbon dioxide (cardox) equipment when flammable materials were involved in the tests.

By the late 1960s, the original backstop in the 500-yard range was rarely used. The structure's roof was considered a potential safety hazard, and base officials decided to tear it down.

The demolition effort succeeded, but the concrete slabs were so well reinforced that breaking them into pieces for removal proved more difficult than imagined, and the rubble was left where it fell.

Today the area contains two smaller and more modern gun ranges designated Range 2 and Range 3. These ranges are used by the Aircraft Survivability Laboratory to test the integrity of aircraft substructures under fire from foreign-made weapons. Substructures tested include wings, stabilizers, fuselages, fuel tanks, cockpit canopies, and instrument casings.

Range 2, located on the north side of the original backstop, was erected in the mid-1970s and is called a "shoot and look" range. Small target specimens are fired upon and then examined visually to assess the damage and determine methods to reduce damage in the future. The gun is fired on the object from distances of around 50'-100'. To realistically simulate long-range fire, the amount of powder in the ammunition cartridges is reduced, thus lowering the projectile speed to the desired level. The powder is loaded into the bottom of the cartridge next to the primer and the remainder of the normal powder space is filled with rice puffs. These occupy space to keep the powder in place, but the explosion instantly pulverizes them with insignificant energy loss.

Range 3 is an elevated gun range constructed of steel and concrete to the south of the original backstop in the late 1960s. Because the target specimen is located on a platform, it can be fired upon from the front, back, bottom or top without being moved. In the early 1970s, jet engines were added to the apparatus so that their by-pass air could simulate the airflow associated with an aircraft in flight. Ducts direct this air to blow across the test area at normal jet speeds of several hundred miles per hour. This airflow makes the gunfire simulation more realistic by spreading fire (and sometimes extinguishing it), applying structural loads, ripping weakened pieces away, and peeling apart damaged composite laminations.

Tests on both of these gun ranges are administered from a concrete blockhouse to their west, constructed in 1974. This building contains computers which record and process experimental data and can control the firing of guns. Cameras are also controlled from the blockhouse and can record impacts with both normal and high-speed video and still cameras. Blockhouse instruments also control and monitor Range 3's infrared system, which can identify interior fires and can also see through carbon-dioxide fire-suppression clouds to reveal when fires are extinguished.

Building 22B: 200 Yard Gun Range Structure

The 25-yard range and 500-yard ranges were in the open, while a trio of 200-yard ranges were enclosed in the concrete structure of Building 22B, built in 1944 by Frank Messer & Sons, Inc. Although these were called the 200-yard gun ranges, they were actually only 425' long. The three ranges, "A", "B", and "C", were all 25' high, but they differed in width at 21', 22', and 43' respectively. The walls and ceilings were constructed of reinforced concrete, with backstops at the east end of the range tunnels consisting of sand pits with the sand sloping forward at approximately 35 degrees. Hardwood timbers above the sand and secured to the ceiling with channel irons prevented ricocheting projectiles from damaging the concrete, while rows of steel plate hanging from the ceiling near the backstops prevented ricochets from bouncing toward the west end where the guns were. Exhaust fans at the east end of the tunnels removed some of the smoke and gases from the range. In addition, an exhaust fan on the roof near the west end captured powder gases and smoke close to the muzzle blast area. Sound absorbing tubes lined the walls and ceilings of the west end to reduce the noise level and stop reverberations within the tunnels.

The tests were controlled from a centrally located booth which was constructed in a manner that allowed the armorers to see the weapons and other test specimens at all times through bulletresistant glass windows. Range "A" also provided a camera opening for taking photographs of bullets striking any target or piece of equipment being fired upon. Range "C" differed from the other ranges in that it was open to the ramp adjacent to the hangar and two bed plates were installed end-to-end within the tunnel mouth to accommodate large stands, such as those required for large turrets and entire nose sections. One bed plate was located next to a nose-wheel pit, used to facilitate the firing of fighter aircraft. Numerous tie-downs provided a means to secure all types of aircraft, including bombers, for turret tests and to test entire fixed-gun installations.

Between 1959 and 1967, the Air Force spent only $170,000 on research for aircraft gun systems. By the mid-1970s, the Electro-Optics Division of the Electronic Technology Laboratory began to utilize the building. With a straight length of 425', this building provided useful facilities for their research on equipment such as electronic sighting systems for weapons and laser-guided weapons systems. This division still occupies Building 22B.

Also in the mid-1970s, some offices of the Avionics Laboratory moved in for the remainder of the decade. In the early 1980s, Building 22B hosted offices for System Program Office (SPO) Cadres. This short-lived program was intended to establish full SPOs from skeleton-crew SPO Cadres which oversaw preliminary system developments until final system approval was received. In 1992 the office portion of the building housed the administrative section of the Avionics Directorate of Wright Laboratory and the U.S. Army Corps of Engineers area office.

For sources, see Bibliography on page 215.

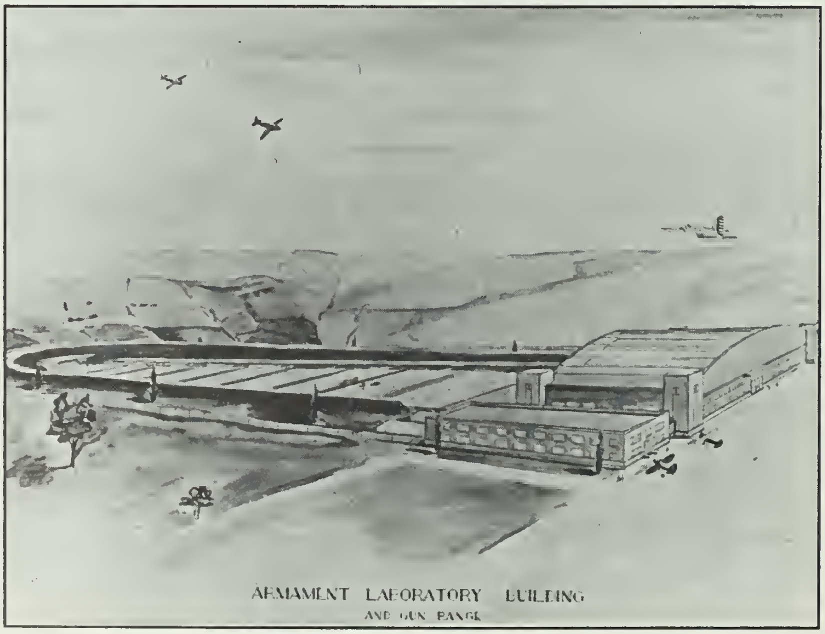


Figure 81: Illustration of Building 22 and gun range. (USAF)

Figure 82: Construction of Armament Laboratory Hangar, 1942. (USAF)

Figure 83: Gun range, Building 22 complex, ca. 1940s. (USAF)

Figure 84: Building 22, looking northeast, 1991.

Figure 85: Rear of Building 22, looking southeast, 1991.

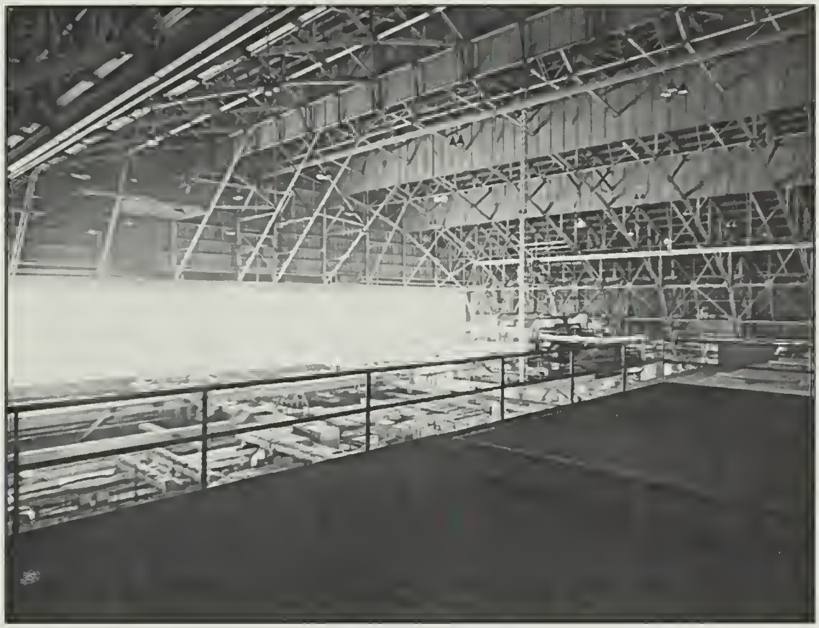


Figure 86: Interior of Building 22, 1991.

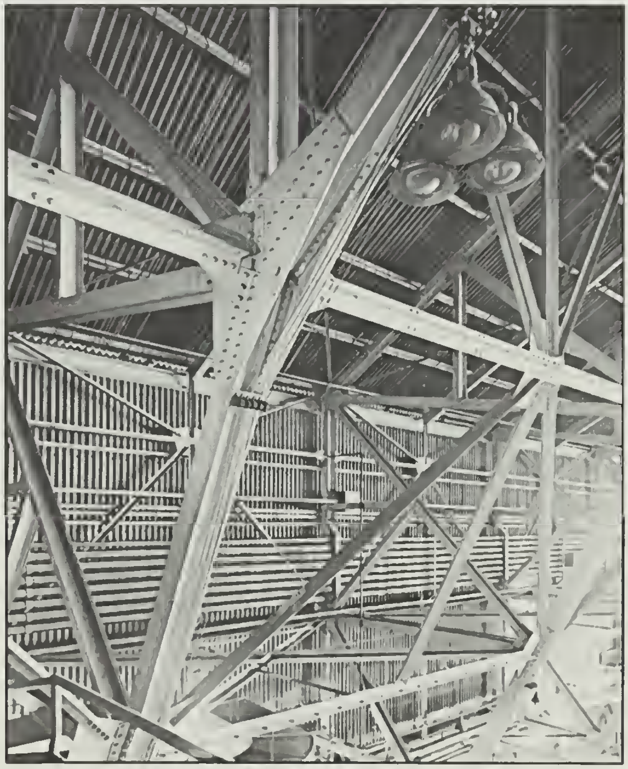
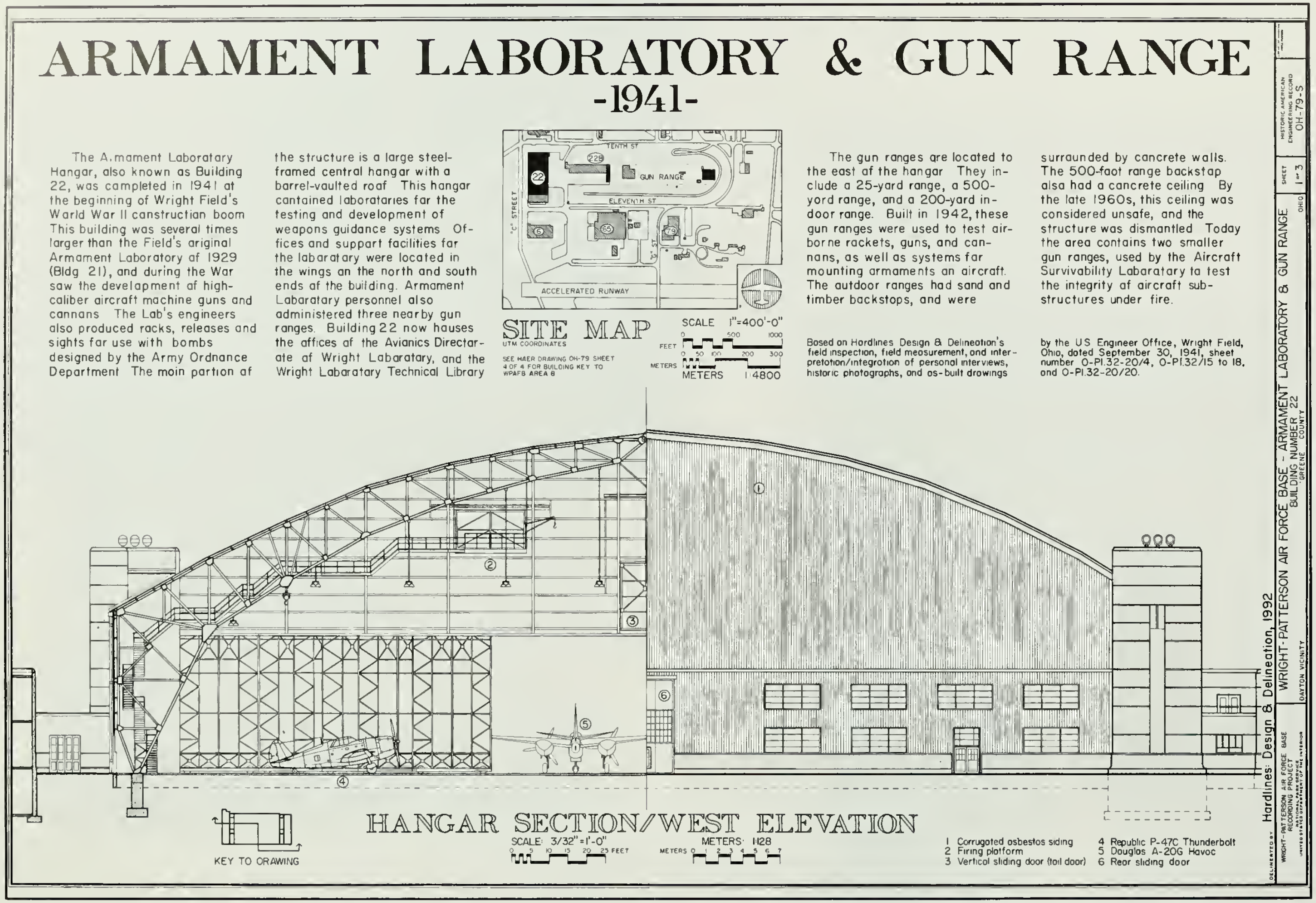


Figure 87: Detail of steel trussing, Building 22, 1992.



ARMAMENT LABORATORY & GUN RANGE

-1941-

The Armament Laboratory Hangar, also known as Building 22, was completed in 1941 at the beginning of Wright Field's World War II construction boom. This building was several times larger than the Field's original Armament Laboratory of 1929 (Bldg 21), and during the War saw the development of high-caliber aircraft machine guns and cannons. The Lab's engineers also produced racks, releases and sights for use with bombs designed by the Army Ordnance Department. The main portion of the structure is a large steel-framed central hangar with a barrel-vaulted roof. This hangar contained laboratories for the testing and development of weapons guidance systems. Offices and support facilities for the laboratory were located in the wings on the north and south ends of the building. Armament Laboratory personnel also administered three nearby gun ranges. Building 22 now houses the offices of the Avionics Directorate of Wright Laboratory, and the Wright Laboratory Technical Library.

The gun ranges are located to the east of the hangar. They include a 25-yard range, a 500-yard range, and a 200-yard indoor range. Built in 1942, these gun ranges were used to test airborne rockets, guns, and cannons, as well as systems for mounting armaments on aircraft. The outdoor ranges had sand and timber backstops, and were surrounded by concrete walls. The 500-foot range backstop also had a concrete ceiling. By the late 1960s, this ceiling was considered unsafe, and the structure was dismantled. Today the area contains two smaller gun ranges, used by the Aircraft Survivability Laboratory to test the integrity of aircraft substructures under fire.

SITE MAP

UTM COORDINATES

SEE HAER DRAWING OH-79 SHEET 4 OF 4 FOR BUILDING KEY TO WPAFB AREA B

Based on Hardlines Design & Delineation's field inspection, field measurement, and interpretation/integration of personal interviews, historic photographs, and as-built drawings by the U.S. Engineer Office, Wright Field, Ohio, dated September 30, 1941, sheet number O-PI.32-20/4, O-PI.32/15 to 18, and O-PI.32-20/20.

HANGAR SECTION/WEST ELEVATION

1 Corrugated asbestos siding
2 Firing platform
3 Vertical sliding door (tail door)
4 Republic P-47C Thunderbolt
5 Douglas A-20G Havoc
6 Rear sliding door

Delineated by: Hardlines: Design & Delineation, 1992

WRIGHT-PATTERSON AIR FORCE BASE RECORDING PROJECT
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

WRIGHT-PATTERSON AIR FORCE BASE - ARMAMENT LABORATORY & GUN RANGE
BUILDING NUMBER 22
DAYTON VICINITY GREENE COUNTY OHIO

SHEET 1 of 3

HISTORIC AMERICAN ENGINEERING RECORD
OH-79-S

Figure 88: Armament Laboratory and Gun Range, Building 22, 1941. (Delineated by Hardlines: Design & Delineation, HAER, 1992)

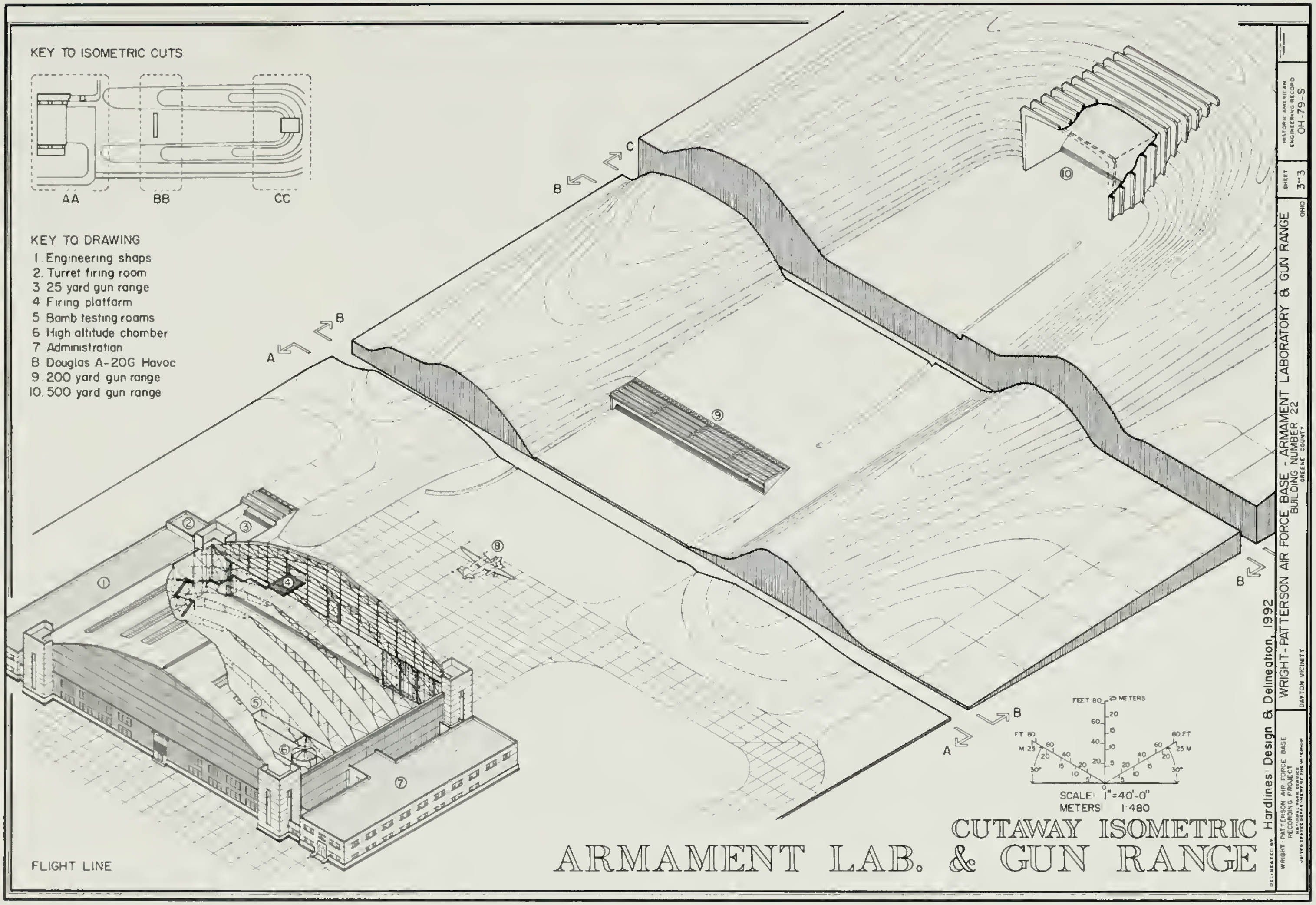


Figure 89: Armament Laboratory and Gun Range, Building 22, 1941. (Delineated by Hardlines: Design & Delineation, HAER, 1992)

BUILDING 23: STATIC TEST LABORATORY NO. 1

HAER No. OH-79-U

Construction Date: 1934

DESCRIPTION: Building 23 is a six-course, American bond brick building with a copper entablature, typical of Wright Field. It measures 183' x 102' with a center roof height of 61'. The south wall is constructed with extra brick and tile to deaden noise from the nearby propeller and power plant laboratories. Originally the north side of the building was the front, with a 100' center opening made up of eight sliding hangar-style doors on two tracks. This opening was bricked in and replaced with conventional entrances after static test operations moved to the new Building 65 in 1944. Its large square corner towers are similar to those of Building 31, but the tower windows are not arched, the bull's eyes are not as ornate, and the decorative corner towers have only the two outer walls finished, resulting in a plainer, less visually dominant structure. The bull's eyes are now covered with green corrugated plastic.

HISTORY: As military aircraft grew larger during the inter-war period, some facilities at Wright Field also had to increase in size. One of these was the static test facility which had to be capacious enough to accommodate the largest military aircraft. At the opening of Wright Field in 1927, static testing was performed in a portion of Building 31, the aircraft assembly hangar. Within a few years this space became terribly inadequate, both because airplanes quickly increased in size and because Wright Field engineers had greatly improved the procedures and therefore the experimental potential of static testing. This required a concomitant improvement in the size of the testing facility, so Building 23 was constructed in 1934 as a Works Progress Administration project and occupied in December of that year.

One design flaw in this building was the use of a magnesium-fluro-silicate hardener on the concrete floors. This caused respiratory ailments and skin conditions among occupants of the building within ten weeks. The problem was solved by painting the floors.

As originally used, the test floor was divided into two halves, each approximately 50' x 180'. Two overhead travelling cranes of 5 and 15 ton capacity serviced the entire building, lifting airframes and test jig components. The 6" thick concrete floor contained inserts which could support loads of 15,000 pounds each. Test structures could also be suspended from the crane and the flat bridge roof trusses, each of which could support a 50,000-pound concentrated load. Two heavy steel jigs were available to test large wing panels. Each could withstand a 2,500,000 foot-pound moment and a 100,000 pound shear. A machine shop was also set up to support the testing activities and perform minor repairs on airframes and parts.

During Building 23's decade as the static test laboratory, one of the most important projects developed cushion loading pads and tension loading pads. This research was performed on the BC-1, a trainer aircraft that was the precursor of the advanced trainer AT-6 Texan, in which nearly all American pilots of World War II passed their flight training. Loading pads are sponge rubber pads that are attached to the test structure (typically a wing) with epoxy. Cushion loading pads are attached to the top of the wing and transmit a compression load from a beam above the wing without damage to the wing's skin. Tension loading pads are attached to the bottom of the wing and loaded via hydraulic jacks. Rather than always loading aircraft with dead weight, engineers had the alternative of applying discrete forces at specific points to obtain more exact simulations of flight conditions.

Building 23 became inadequate when the military buildup for World War II produced both larger aircraft and the need to perform several static and structural tests simultaneously. The enormous Building 65 took over these functions in November 1944, and Building 23 began to host a new variety of experiments, including engine accessory tests. With 18,000 square feet of space, two large cranes, and a 440-volt electrical system able to carry a 500-horsepower drive system, this facility was perfectly suited for the testing of ignition, control, and other associated systems and components.

In the late 1950s, the Aerospace Medical Laboratory installed medical science equipment in a portion of the building. In July 1956, the Medical Laboratory set up two ejection towers. One ejected subjects 35' downward into a curve of radius 50', while the other ejected subjects upward 100' at 40'-80' per second. The vertical accelerator, installed in July 1957, studied buffeting, vibration, and impact on objects of up to 400 pounds accelerated repeatedly to three times the force of gravity (3G) in a vertical distance of 20'. At the same time, the Medical Laboratory first used equilibrium chairs to study the mechanical and physiological effects of small amplitude vibrations in all three axes of space. Two years later, a 46' deceleration tower was introduced to test human subjects. It had an experimental capability of imposing up to 30G.

Building 23 hosted a variety of other facilities before becoming part of the Avionics Laboratory in 1987. One of the most interesting was the dynamic analyzer capsule of the 1960s. Constructed from pieces of a Snark missile, it used a system of six hydraulic rams to simulate the dynamic vibrations of high-altitude aircraft and was dubbed the "Rock and Roll." It was used to test and perfect photographic equipment for reconnaissance aircraft without expensive in-flight testing.

For sources, see Bibliography on page 215.

Figure 90: Building 23, looking southeast, 1991.

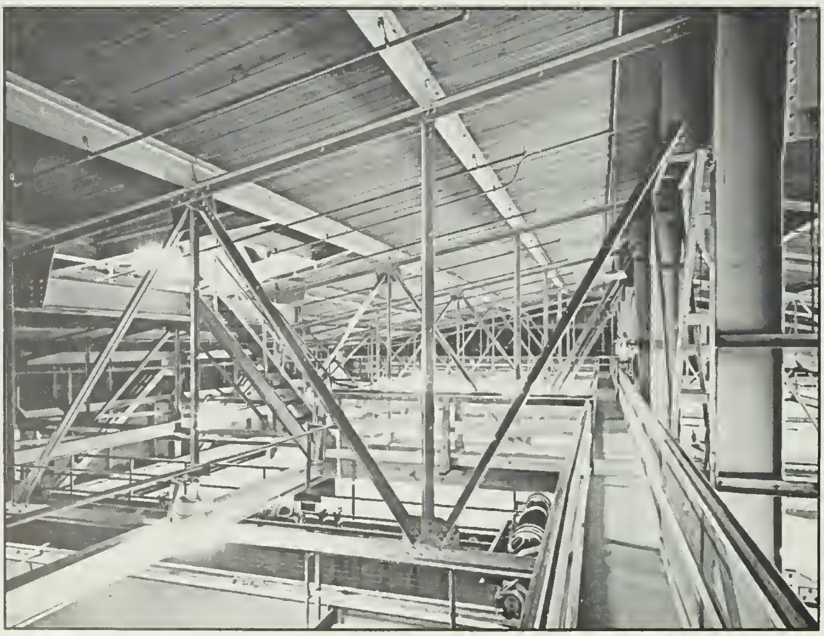
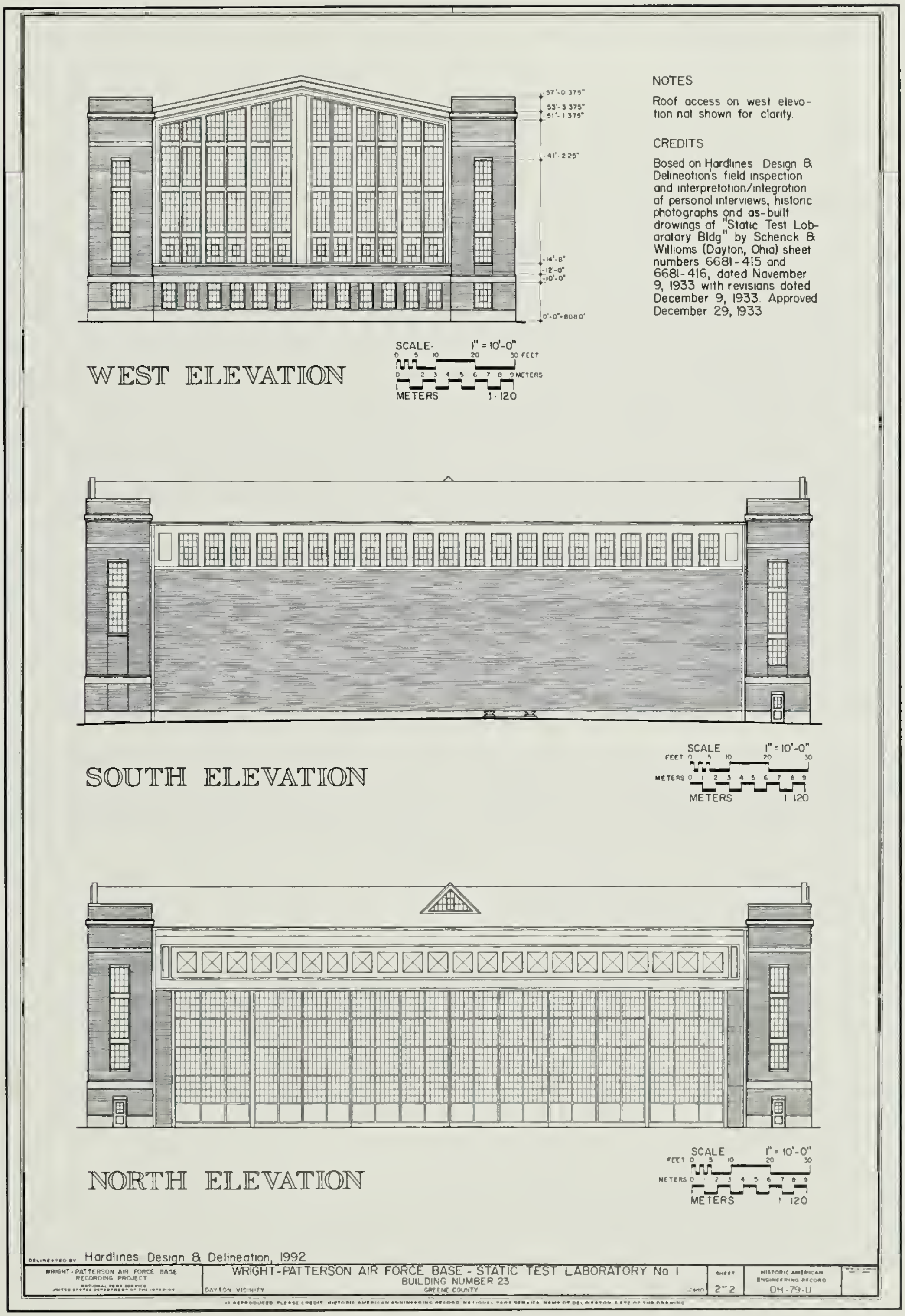


Figure 91: Building 23, showing rafters and trussing, 1992.



NOTES

Roof access on west elevation not shown for clarity.

CREDITS

Based on Hardlines Design & Delineation's field inspection and interpretation/integration of personal interviews, historic photographs and as-built drawings of "Static Test Laboratory Bldg" by Schenck & Williams (Dayton, Ohio) sheet numbers 6681-415 and 6681-416, dated November 9, 1933 with revisions dated December 9, 1933. Approved December 29, 1933

DELINEATED BY Hardlines Design & Delineation, 1992

WRIGHT-PATTERSON AIR FORCE BASE RECORDING PROJECT
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

WRIGHT-PATTERSON AIR FORCE BASE - STATIC TEST LABORATORY No 1
BUILDING NUMBER 23
DAYTON VICINITY GREENE COUNTY OHIO

SHEET 2 of 2

HISTORIC AMERICAN ENGINEERING RECORD
OH-79-U

IF REPRODUCED PLEASE CREDIT: HISTORIC AMERICAN ENGINEERING RECORD, NATIONAL PARK SERVICE, NAME OF DELINEATOR, DATE OF THE DRAWING

Figure 92: Static Test Laboratory No.1, 1935. (Delineated by Hardlines: Design & Delineation, HAER, 1992)

BUILDINGS 24A-C: 20-FOOT WIND TUNNEL COMPLEX

HAER No. OH-79-AO

Construction Dates: 1939-42

DESCRIPTION:

Building 24A: Power Building for Wind Tunnel Complex

Building 24A is a three-story building featuring six-course brick, a high concrete foundation and a parapeted, concrete-coped, flat roof. On the east and west sides of the building, eight window bays are arranged two-four-two, with three-quarter rectangular pilasters between the sets and at the ends of the building. The window bays feature long, narrow windows at the second level, and shorter windows on the lower and upper levels. An addition connecting the building to Building 25C has eliminated the lower level window bays on the east side.

The north entrance has double metal doors flanked by six over six steel-sashed windows. Above the doors, beginning half way up the building, three narrow window bays extend to the top level. To the south of the building, a large craneway allowed for the installation and removal of the fan assembly. It still overlooks the complex, but is no longer operable.

The building contains two motor generator sets, a 40,000-horsepower induction motor, and a 75-ton overhead crane. A second level balcony at the south end of the building houses the control room for the motors and motor-generator sets, and directly below are the control panels for the facility's electrical distribution system.

Building 24B: Sonic Fatigue Facility Support Area

Building 24B was the original test chamber for the 20-Foot Wind Tunnel. This four-story, rectangular, concrete building has a low-parapeted flat roof. The wind tunnel openings on the north and south sides are now cemented over. Building 24C abuts the east side, while the west side features concrete pilasters and twenty-four vent-like windows.

Building 24C: Shop and Engineering Building

This one-story shop and office building also has a parapeted flat roof. On the south facing end are doors flanked by two tall window bays with concrete sills. The east-facing mid section consists of two stories with a penthouse. There are eight large window bays on the southeast side. The advancing two-story entrance has windows on the penthouse and top level with two brick mullions. The aluminum double doors have a concrete lintel and are flanked by two rectangular brick pilasters and ribbon windows.

HISTORY: Best known for the 20-Foot or Massie Memorial Wind Tunnel that it originally supported, the Building 24 complex comprises buildings dating from 1939. Structures from the World War II era were the first in what is now called the Aeromechanics Research Complex, a one-block area which includes, or included, the 20-Foot and 10-Foot Wind Tunnels, the Vertical Wind Tunnel, the Subsonic Aerodynamic Research Laboratory, the 2-Foot Trisonic Gasdynamic Facility, the 2-Foot Hydrodynamic Facility, the 6-Inch Supersonic Wind Tunnel, the 50 Megawatt Facility, and the Sonic Fatigue Facility.

20-Foot Wind Tunnel

In the late 1930s, physicist Dr. Theodore Von Karman was commissioned by the Army Air Forces to design the multi-million dollar 20-Foot Wind Tunnel. Captain Louis E. Massie, the first chief of the Wind Tunnel Branch, oversaw its planning, design and construction. Tragically, in 1940 when the tunnel was 90 percent complete, Captain Massie died in a P-36 plane crash. At its formal dedication in 1942, the tunnel was christened the Massie Memorial Wind Tunnel.

The new wind tunnel was, as one of many contemporary magazine reports put it, "truly colossal." The 20-Foot Wind Tunnel's 40,000 horsepower motor was the largest variable-speed, wound-rotor-type induction motor of its time, making the tunnel the most powerful large tunnel in the world--the previous most powerful wind tunnel only had two 4,000-horsepower motors. The tunnel utilized a modified Kramer system to regulate the speed of the motor, and thus the fans and airspeed. Two motor-generator sets worked together to govern the main motor's rotor.

When operating at full capacity, the two sixteen-blade fans approached 300 rpm while driving air through the 616'6" circuit at 450 mph. In an era where hypersonic tunnels in the mach 10-20 range are almost common place, 450 mph may sound rather primitive but, considering the enormous test section, the tunnel was impressive even by today's standards. To regulate the heat generated by the 40' fans, a section just prior to the fans exchanged approximately 30 percent of the tunnel airflow with ambient air. The 20' diameter test section accommodated full scale missiles or large scale models up to 16' long with a 15' wing span mounted on a six-component external balance. Models were installed and adjusted using a 10-ton elevator below the test section. The testing instruments themselves were housed in a 68'-high, reinforced-concrete building, in which technicians could observe and calibrate the behavior of models inside the tunnel.

Completed in 1942, the 20-Foot Wind Tunnel contributed to the design of many World War II fighters and bombers, including considerable work on the B-58. Throughout its two decades of aeronautical experimentation, the 20-Foot Wind Tunnel contributed to countless aircraft and missile designs, including the P-47, P-61, and XV-1 McDonnel Convertiplane. Tunnel personnel also handled engine, nacelle, and propulsion experiments for such aircraft as the B-29 and B-36. Occasionally, the tunnel was used to conduct experiments on fire suppression systems. An F-84 was once mounted in the tunnel and bullets fired into its burners to test the plane's combat effectiveness.

The versatility of a tunnel with such a large test section was demonstrated when it was used for tests on a German V-1 rocket smuggled out of Europe. Ordinarily, however, tunnel personnel conducted one of four types of experimentation: force and moment tests on models; pressure distribution and wake surveys; engine cooling studies; and powered model tests. Powered and unpowered models accounted for approximately 70 percent of the tunnel's time, while wings, parachutes, and aircraft components each accounted for 10 percent.

As aircraft began to exceed the speed of sound, the tunnel's effectiveness diminished. The need for subsonic research did not disappear, as even hypersonic vehicles must take off and land at subsonic speeds, but this type of testing could be done by NASA and even private industry. Consequently, the 20-Foot Wind Tunnel was deactivated on April 1, 1959, and the tunnel structure itself, which had dominated the area for almost two decades, was razed in 1960.

Building 24A: Power Building for Wind Tunnel Complex

Built as the power building for the 20-Foot Wind Tunnel, Building 24A has changed very little in fifty years. Equipment in the building could power either the 20-Foot Wind Tunnel or the 10-Foot Wind Tunnel (built in 1943), and now supplies power for the Structural Dynamics Facility (originally called the Sonic Fatigue Facility) and the Subsonic Aerodynamic Research Laboratory. The drive shaft from the Building's 40,000-horsepower motor extends from the south end to Building 462, where it drove the compressor for the Sonic Fatigue Facility during the 1960s. The compressor, the largest one of its time, provided high volume airflow to a bank of large noise generators. These hydraulically operated sirens could generate noise level up to 170 decibel for the structural testing of aircraft components.

Building 24B: Sonic Fatigue Facility Support Area

Primarily the test section area for the 20-Foot Wind Tunnel, Building 24B also features a control room and support equipment for the tunnel. Two air locks provided access to the area containing the test chamber. Both air locks remain, although one has been converted into a telephone booth, and all the doors have been replaced. A 20-ton crane allowed for the installation of models, heavy equipment and the closed throat section. A 10-ton elevator beneath the test section served as a working platform for model adjustments. The platform and elevator equipment are intact, although not operable. The facility also included a 1/17.45 scale model of the tunnel powered by a 100-horsepower motor.

The building is currently a support area for the Sonic Fatigue Facility, and includes two test chambers and a large butler building. The butler building fills most of the open area vacated by the 20-Foot Wind Tunnel's test section, and contains experiments on structures for use in space.

Building 24C: Shop and Engineering Building

Built as a shop and office area for the 20-Foot Wind Tunnel, the building still functions as a machine shop and office space for the Flight Dynamics Directorate. The construction contractor for this building was the Simpson Construction Company.

For sources, see Bibliography on page 215.

Photographs and drawings of Buildings 24A-C begin on page 129.

20-Foot Massie Memorial Wind Tunnel

Type:	Single Return	
Overall Size:	260’ x 135’	
Centerline Circuit Length:	616’ 6"	
Model Type:	2 or 3 dimensional	
Test Section:	Circular, 20’ diameter, 20’-30’ long, open or closed throat	
Max. Diameter:	45’	
Contraction Ratio:	5.06 to 1	
Max. Velocity:	450 mph empty (mach .56), 400 mph average model	
Max. Dynamic Pressure:	425 psf empty, 375 psf average model	
Power:	40,000 hp AC induction motor, modified Kramer speed control system	
Energy Ratio:	4.9	
Temp. Control:	Air exchanger	
Operating Temp. & Press. Range:	Atmospheric	
Air Drive:	Two 40’ diameter fans, 16 laminated spruce blades per fan, 16’ hub	
Drive Shaft:	121’ long, 16" diameter, solid steel shaft	
Max. Fan rpm:	297	
Model Support System:	Overhead Orthogonal Balance (1,2, or 3 strut support system)	
Balance Capacity and Range:	Lift	±13,000 lbs.
	Drag	+2,900 lbs. to -3,100 lbs.
	Side Force	+1,500 lbs. to -1,700 lbs.
	Roll	±2,000’ lbs.
	Yaw	±1,000’ lbs. (±30°)
	Pitch	±7,750’ lbs. (±42°)

BUILDINGS 25A-D: 10-FOOT WIND TUNNEL COMPLEX

HAER No. OH-79-AP

Construction Dates: 1943-1951

DESCRIPTION:

Building 25A: Cold Chamber

Building 25A is a four-story, split level, concrete building, originally L-shaped with one wing 62' x 122' and the other 60' x 59'. Additions were made in 1949 and 1957, during which the lower section was extended to the south.

Building 25B: Test Chamber Building

Building 25B is a four-story, high-bay, cast-in-place concrete building. The tunnel portion of the 10-Foot Wind Tunnel is still in place, running through the building from west to east. The conversion in the 1960s to the 50 Megawatt Facility did not alter the building significantly, except for the new hardware inside the tunnel structure and its related equipment. One of the 10-Foot Wind Tunnel's original 20,000-horsepower motors sits idle against the south wall.

Building 25C: Subsonic Aerodynamic Research Facility

The three-story, open bay building features six-course brick, a high concrete foundation and a parapeted concrete coped flat roof. The north end of the building has screen-covered blow-out panels over its entire expanse. Buildings 25C and 24A have nearly identical pilaster and window bay arrangements, both displaying elements of the Georgian style. The buildings are now connected by a one-story, flat roofed addition.

Building 25D: Scavenging Building

Building 25D is a two-story brick building, with a low-parapeted flat roof with concrete coping. It has steel-sashed windows with concrete sills. The north side has flat soldier arches on the three long window bays, while the south side abuts Building 24B.

Among the equipment currently in Building 25D is a set of auxiliary motors and a two-stage compressor previously used for the 10-Foot Wind Tunnel. Not presently in use, the set may be employed in the future for auxiliary airflow to the Subsonic Aerodynamic Research Laboratory (SARL), for miscellaneous secondary flows such as experiments requiring simulation of cabin explosions or jet exhaust. Also in the 50' high building is a 25-ton bridge crane, a control room, and an auxiliary compressor system.

HISTORY:

Building 25A: Cold Chamber

Completed in 1943, the Cold Chamber was designed by J. Gordon Turnbull, Inc., of

Cleveland, Ohio, with consulting engineers Svedrup & Parcel, of St Louis. Frank Messer & Sons, Inc., of Cincinnati, was the contractor. The building was originally known as the Frigitorium and belonged to the Aeronautical Accessories Laboratory. It contained cold chambers which used four 105,000-gallon brine tanks to attain temperatures as low as -75° F for arctic testing. The cold chambers no longer exist. Among the facilities now housed in Building 25A is the 2-Foot Hydrodynamic Facility, a 1986 water tunnel that, while not as precise as a wind tunnel, provides a reasonably accurate, qualitative simulation of an aircraft in flight. Finally, Building 25A holds auxiliary equipment for the Trisonic Gasdynamic Facility (see Building 26), and the 50 Megawatt Electrogasdynamic (see Building 25B).

Cold Chamber System

Cold Room Dimension:	82' x 25' x 25'
Insulation:	14" corkboard
Cold Room Air Circulation:	60,000 ft^3/min., two 30 hp fans
Cold Cells (2):	59' x 11' x 18'
Insulation:	6" Ferrotherm (13 layers)
Refrigeration Temperature:	-75° F
Refrigeration Capacity:	500,000 BTU/hr net
Compressors:	5 Ammonia
Total Horsepower:	500
Ammonia Pumps (3):	45 gpm, 5 hp each
Water Pump:	360 gpm, 15 hp
Exciter:	300 amp, 250 v, 100 hp

Building 25B: Test Chamber Building

Built in 1944, Building 25B contained the test section and control room for the 10-Foot Wind Tunnel. The 21,738-square-foot building also housed office space, a crew room, a model room, and two traveling overhead cranes (40-ton and 5-ton).

Designed for testing models of high altitude bombers and fighters, this closed circuit tunnel was originally intended for high speed subsonic testing, but soon became more valuable as a transonic facility. Unlike the 20-Foot Wind Tunnel nearby, the 10-Foot tunnel could simulate the temperatures and pressures associated with flight from sea level up to altitudes of 50,000'.

Construction on the tunnel began in March 1943; it was operational by January 1947. Laid out in a 262'6" x 100' rectangle, the tunnel exited the east side of Building 25B where it reached its maximum diameter of 40' and gradually narrowed before entering Building 25C. In this building the two 20,000-horsepower motors and fan section drove the air up to a speed of Mach 1.24. The tunnel then returned to the west end of Building 25B, where its test section, control room and related equipment resided, for a centerline circuit length of 588' and a total volume of 358,000 cubic feet. The tunnel itself was a pressure-sealed steel tube built to withstand pressure differentials of 1 atmosphere in either direction.

Approximately 70 percent of the tunnel's research time went to missile and aircraft models, while the remaining 30 percent was spent on wings and other components. Many special conditions arise in the transition from subsonic to transonic speeds. In the days before computer analysis, the nonlinear equations needed to explain these special aerodynamic circumstances were not practical. The 10-Foot Wind Tunnel, therefore, was instrumental in solving many of the transonic problems. Dr. Bernhard Goerthert, a leader in transonic research for Germany during World War II, came to Wright Field in the late 1940s through Project Paperclip. Under his direction, the 10-Foot Wind Tunnel helped overcome many important transonic obstacles, such as drag rise--a sudden increase in wing drag when shockwaves occur. Throughout the 1950s, the tunnel's research was instrumental in the development of many aircraft and weapon systems, such as the B-58, F-111, F-101, F102, Bomarc, Snark, Rascal, Matador, Navaho and the A4 heat-seeker.

In 1958 the 10-Foot Wind Tunnel was shut down to make room for the 50 Megawatt Electrogasdynamic Facility for study of the conditions experienced by hypersonic aircraft upon re-entry into the earth's atmosphere. Components are tested in an airflow that is heated by a powerful continuous electric arc.

Building 25C: Subsonic Aerodynamic Research Facility

Built in 1944, this building originally contained the motors and fan section of the 10-Foot Wind Tunnel. The motors and fans were removed upon conversion to the 50 Megawatt Facility; the tunnel remained. With the demise of the 50-Megawatt Facility, the tunnel section was removed and the tunnel openings sealed to make room for the new Subsonic Aerodynamic Research Laboratory (SARL), which dominates both the interior and exterior of Building 25C. The tunnel's inlet takes up the north wall of the three-story building and the tunnel extends through the middle of the open bay building and out the south end. The tunnel's outlet extends out of the building's south end, where a two-story structure has been built to house the tunnel's 20,000-horsepower motor and support the exhaust deflector shields.

Building 25D: Scavenging Building

Built in 1951 as the Scavenging Building to evacuate the 10-Foot Wind Tunnel, Building 25D held a set of motors and compressors, including two 4-stage centrifugal compressors driven by a 4500 horsepower motor.

Today the structure houses the Environmental Control Systems Simulators.

For sources, see Bibliography on page 215.

10-Foot Wind Tunnel

Type:	Single Return
Overall Size:	262' 6" x 100"
Centerline Circuit Length:	588'
Model Type:	2 or 3 dimensional
Test Section:	10' diameter, 18' 3" long, circular, closed throat
Max. Diameter:	40'
Contraction Ratio:	16 to 1
Max. Velocity:	Mach 1.24
Max. Dynamic Pressure:	1455 psf
Power:	Two 20,000 hp AC induction motors using 20' Wind Tunnel speed control system
Energy Ratio:	7
Temp. Control:	Calcium Chloride brine heat exchanger
Operating Temp. & Press. Range:	-30° to +160° F (stagnation), 1/10 to 2 atmospheres (stagnation)
Air Drive:	Four counter-rotating 19' diameter fans, 16 laminated spruce blades per fan, 11' diameter hub
Drive Shaft:	Two 42' long, 18" diameter solid steel shafts
Max. Fan rpm:	465
Model Support System:	Orthogonal balance (Wing through support system; Semi-span support system; 1,2, or 3 strut support system); Rear sting support (with or without strain gage balance)

Balance Capacity and Range:

Orthogonal Balance Capacity:

Lift	±10,000 lbs.
Drag	+3,000 lbs.
Side Force	+1,000 lbs.
Rolling Mom.	±3,000' lbs.
Yawing Mom.	±3,000' lbs.
Yaw	±5°
Pitch	-15° to +20°
Pitching Mom.	±3,000' lbs.

Strain Gage Balance Capacity:

Lift	±350 lbs.
Drag	+225 lbs.
Side Force	+410 lbs.
Rolling Mom.	±240" lbs.
Yawing Mom.	±2,400" lbs.
Pitching Mom.	±1,900" lbs.
Pitch or Yaw	-3° to +8°

Freon Refrigeration System for 10-Foot Wind Tunnel

Refrigeration capacity:	1175 tons @ 70°F, 280 tons @ -40°F
Refrigerant Temperature, Primary:	-60° F
Refrigerant Temperature, Secondary:	-40° F
Brine Tank Capacity (4):	105,000 gallons each
Total Brine Storage:	315,000 gallons
Total Refrigeration Storage:	288,000,000 BTU
Brine Range:	-40° F to +120° F
Brine Circulated Through Cooler:	2500 gpm (125 hp pump)
Brine Circulated Through Tunnel Heat Exchanger:	7500 gpm (500 hp pump)
Number of Compressors:	2 Centrifugal
Total Horsepower:	2250
Speed Range:	3800 to 7100
Condenser Water Tower:	3500 gpm
Water Tower Fans:	Two 30 hp
Water Pump:	2000 gpm (75 hp)
Water Pump:	1000 gpm (40 hp)
Heat Exchanger (Wind Tunnel):	358,000 ft^2

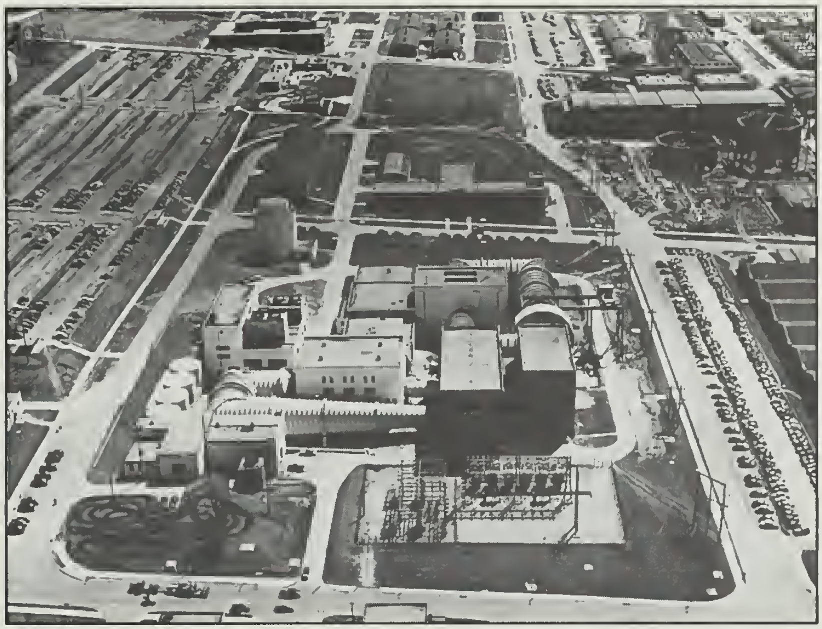


Figure 93: Wind tunnel complex, ca. 1940s, with 10-Foot Wind Tunnel in left foreground, 20-Foot Wind Tunnel on right, and Vertical Wind tunnel in left background. (USAF)

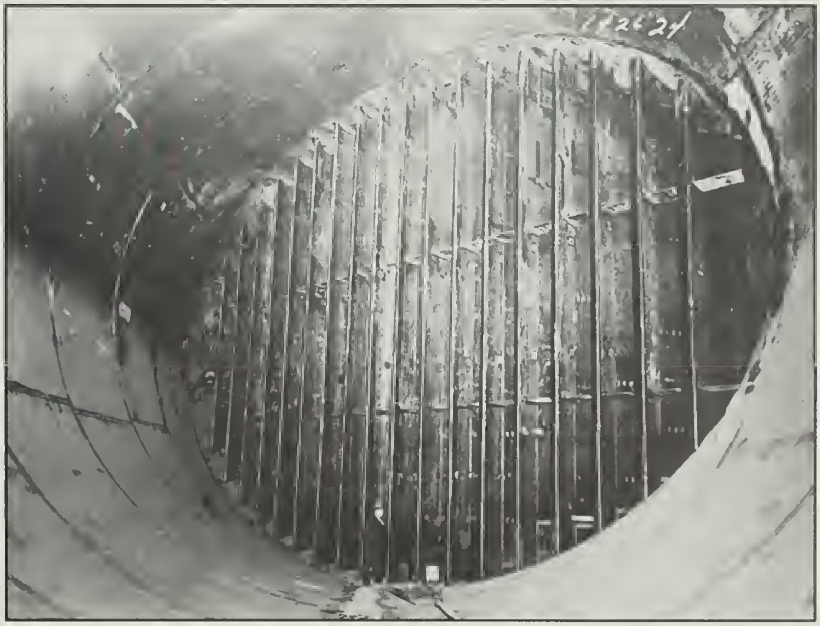


Figure 94: Interior of 20-Foot Wind Tunnel, ca. 1940s. (USAF)

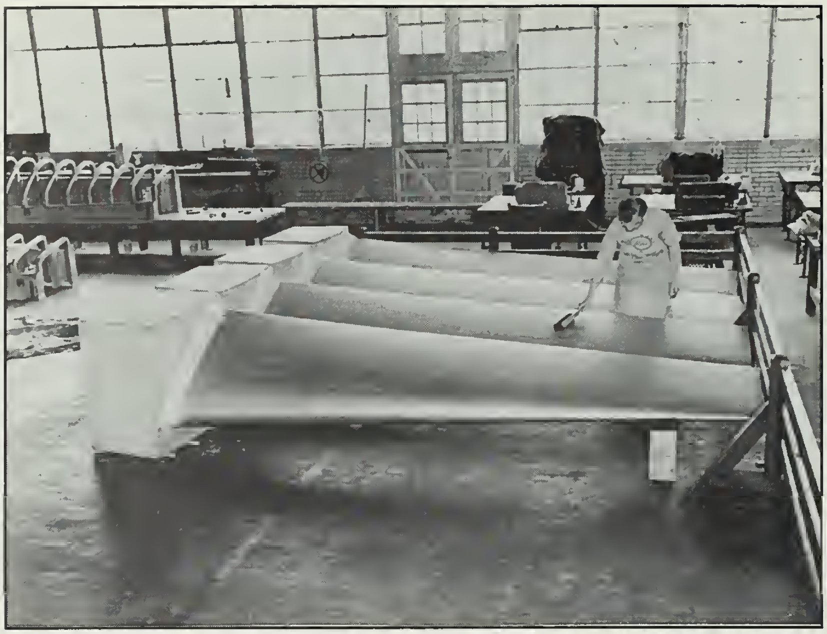


Figure 95: Finishing fan blades for 20-Foot Wind Tunnel, ca. 1940. (USAF)

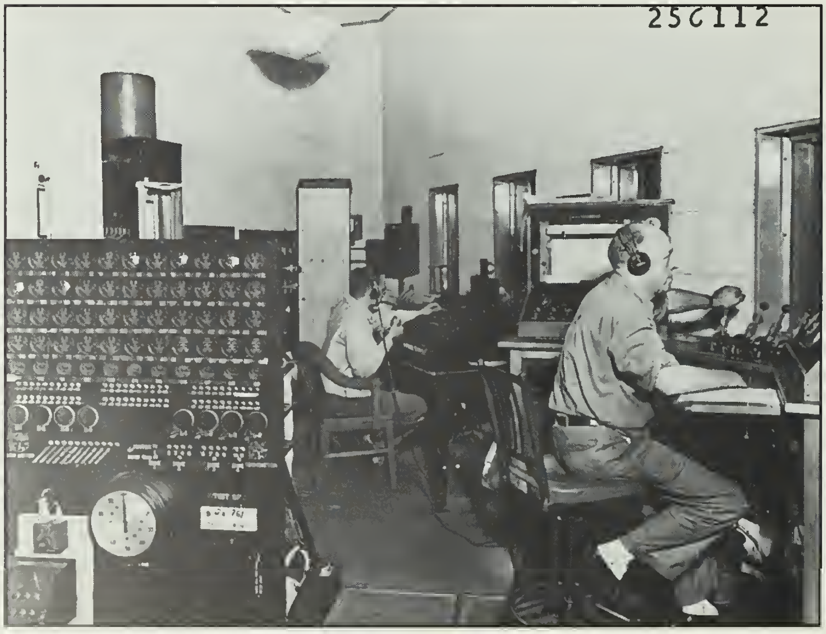


Figure 96: Control room of 20-Foot Wind Tunnel, Ca. 1940s. (USAF)

Figure 97: Building 24 complex, looking southeast, 1991.

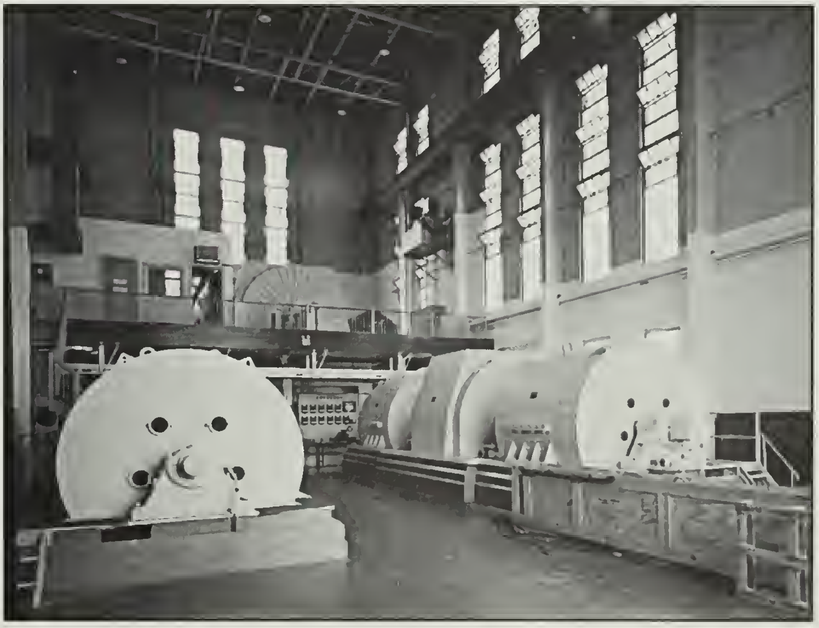


Figure 98: Interior of Building 24A (Power Building), 1991.

Figure 99: Building 25B (Test Chamber), looking northwest, 1991.

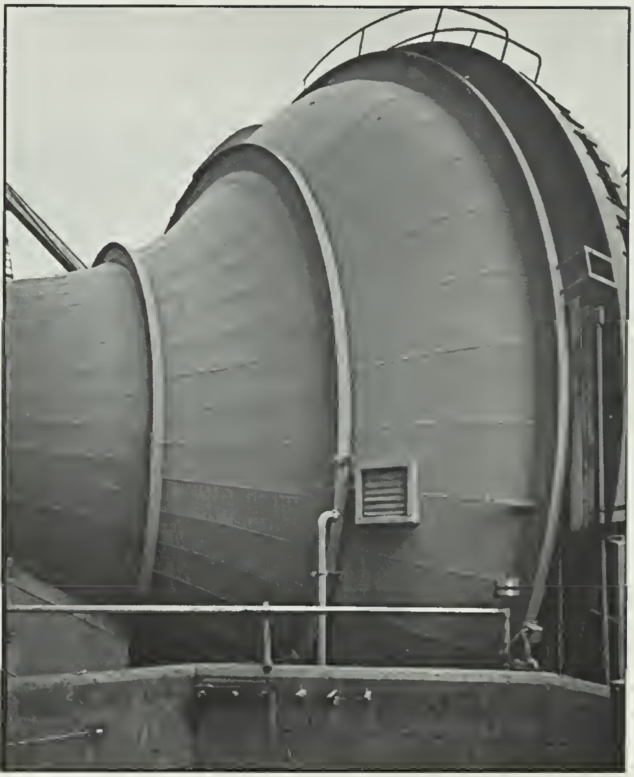


Figure 100: Section of 10-Foot Wind Tunnel, 1991.

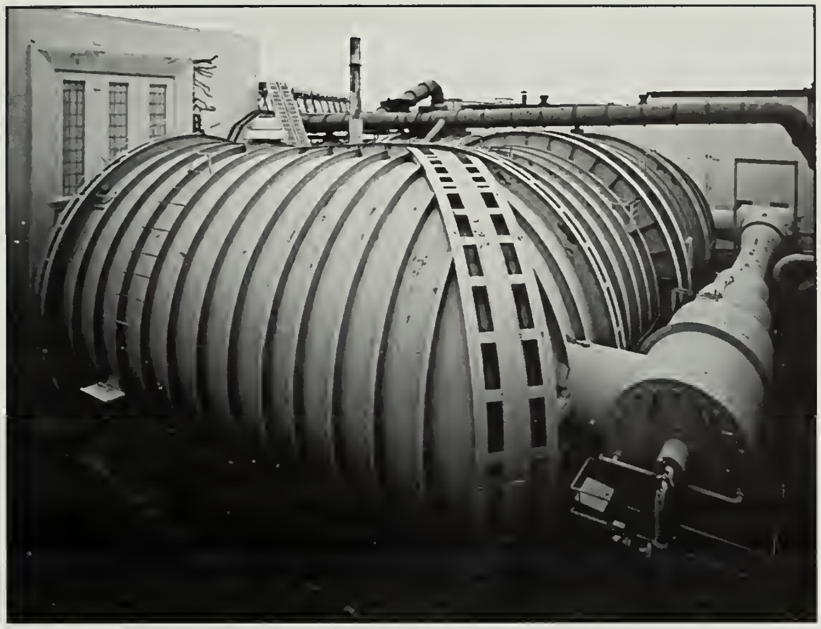


Figure 101: Section of 10-Foot Wind Tunnel, looking northwest, 1991.

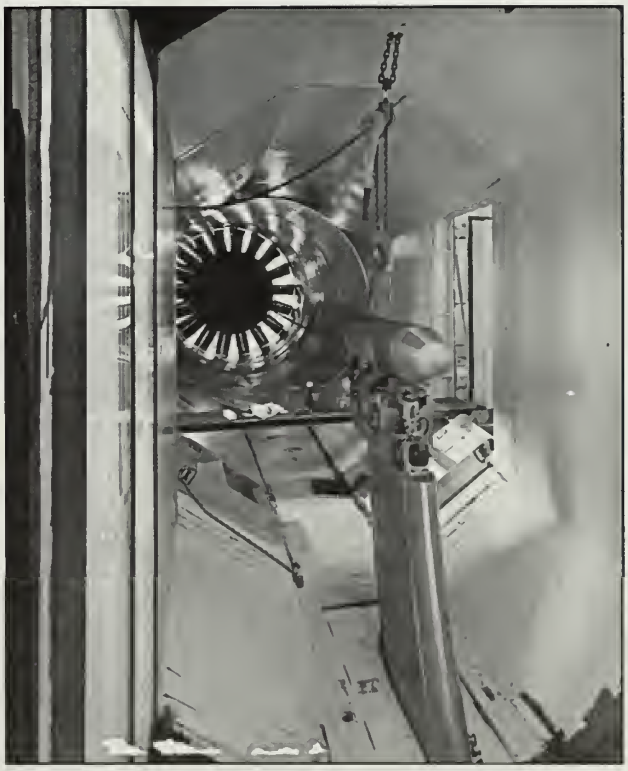
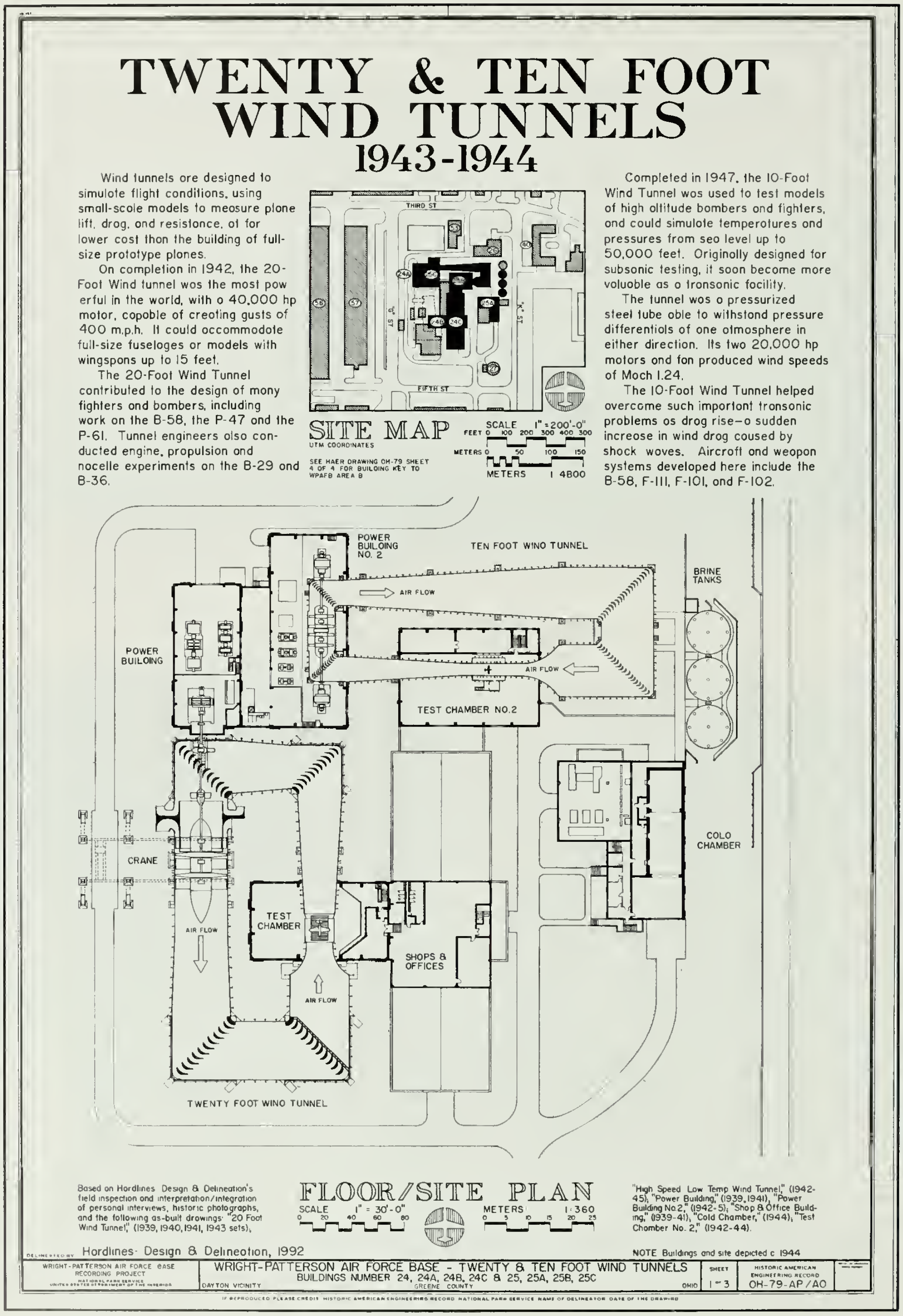


Figure 102: Interior view of 10-Foot Wind Tunnel, 1991.



TWENTY & TEN FOOT WIND TUNNELS

1943-1944

Wind tunnels are designed to simulate flight conditions, using small-scale models to measure plane lift, drag, and resistance, at far lower cost than the building of full-size prototype planes.

On completion in 1942, the 20-Foot Wind tunnel was the most powerful in the world, with a 40,000 hp motor, capable of creating gusts of 400 m.p.h. It could accommodate full-size fuselages or models with wingspans up to 15 feet.

The 20-Foot Wind Tunnel contributed to the design of many fighters and bombers, including work on the B-58, the P-47 and the P-61. Tunnel engineers also conducted engine, propulsion and nacelle experiments on the B-29 and B-36.

Completed in 1947, the 10-Foot Wind Tunnel was used to test models of high altitude bombers and fighters, and could simulate temperatures and pressures from sea level up to 50,000 feet. Originally designed for subsonic testing, it soon became more valuable as a transonic facility.

The tunnel was a pressurized steel tube able to withstand pressure differentials of one atmosphere in either direction. Its two 20,000 hp motors and fan produced wind speeds of Mach 1.24.

The 10-Foot Wind Tunnel helped overcome such important transonic problems as drag rise—a sudden increase in wind drag caused by shock waves. Aircraft and weapon systems developed here include the B-58, F-111, F-101, and F-102.

SITE MAP

UTM COORDINATES

SEE HAER DRAWING OH-79 SHEET 4 OF 4 FOR BUILDING KEY TO WPAFB AREA B

SCALE 1" = 200'-0"

Based on Hardlines Design & Delineation's field inspection and interpretation/integration of personal interviews, historic photographs, and the following as-built drawings: "20 Foot Wind Tunnel," (1939, 1940, 1941, 1943 sets); "High Speed Low Temp Wind Tunnel," (1942-45); "Power Building," (1939, 1941), "Power Building No. 2," (1942-5); "Shop & Office Building," (1939-41); "Cold Chamber," (1944); "Test Chamber No. 2," (1942-44).

FLOOR/SITE PLAN

SCALE 1" = 30'-0"

METERS 1:360

DELINEATED BY Hardlines- Design & Delineation, 1992

NOTE Buildings and site depicted c 1944

WRIGHT-PATTERSON AIR FORCE BASE RECORDING PROJECT NATIONAL PARK SERVICE UNITED STATES DEPARTMENT OF THE INTERIOR	WRIGHT-PATTERSON AIR FORCE BASE - TWENTY & TEN FOOT WIND TUNNELS BUILDINGS NUMBER 24, 24A, 24B, 24C & 25, 25A, 25B, 25C DAYTON VICINITY GREENE COUNTY OHIO	SHEET 1 - 3	HISTORIC AMERICAN ENGINEERING RECORD OH-79-AP/AO

IF REPRODUCED PLEASE CREDIT HISTORIC AMERICAN ENGINEERING RECORD NATIONAL PARK SERVICE NAME OF DELINEATOR DATE OF THE DRAWING

Figure 103: 20- and 10-Foot Wind Tunnels, 1943-1944. (Delineated by Hardlines: Design & Delineation, HAER, 1992)

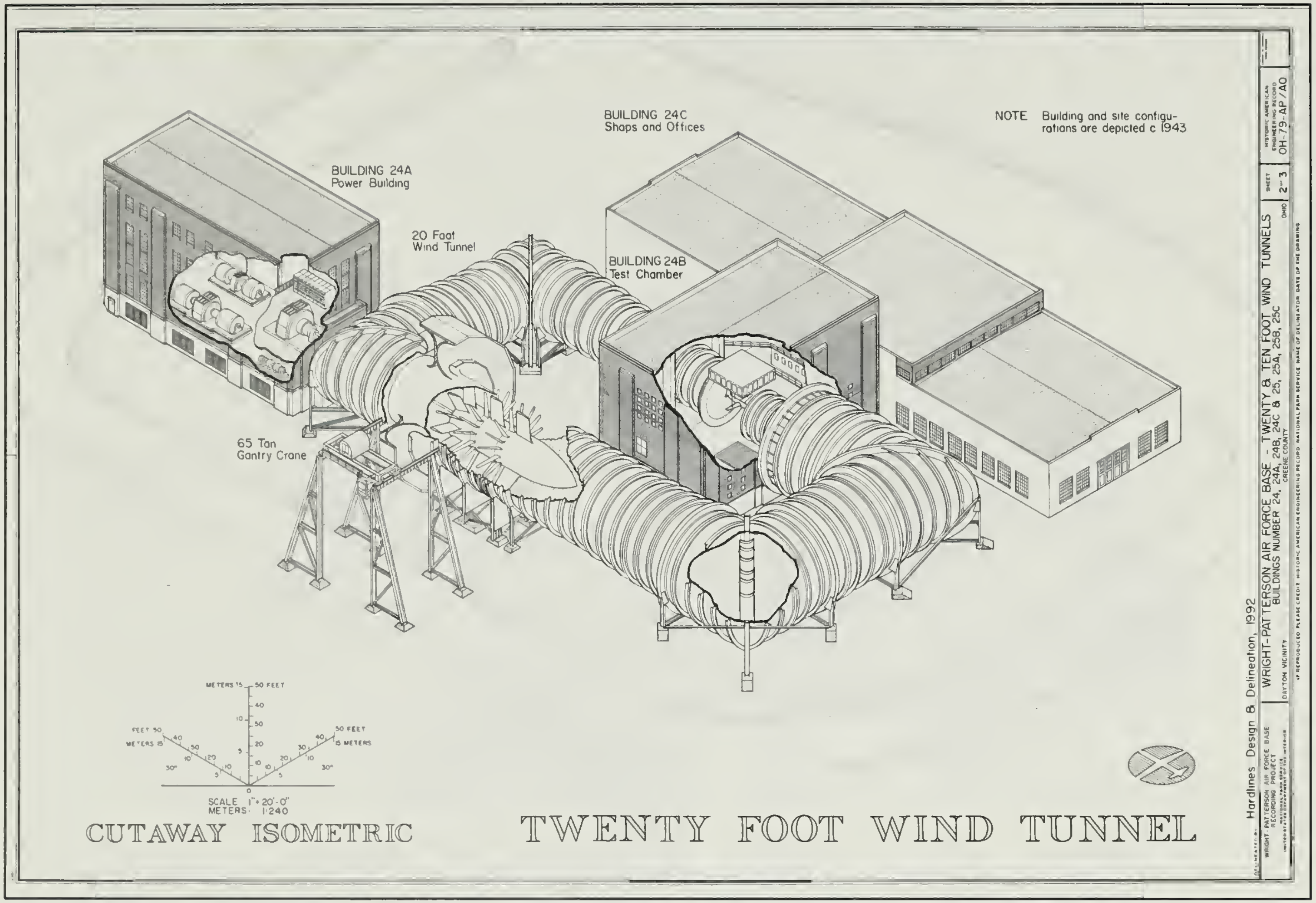


Figure 104: 20-Foot Wind Tunnel, 1943-1944. (Delineated by Hardlines: Design & Delineation, HAER, 1992)

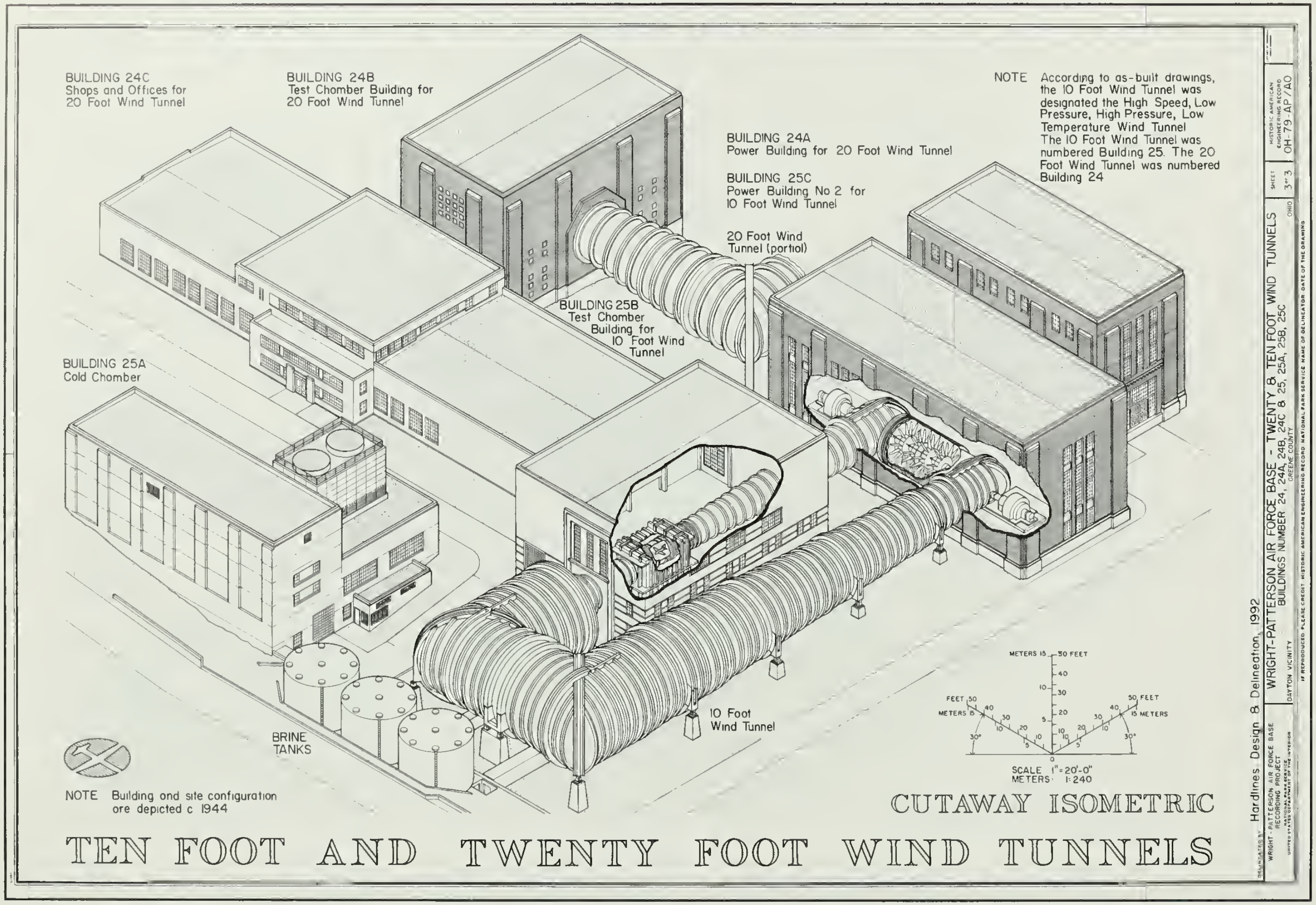


Figure 105: 10-Foot and 20-Foot Wind Tunnels, Building Complexes 24 and 25, 1944. (Delineated by Hardlines: Design & Delineation, HAER, 1992)

BUILDING 26: SUPER SONIC TEST LABORATORY

HAER No. OH-79-BC

Construction Date: 1943-45

DESCRIPTION: Building 26 sits in the northeast corner of the wind tunnel complex, and, although it is largely obscured by additions, tanks, fences and pipes, it is consistent in style with the other buildings in the vicinity. The three-story, split level, reinforced-concrete building has a flat roof with a wood cornice and frieze band, a penthouse, and irregular wings. The two-story west end has a parapeted roof front and four upper level window bays. The roof underside and the control room inside have been acoustically treated.

HISTORY: In September of 1943, construction began on Building 26, the new Supersonic Testing Laboratory. By 1950, the Two Foot Supersonic Wind Tunnel was operational, with the Six-Inch Supersonic Wind Tunnel following a year later.

Two-Foot Trisonic Gasdynamics Facility

The "trisonic" in this wind tunnel's name refers to its capability to operate at subsonic, transonic, and supersonic speeds. The tunnel operated for two decades as the Supersonic Gasdynamics Facility, capable of only supersonic and relatively inefficient subsonic testing. In the early 1970s, however, a 15" transonic section was designed to fill the transonic void left by the conversion of the Ten-Foot Wind Tunnel to the 50 Megawatt Facility.

For subsonic testing, this closed circuit, variable density wind tunnel generates airflow at mach speeds from 0.23 to 0.85. With the transonic insert in place, airflow through mach 1 can be attained. For supersonic testing, different sets of nozzles are inserted for discrete mach numbers of 1.5, 1.9, 2.3, and 3.0. In the early 1960s the tunnel's compressor could be connected in series with the Ten-Foot Wind Tunnel's old scavenging pumps in Building 25D, which gave the tunnel a mach 5 capability. However, that configuration produced an airflow with a Reynolds Number too low for practical applications. (Reynolds Number is the ratio represented by dividing the product of the density of the fluid and the velocity of the fluid and the linear dimension of the body in the fluid by the kinematic coefficient of viscosity of the fluid. Thus, as the size of the model decreases, the density of the fluid must increase proportionally for the test to accurately illustrate the aerodynamic properties of the full scale model in flight. This becomes an especially critical factor for high speed tunnels, as they usually have very small test sections and therefore are limited to very small scale models.)

Powered by a 3500-horsepower induction motor and a 5000-horsepower AC synchronous motor, the ten stage, axial flow compressor features unique variable vanes. The stagnation section contains a honeycomb and screen arrangement to minimize turbulence. This section also maintains the airflow's temperature at 100°F (±1°) with a water-cooled heat exchanger. Model support for the tunnel is a rack-mounted 50" radius crescent, equipped with a variety of sting extensions. The test section is equipped with Schlieren quality windows. The tunnel's optical instrumentation includes excellent Schlieren and laser light sheet capabilities, spherical and parabolic mirrors, optical benches, light sources, cameras, and an interferometer. A Jarrel Ash 3.4 meter grating spectrograph was transferred to Building 254 in the early 1960s. Consuming eight million watts per hour, the Trisonic Gasdynamics Facility's continuous run-time makes it preferable to many other high temperature, high speed tunnels. Throughout its 40 years of operation, the tunnel has contributed to many advanced aircraft and missile projects. High angle of attack studies are popular in the tunnel, which can simulate angles up to 48°. For example, numerous nozzle designs for the X-29 nose tip have been tested in the facility. The nozzles, which improve high angle of attack and tight turning capabilities, are also being considered for use on several of the advanced fighters currently in service (F-15, F-16 and F18). Along with the X-29, numerous other hypersonic glide vehicles (some of which are not expected to be in production until 2010 and beyond) have been tested in the Trisonic Gasdynamics Facility. Some other designs recently analyzed in the tunnel include submerged inlets for aircraft and missiles, a Canadian delta wing model, and ICBM nose tips capable of penetrating 50' of concrete.

Six-Inch Supersonic Wind Tunnel

Built in 1949, the Six-Inch Supersonic Wind Tunnel facility conducted aerodynamic testing on models in the supersonic range by 1951. Powered by one 1,000-horsepower variable-frequency motor, the variable-density, closed-return wind tunnel had mach capabilities to 2.5, with a test section measuring 6" x 6" x 12". However, by the mid 1950s the tunnel, though not officially closed, was no longer being used. With no foreseeable use, the Air Force donated the Six-Inch Wind Tunnel to Ohio State University in 1958.

For sources, see Bibliography on page 215.

Two Foot Trisonic Gasdynamics Facility

Type:		Closed circuit, variable density, continuous flow
Overall Size:		71'3" x 27'
Centerline Circuit Length:		160'
Model Type:		3 dimensional
Test Section:		Closed throat, rectangular, 2' x 2', 4' long
Max. Diameter:		9'
Contraction Ratio:		16:1
Velocity:	Subsonic:	mach 0.23 - 0.85
	Transonic:	through mach 1
	Supersonic:	discrete mach numbers 1.5, 1.9, 2.3 and 3.0
Max. Dynamic Pressure:		
	Subsonic:	350 psf
	Transonic:	1400 psf
	Supersonic:	600 - 1000 psf
Total Pressure:		0-4000 psf (normal range: 1100-2800 psf)
Max. Reynolds Number/Foot:		
	Subsonic:	2.5 million
	Transonic:	8 million
	Supersonic:	3 - 5 million
Power:		3500 hp induction motor, 5000 hp AC synchronous motor
Temp. Control:		Water cooled (calcium chloride brine heat exchanger)
Operating Temp. & Press. Range:		Tunnel stagnation temperature maintained at 100°F ±1°, stagnation pressure maintained to within ±1 psf of any pressure within range
Air Drive:		Allis Chalmers 10-stage, axial flow compressor
Drive Shaft:		10' long.
Max. Fan rpm:		3490
Model Support System:		Rack mounted 50" radius crescent with position displayed on operator's console with any accuracy to 0.01°F, pitch range from -1°F to +18.5°F (-1° to +12°F for transonic section)

Figure 106: Building 26, looking northwest, 1991.

BUILDING 27: VERTICAL WIND TUNNEL

HAER No. OH-79-A

Construction Date: 1943-45

DESCRIPTION: The cylindrical Vertical Wind Tunnel building rises 75' above the ground with an outside diameter of 65'8½". The reinforced concrete structure consists of the foundation wall, a main section, measuring 58'4", topped by a 16' penthouse. The inner shell of the wind tunnel and the penthouse are both 40' in diameter. The penthouse, which contains the 1000 horsepower motor for the wind tunnel fan and a 5-ton crane, has six windows, an access door and a set of double doors. The fan propeller at the top of the tower is 16' in diameter and is set in a circle of concrete faced with steel. The outer shell contains no windows, but has seven vents that span the height of the seventh lift. In the space where an eighth vent would be, an access door opens to a concrete stairway which winds to the penthouse level. On the west side of the building, a one-story motor generator house adjoins the outer shell.

HISTORY: One of the most interesting buildings at Wright-Patterson Air Force Base is the Vertical Wind Tunnel. It was built during World War II as an inexpensive, low-speed, in-house research and development facility to test parachute performance and aircraft spin characteristics. Despite a remarkably simple design and a relatively low operating cost, the tunnel has contributed to numerous advances in aeronautical technology. Approaching its fiftieth year of virtually trouble-free operation, the Vertical Wind Tunnel has been one of the most economically efficient pieces of equipment in Air Force history.

Construction began on the Vertical Wind Tunnel in 1943. The structures were designed by the Cincinnati, Ohio, firms of Potter, Tyler & Martin, and Hunt & Allen, and constructed by Frank Messer & Sons, also of Cincinnati. The wind tunnel was partly operational by May 1944, and completed in August 1945. The Vertical Wind Tunnel at Wright-Patterson Air Force Base is the only one operated by the Air Force. Currently, the only comparable facility in the country is NASA's vertical wind tunnel at Langley Air Force Base, although it has a larger test section and operates at slower air speeds.

One of the primary functions of the Vertical Wind Tunnel was to test aircraft spin characteristics. By spin testing prototypes in a vertical wind tunnel, designers could identify which designs or components made the aircraft least susceptible to "tailspin." Tailspin was one of the more significant risks in aircraft testing, occurring when an aircraft spiralled uncontrollably to the ground. For example, early models of the X-5 were plagued with a persistent inability to recover from tailspin, but after Vertical Wind Tunnel testing, engineers eliminated the problem by adding a simple ventral fin. Among the other aircraft tested in the Vertical Wind Tunnel, usually in 1/20th scale, were the X-1, X-2, X-3, T-37, F-86 and Century series fighters.

The Vertical Wind Tunnel has also made many notable contributions in the field of parachute dynamics. Capable of testing parachutes up to 6' in diameter, the tunnel performs experiments that measure such properties as drag, opening shock and stability of retardation. Similarly, the tunnel has also been involved in studying the drag and stability of missiles and re-entry bodies with and without drag-producing devices attached. For example, the tunnel has played an integral role in the development of Sense and Destroy Armor missiles (SADARM). The SADARM system uses a vortex ring parachute that maintains a constant spin rate and drop velocity to provide a high degree of stability for its missile. Other types of testing that have been conducted in the tunnel include rotary wing characteristics, ejection seat stabilization systems, and model tests such as oil flow experiments and force-pressure measurements.

Beginning in 1959, the Vertical Wind Tunnel spent several years operating on a stand-by basis only. It is still operational, however, and appears to be in no danger of shutting down. Aside from parachute testing, the tunnel is occasionally used for aircraft model tests. It also provides the military with a very safe and relatively inexpensive means of teaching basic free-fall techniques. Since the mid 1980s, the U.S. Army has trained its sky-diving students in the tunnel on a regular basis.

The building's exterior has undergone no significant alterations and, other than having the penthouse and seventh lift painted dark brown, its exterior remains virtually unchanged from its original appearance. The interior and the tunnel itself have been modified only slightly. The original corner vanes that guided the airflow near the top of the tunnel were removed, and replaced by a metal shroud that wraps the 90° corner with a more efficient curve. Moreover, the return section has been augmented with a plywood sheath. Attached to the inside wall of the tunnel with timber scaffolding, the sheath lifts away from the wall, narrowing the return duct at the top of the tunnel. The sheath then gradually merges back with the inside wall near the bottom, expanding the duct to the original 7'6". The shroud and sheath both work to speed and smooth the airflow through the return section.

For sources, see Bibliography on page 215.

Figure 107: Vertical Wind Tunnel, looking northeast, 1991.

Vertical Wind Tunnel

Type:	Annular return
Overall Size:	56’8" Diameter, 75’ total height
Centerline Circuit Length:	163’
Model Type:	3 dimensional free flight
Test Section:	16 sided polygon, 12’ across, 15’ high, open throat
Max. Diameter:	Not available
Contraction Ratio:	9.86:1
Max. Velocity:	95 mph (mach .13); 102 mph (mach .14) when empty and without net
Max. Dynamic Pressure:	25 psf
Power:	1000 hp DC synchronous motor, Ward Leonard speed control system
Energy Ratio:	.65
Temp. Control:	None
Operating Temp. & Press. Range:	Atmospheric
Air Drive:	One 16’ diameter fan with 4 laminated maple blades; variable pitch has been disconnected, but still adjustable manually.
Drive Shaft:	10’ long, 6" diameter solid steel shaft
Max. Fan rpm:	875
Model Support System:	Horizontal Parachute Test Strut; vertical, light weight sting mounted models; many tests done in free flight, such as radio controlled models for spin testing
Balance Capacity and Range:	Parachute Drag 200 lbs. Parachute Side Force 100 lbs.
Data System:	Electronic and video systems
Cost:	$750,000 (1986 estimated replacement value: $5,000,000)

Figure 108: Wind Tunnel complex, 1944; 20-Foot Wind Tunnel is in left background, Vertical Wind Tunnel is in foreground. (USAF)

Figure 109: Control Room of Vertical Wind Tunnel, 1991.

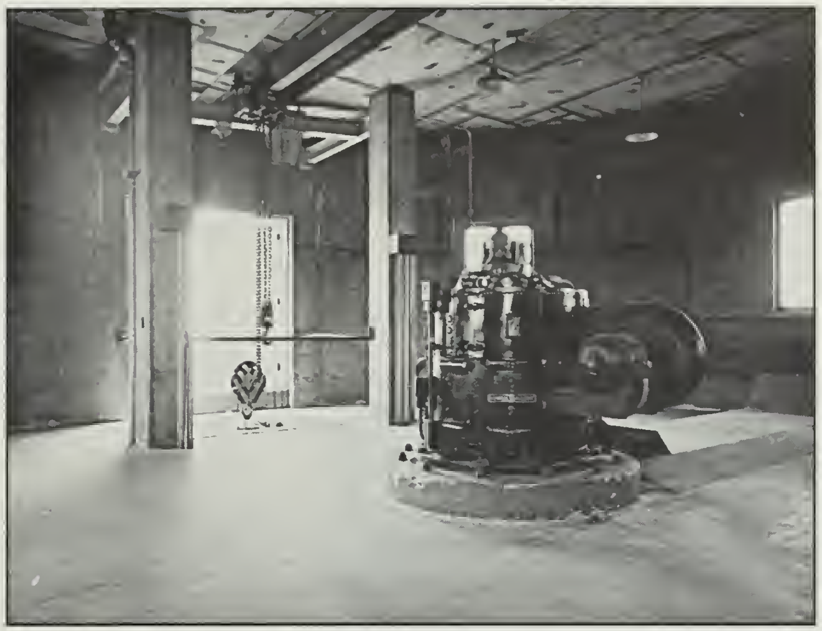


Figure 110: Penthouse of Vertical Wind Tunnel, showing hoist and fan motor, 1991.

Figure 111: Interior view of basement, Vertical Wind Tunnel, 1991.

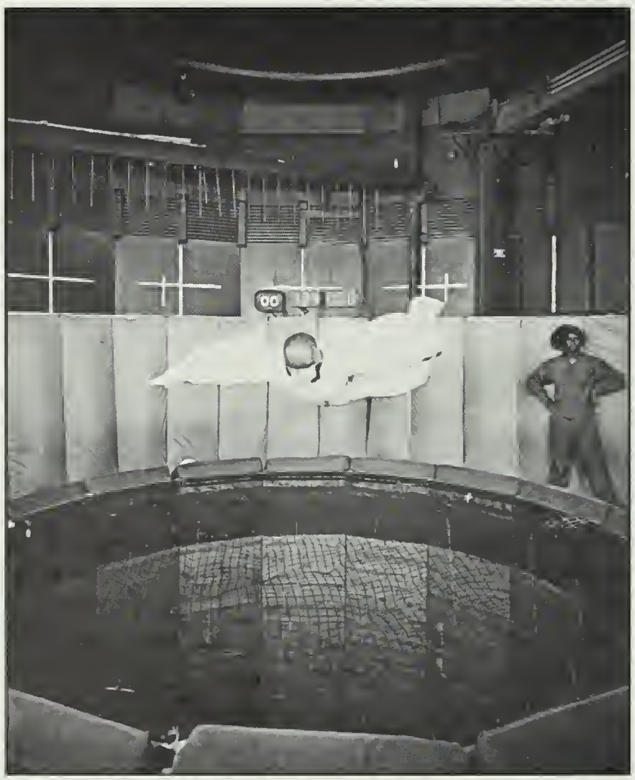


Figure 112: Subject practicing parachuting in test area, Vertical Wind Tunnel, 1991.

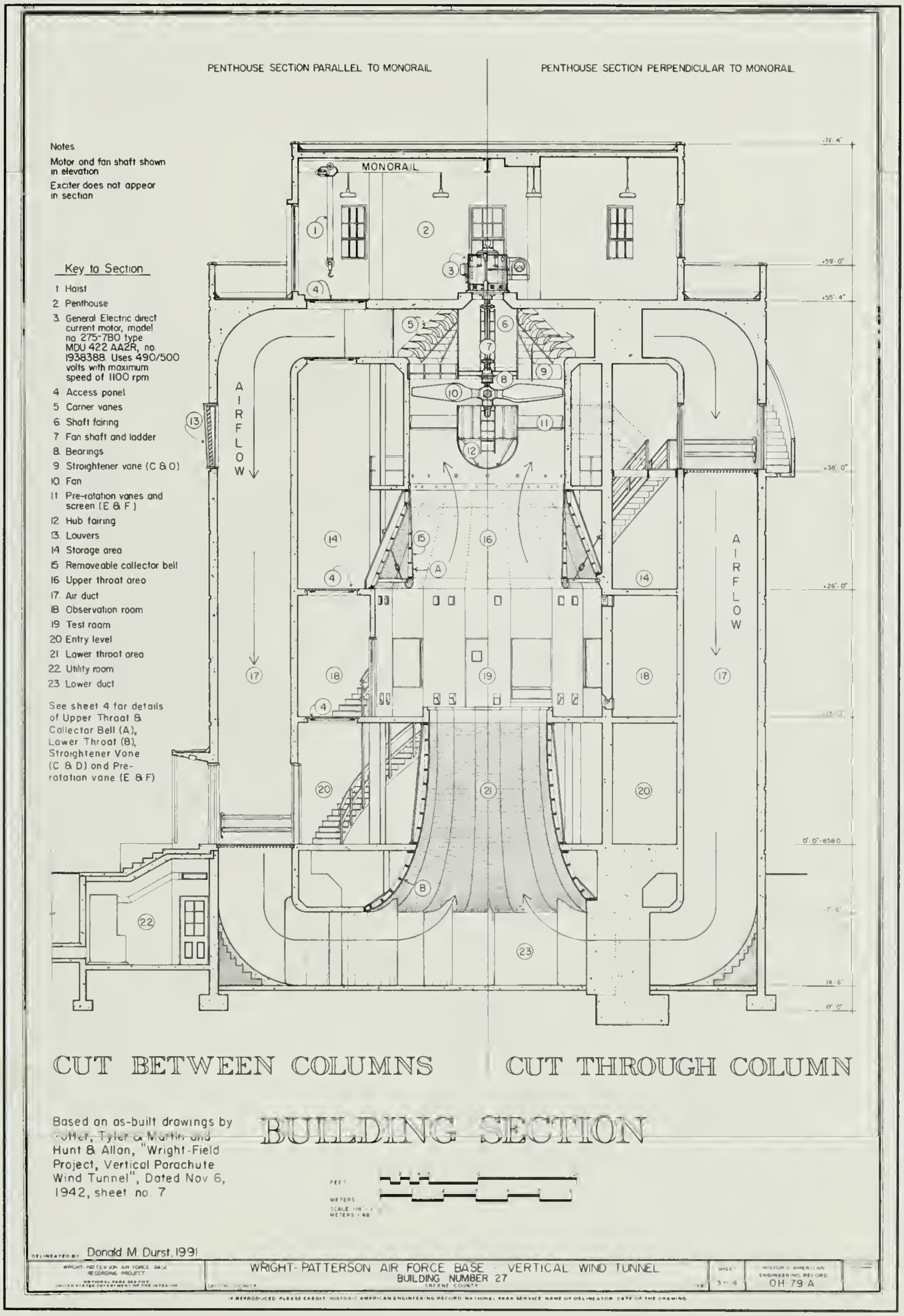


Figure 113: Vertical Wind Tunnel, 1944. (Delin. by Donald M. Durst, HAER, 1991) [See also drawing on page 29.]

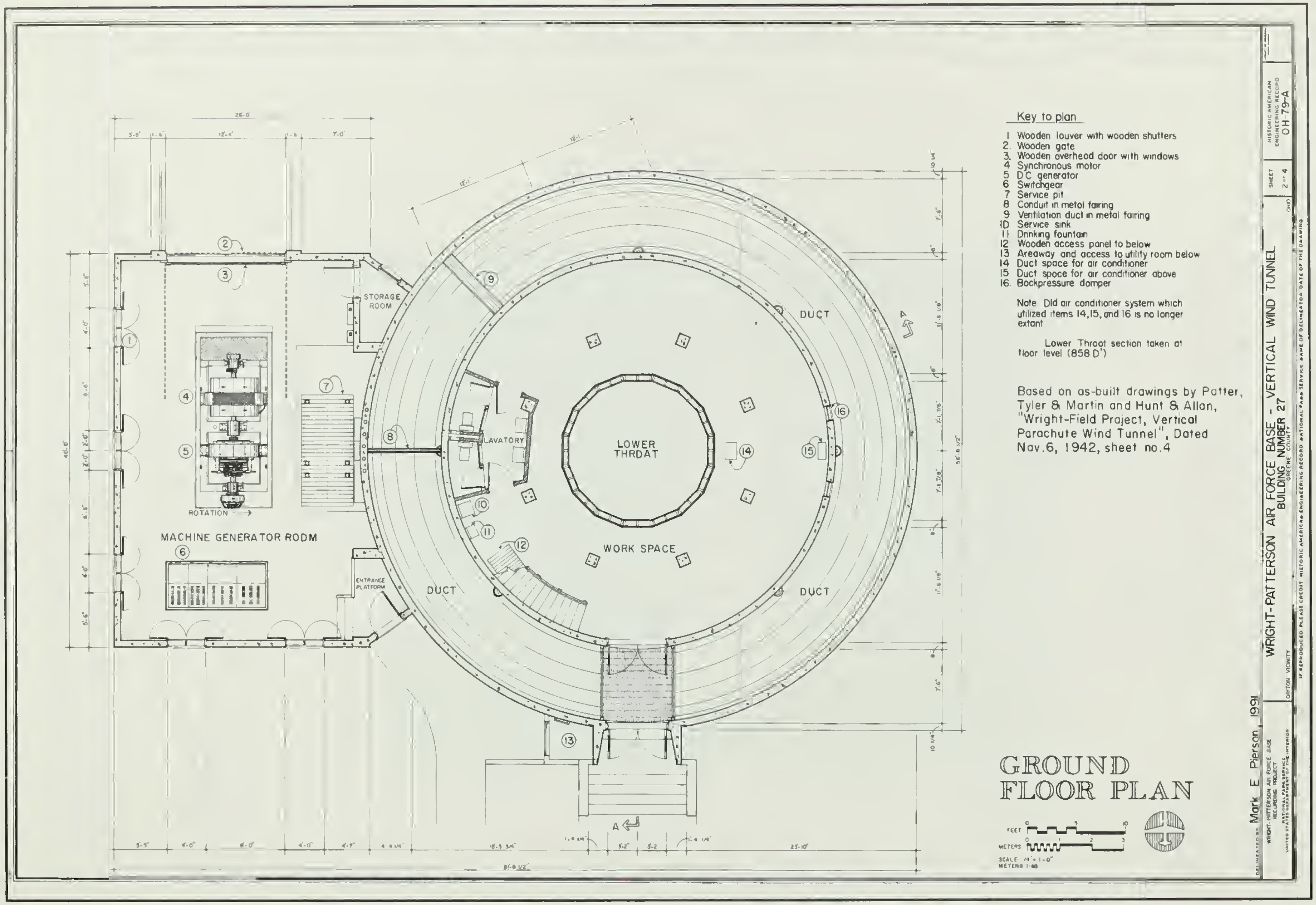


Figure 114: Vertical Wind Tunnel, 1944. (Delineated by Mark E. Pierson, HAER, 1991)

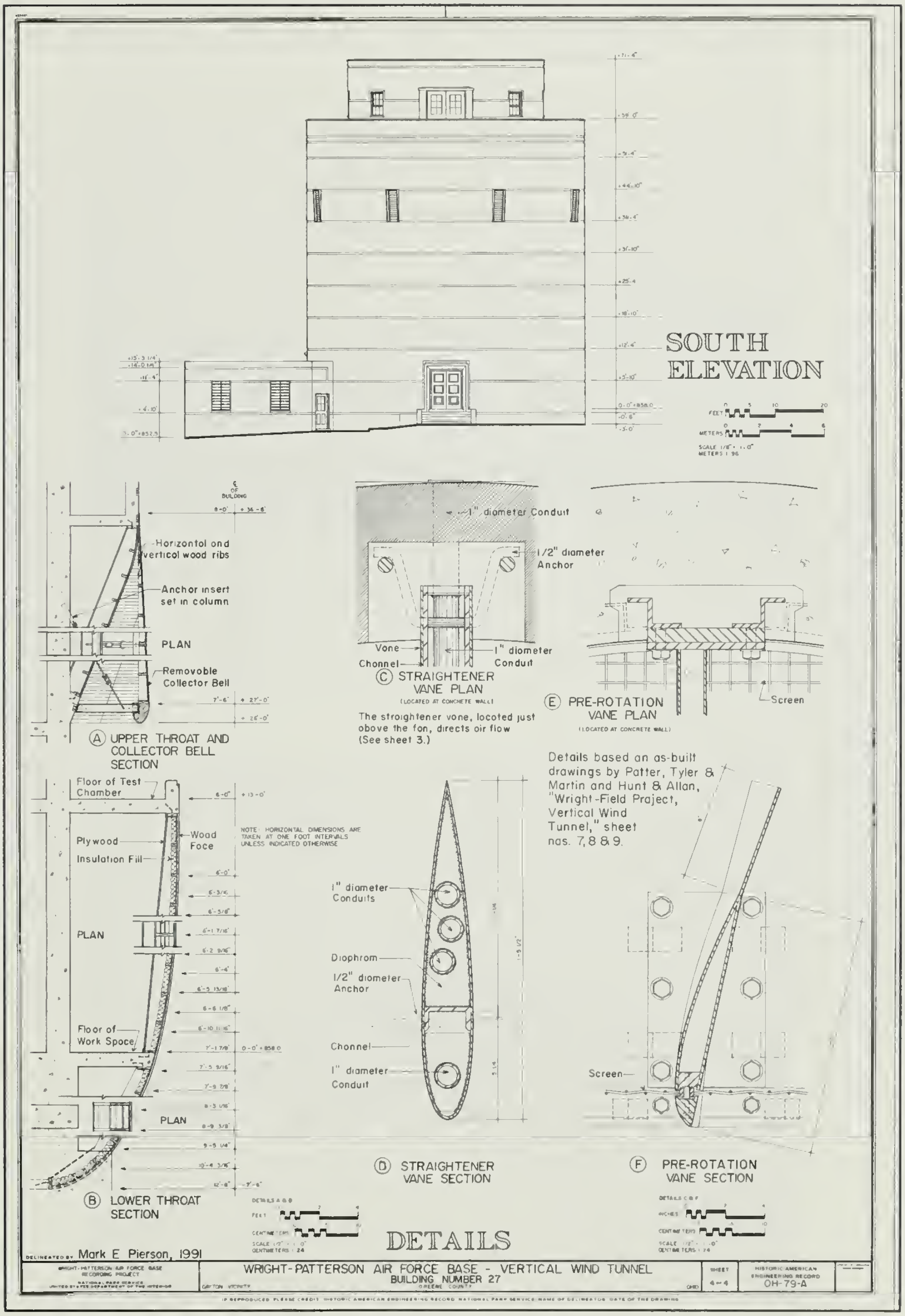


Figure 115: Vertical Wind Tunnel, 1944. (Delineated by Mark E. Pierson, HAER, 1991)

BUILDING 28: AIRCRAFT RADIO LABORATORY

HAER No. OH-79-AC

Construction Date: 1942

DESCRIPTION: Building 28 is an E-shaped, two-story, concrete building with brick facade. It was a planned departure from the architectural style of earlier Wright Field laboratories, retaining the American bond brick pattern in its three-story exterior, but eliminating the copper entablature, gables, and corner towers. Instead, it has a flat roof above a grooved cement frieze, aluminum window frames, and glass blocks in square arrays between the windows. The top section of the brick wall also has grooves to heighten the Art Moderne impression. Both major additions, the northwest wing (added shortly after the original construction) and the northeast wing (added in 1943), maintain the original style, but are more understated than the facade. A small penthouse was erected in 1948 and removed in 1980.

HISTORY: Building 28 was constructed in 1942 to replace the radio laboratory in Building 17, and in consequence was initially known as the New Aircraft Radio Laboratory. The research performed in Building 28 involved both radio communication and radio navigation. Some of the first equipment installed tested radio components in simulated environmental extremes of altitude, humidity, and temperature, as well as in conditions of vibration, noise, acceleration, shock, salt spray, and fungal infestation. Later, engineers also investigated methods of interference elimination and tested new generations of aircraft radio transmitters and receivers. Because the laboratory was built into the side of a hill, it possessed a west elevation high enough to conduct tests with aircraft in flight. This was useful in tests of IFF (Identification, Friend or Foe) equipment, including the Mark X SIF (Selective Identification Feature) Interrogator.

By the late 1970s, laboratories were gradually moving to other locations on base and being replaced by offices. After upgrading the interior in 1982 and 1983, the LANTIRN SPO (Low-Altitude Navigation and Targeting Infra-Red Night System Program Office) moved in. Consisting of two pods slung underneath an aircraft, LANTIRN systems use infrared radar to track both terrain and targets. This technology allows pilots to fly safely and fight effectively at night and in bad weather.

System Program Offices for both the U-2 and SR-71 surveillance aircraft were also located in Building 28 until those aircraft were phased out. While the LANTIRN SPO has also moved, Building 28 continues its heritage of electronics excellence by hosting the Air Force Electronic Combat Office, the Electronic Combat and Reconnaissance SPO, the Special Operations Forces SPO, and the EF111A Tactical Electronic Jamming Aircraft SPO.

For sources, see Bibliography on page 215.

Figure 116: Building 28, looking northwest, 1991.

Figure 117: Building 28, looking northeast, 1991.

BUILDING 29: AERO MEDICAL LABORATORY

HAER No. OH-79-AQ

Construction Date: 1942

DESCRIPTION: Built in 1942, this four-story rectangular building with a basement has a concrete foundation and concrete block walls with a stucco finish. The first three stories constitute the main structure, with a smaller fourth floor penthouse centered on the flat roof. On top of the penthouse, a cubical structure houses the original 1940s elevator equipment.

Wide steps lead to the entrance, which has a concrete canopy and rectangular transom. Flanking the entrance are four bays of twelve-pane windows, while the middle two floors have five bays. Filling the space between the window bays is applied six-course, American bond brick. The fourth floor penthouse has two narrow window bays flanking an access door. The east and west sides each have a single canopied door with an elongated six-pane glass window bay above the doorways. Three-story, single window bays flank the side entrances.

HISTORY: In 1935 the Air Corps established the Physiological Research Laboratory (PRL) at Wright Field to study the effects of human tolerances to the increased speeds, altitudes and durations experienced by aviators, with the intention of designing the equipment necessary to increase these tolerances. Originally located in the basement of Building 16, in 1942 the PRL became the Aero Medical Research Laboratory (AMRL) and moved to its new location, Building 29. Architects from the Wright Field District Office, U.S. Army Corps of Engineers, designed the building, which was built by Frank Burke & Sons. In December of 1942, the unit was renamed the Aero Medical Laboratory.

The facilities moved to Building 29 included most of the administrative offices, the Physiology Branch, the Biophysics Branch, the Clinical Research Branch, the Psychology Branch, the altitude/cold chambers, an all-weather room, a copper mannequin test room, a vision test facility, and the AMRL library. Support facilities were located in other buildings: Building 55 contained the second human centrifuge; Building 196 housed the Oxygen Branch, while the Oxygen Equipment Test Facility and an altitude chamber were in Building 197; Building 198 contained the machine and wood shops.

Among the equipment transferred to the new building were three pressure chambers designed to simulate high altitude conditions of extreme pressures and temperatures. The two small chambers each had a capacity of 3 cubic feet and were refrigerated by dry ice. Evacuation was effected by individual hyvac pumps or by connecting the chambers to the main laboratory vacuum system. The effect of altitude was produced by a special manometric control system. The large chamber was a cylinder, measuring 31' in length and 8' in diameter, laid in a horizontal position. It was divided into three connecting sections; the central compartment served as a lock through which access could be gained to the two end ones without interfering with their pressure conditions. It was possible to achieve pressure equivalent to 80,000 feet and temperatures down to -65°F. The pressure chambers were placed in the basement of Building 29.

During the 1940s, the Laboratory concentrated on the physiological effects of acceleration, abrupt deceleration, curvilinear flight, and high altitude flight. Among the advances made by the Laboratory for such conditions were G-suits, improved oxygen systems, pressure breathing, electrically heated flying suits, automatically opening parachutes, flying goggles, and upward ejection seats.

The Aero Medical Laboratory moved into research on the effects of jet and space flight in the 1950s; additional medical problems were created by the increased flight velocities, the high acceleration forces, reduced response times, and the very high altitude flight profiles. The Laboratory conducted large scale anthropometric studies of Air Force personnel, studied the effects of zero gravity on monkeys and mice, conducted the first human tolerance experiments in linear deceleration (using a rocket sled), and developed partial pressure suits which met high altitude emergency requirements and the first full pressure suit. In anticipation of nuclear powered aircraft, the Laboratory conducted 120-hour aircrew habitability studies. During this decade, Building 29 acquired a Link trainer facility and a thermal chamber. Further support facilities were added in other buildings, including the animal surgical room, the spin table, the third human centrifuge, the bioelectronics laboratory, acoustical chambers, and the instrumentation laboratory in Building 33; training simulator facilities, a visual simulation and analogue computer, and an instrumentation laboratory in Building 190; biochemical laboratories, nutrition laboratory, and an altitude chamber in Building 248; and for the survival equipment test facility and oxygen equipment test facility in Building 824.

In August 1959 the name of the Aero Medical Laboratory was changed to Aerospace Medical Laboratory. Early aerospace research had begun by 1957 with the object of developing sufficient medical knowledge to design a manned vehicle for low earth orbital flight. The problems addressed included human thermal stress in space environment, physiological criteria, nutrition in space flight, visual problems, and personal protection for astronautical operations.

The work of the Aerospace Medical Laboratory in the 1960s was dominated by the challenge of manned space flight. In addition to handling Air Force projects, the Laboratory was called upon to provide technical support for NASA, which did not have adequate biotechnical capabilities. Aerospace engineers at Wright-Patterson developed new areas of research which resulted in the establishment of national standards on noise hazards and vibration exposure, human engineering design procedures, and toxic exposure limits.

Aeromedical facilities that were developed during the 1960s included the Lunar Landing Facility in Building 156, the computer-based Human Engineering System Simulator in Building 248 and the Dynamic Environmental Simulator (a three-axis centrifuge) in Building 33. Building 29 acquired the Heat Pulse Thermal Facility for analyzing safe exposure criteria and human tolerances to intense transient heat pulses such as those expected to be encountered in rapid reentry from space. However, much of the aeromedical research previously conducted in Building 29 had been relocated or discontinued, and by the end of the 1960s the Heat Pulse Thermal Facility was the only aeromedical operation still in the building.

Currently, Building 29 is occupied exclusively by office space and other support for Detachment 1 of the Armstrong Aerospace Medical Research Laboratory.

For sources, see Bibliography on page 215.

Figure 118: Building 29, ca. 1940s. (USAF)

Figure 119: Building 29, looking north, 1992.

BUILDING 30: AUDIO-VISUAL LABORATORY

HAER No. OH-79-BB

Construction Date: 1942-43

DESCRIPTION: The Audio-Visual Laboratory is a two-story, rectangular, cinder-block building with a low-parapeted flat roof. There is a single header brick course under the roof coping that surrounds the building. All the windows are replacement, and have concrete sills. On the north and south sides, steel fire escapes have single steel access doors on both levels. The east entrance has wide steps with steel railings leading up to a set of canopied double steel doors, each with a single glass pane. A two-story addition is attached to the north side.

Office space occupies the two above ground floors, while the video studio, control room, graphics facility and video storage all reside in the basement. The current television production facilities were installed in 1988, and include computerized videotape editing equipment, digital graphics, and ½" SP Betacam VTR's. Also in the basement, eight original refrigerated (to 55°F) film vaults remain, although only one still serves that purpose. The vaults have special ducts leading straight up through the roof, should the volatile concentration of celluloid explode. The original dark room has been converted to a client's lounge/dressing room.

HISTORY: Built in 1942 as the Technical Data Annex No. 1, Building 30 was designed as an audio-visual facility, and has remained in that capacity for the last fifty years. Beginning in 1952, Building 30 personnel (then the 1350th Photographic Services Squadron) were responsible for writing, producing, directing, and editing all official Air Force films. Except for the period 1958-1962, when the Squadron (by then the 1350th Motion Picture Squadron) was located in Orlando, Florida, Building 30 continued to be the heart of Air Force film production until 1983. Now headquarters for Detachment 2, 1361st Audiovisual Squadron, including the Wright-Patterson Air Force Base Television Production Studio, the building has been used primarily for video production since 1983.

For sources, see Bibliography on page 215.

Figure 120: Building 30, looking northwest, 1991.

BUILDING 31: AIRCRAFT ASSEMBLY HANGAR

HAER No. OH-79-E

Construction Date: 1927

DESCRIPTION: Building 31 is a imposing, single-bay structure with a center height of almost 55'. Steel roof trusses on the northern half of this central space are supported by columns, but south of the building's axis the trusses are cantilevered, providing an uninterrupted area in which to park and maneuver airplanes. The concrete foundation and floor support brick walls of six-course, American bond brick beneath a low-pitched, single-gabled roof and wide copper entablature. The windows in the east and west ends are in a steel-sashed, factory format. Large hangar doors originally occupied the entire south side, but as the building's function shifted away from experiments on whole airplanes in the late 1940s, these were replaced by a brick wall with twelve bays of multi-pane, steel-sashed factory windows, two dock entrances, and double doors. The windows were soon filled in as well, because they shattered under the sudden air pressure fluctuations caused by bursting tires. A wide concrete band extends along the top of the twelve long windows in the south wall.

Anchoring each corner are large square decorative towers. Single doors on two sides of each tower are topped by elongated Renaissance arch windows. Above the windows are glass-filled bull's-eyes with concrete surrounds and three more concrete belts trimming the brick exterior. The original glass-enclosed Wright Field control tower perched on the southwest tower until its removal in the late 1970s. It had been unused since a new tower was included with Building 8 in the flightline complex constructed in 1943.

Attached to the east end of the building is an original 50' x 60' dope room. (Dope was a varnish-like substance used to waterproof and strengthen the cloth covering of early airplane wings.) In 1948 a transformer vault of 50' x 35' was added south of and adjacent to the dope room to support the increased electromechanical requirements of the improved facility.

The aircraft assembly process in Building 31 was supported by the wood, metal and machine shops in Building 32 which are attached to the north wall of the hangar.

HISTORY: Building 31 was one of the original Wright Field buildings and was constructed simultaneously with Building 32, the original Wright Field engineering shops facility. (Until they were enlarged in 1941, these shops were considered part of Building 31.) The building was designed by the Office of the Constructing Quartermaster; the foundation was laid by Green and Sawyer, of Lima, Ohio; and the superstructure was built by E.H. Latham Co. of Columbus, Ohio. Its use as an aircraft assembly and test hangar required a lofty three-story height. Until 1934, it also housed static test facilities. In the 1930s and 1940s, Building 31 began to host research and development on aircraft wheel assemblies and landing gear, and those vital functions have remained there ever since.

During the first decade of Wright Field's existence, Building 31 was certainly one of the most vital components of Wright Field's commitment to aeronautical engineering. Engineers in Building 31 tested virtually every model of aircraft that entered Air Corps service through World War II, and discovered the flaws that prevented many other aircraft from entering service. Contemporary photographs are replete with airplanes inside the assembly hangar and outside, either parked or traveling to and from the flying field to the southwest.

The assembly hangar bustled with activity throughout the 1930s, a period when much of the American military establishment was neglected due to isolationism and the Depression. Aeronautical technology was the cutting edge of military engineering throughout the world, and the United States

Army Air Corps was able to carry on its work, albeit under budget constraints. The Air Corps brought to Wright Field all prototype airplanes it wished to test. Before flight testing could begin, engineers and technicians in Building 31 assembled the aircraft and performed laboratory tests on the planes and their various structural components.

The Materiel Division of the Air Corps had the responsibility to test the structural strength of all aircraft obtained from contractors by the Air Corps and to develop improved methods of assembling them. The structures testing in Building 31 continued the earlier work of the Airplane Engineering Division at McCook Field. Engineers calculated the maximum strength of essential structures both at rest and in motion. During static tests the aircraft were held at rest and loaded with lead bars or shot-filled bags until failure occurred or the strength was judged sufficient to support the aircraft in any mission. The dynamic testing involved lifting the structure under examination to a specific height and angle and then dropping it. By selecting appropriate positions from which to perform the drops, simulations of specific landing conditions were duplicated. These tests ensured that aircraft and their wheel assemblies could sustain the repeated shock and jar of landing.

In December of 1934, all static test operations moved to Building 23, a newly completed facility specifically constructed for that function. The aircraft assembly operation remained in Building 31 until World War II, by which time most military aircraft were too large to allow efficient use of that interior space, and new hangars had been constructed along the improved flightline. This allowed the mission of Building 31 to shift to more specific, but equally vital operations that it has retained to this day.

In 1938 a wheel brake and tire research facility was set up in Building 31, and in 1943 a landing gear test facility also began functioning. These performed research and development on landing gear systems and components, including wheels, tires, inner tubes, braking systems, shimmy and steering devices, and related hardware. Work here was intense during the war, but during the 1950s the laboratory experienced a decline in demand for its services. The Air Force used it only when VIPs requested demonstrations of the enormous equipment, although private firms occasionally contracted to use the facility with their own people.

This situation began to change in the early 1960s when new aircraft required this unique equipment, rather than the more limited facilities of the defense industry contractors. Both the 192" Dynamometer and the #4 Drop Test Machine were the largest machines of their kind and remain so to the present day. Here follows an account of this laboratory's accoutrements in 1962, all of which are still in use, though some have been modified:

Landing Gear Drop Test Machines

	Load Range (lb)	Max. Head Travel (ft)
#1	1,350 - 3,600	15
#2	2,000 - 10,300	20
#3	5,000 - 35,000	25
#4	35,000 - 150,000	25

Dynamometers

Flywheel Diameter (inches)	Test Subject	Max. Load (lb)	Max. Speed (mph)
192	Tire/Wheel/Brake	290,000	200
120	Tire	84,000	300
120	Tire/Wheel/Brake	60,000	120
84	Tire/Wheel/Brake	40,000	250
66	Tire/Wheel/Brake	10,000	120

The drop test machines are used to simulate aircraft landing impacts on tires and wheels or entire landing gear. Very simply, the structure to be tested is attached to the movable head and dropped vertically with a known force. This can be performed repeatedly, if desired, and in patterns which simulate the effects of landing and taxi on smooth or rough runways. These tests measure the landing-gear strut pressures, beam stresses, dampening coefficients, and loads transmitted to the aircraft structure.

The dynamometers consist of a large flywheel and a carriage to which the aircraft wheel is attached. The flywheel spins at a known rotational speed, and the carriage moves the tire into contact with it, causing the tire to rotate under a known force. Tire and wheel tests are generally run until failure occurs, both to test the durability of the tire and to observe the reaction of the wheel assembly to the torque stress which it undergoes as the tire rips apart with tremendous moment. These machines are also used to test the effectiveness of braking systems on the wheels.

This laboratory facility possesses both the largest dynamometer of this type and the most powerful drop test machine in existence. In addition to aircraft wheel assemblies, they have been used to test land-based earthmover tires and the landing gear for the Space Shuttle. The modern facility includes all of the original dynamometers and drop test machines as well as newer equipment such as a tire force machine, which measures the forces and moments on a tire on varied landing surfaces, and a burst pit, in which the ultimate strength of a tire is tested in a pit underneath a concrete slab by filling the tire with water and increasing the pressure until it bursts.

For sources, see Bibliography on page 215.

Figure 121: Building 31, looking northeast, 1991. [See also photograph on page 10.]

Figure 122: Building 31, looking southeast, with old metal shop on left, 1991.

Figure 123: Ceiling trusses, Building 31, 1991.

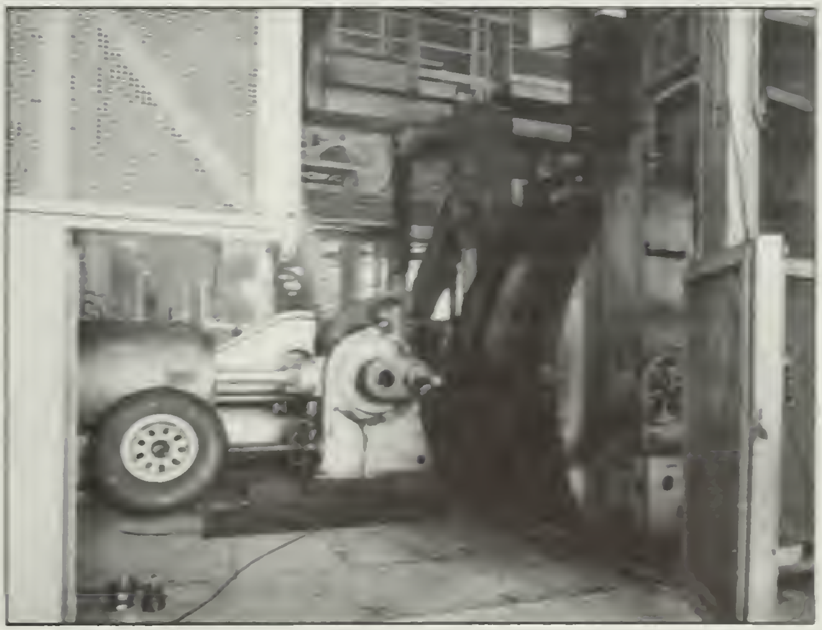


Figure 124: One of the dynamometers in Building 31, 1991

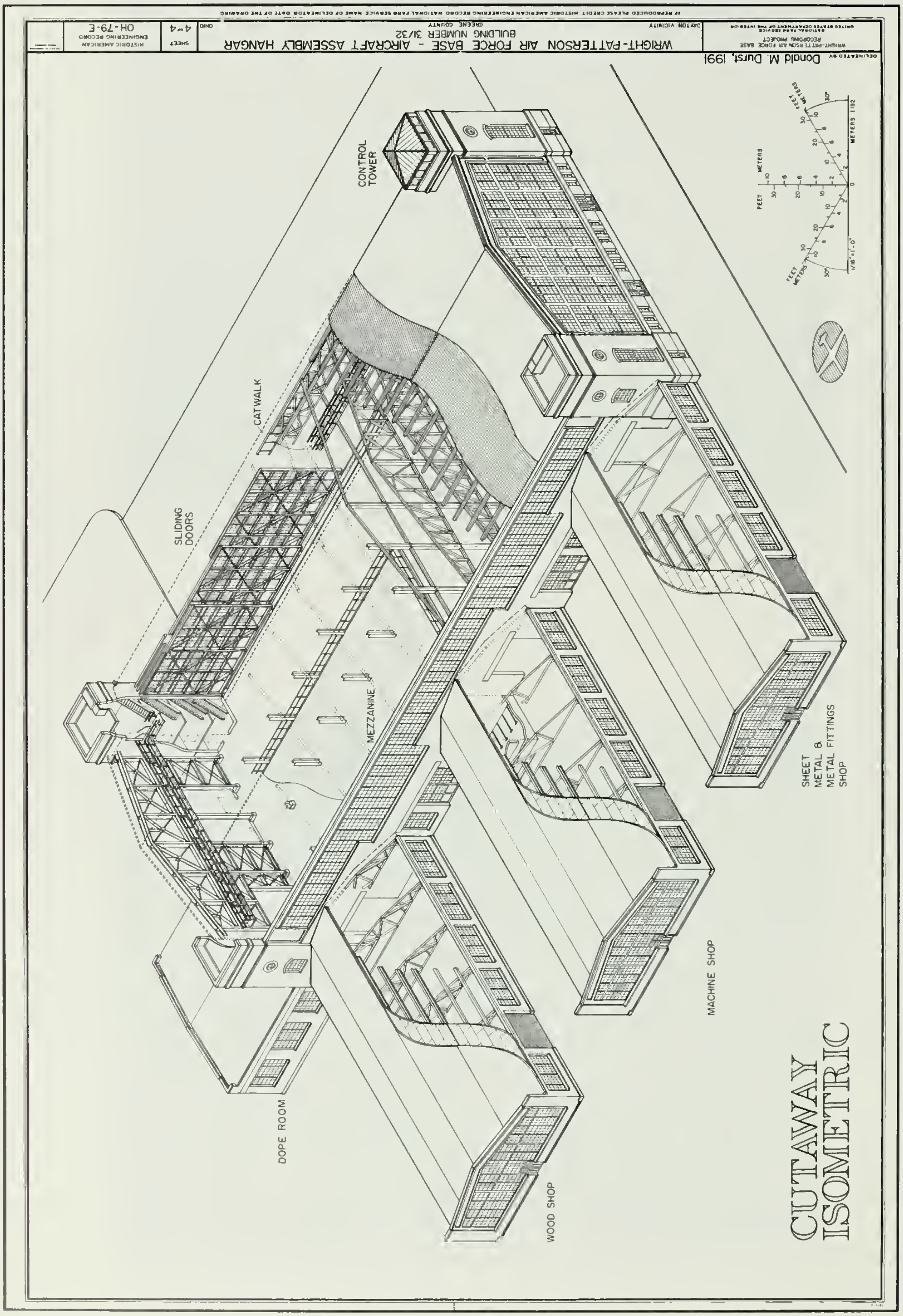


Figure 125: Aircraft Assembly Hangar, Building 31/32, 1927. (Delineated by Donald M. Durst, HAER, 1991).

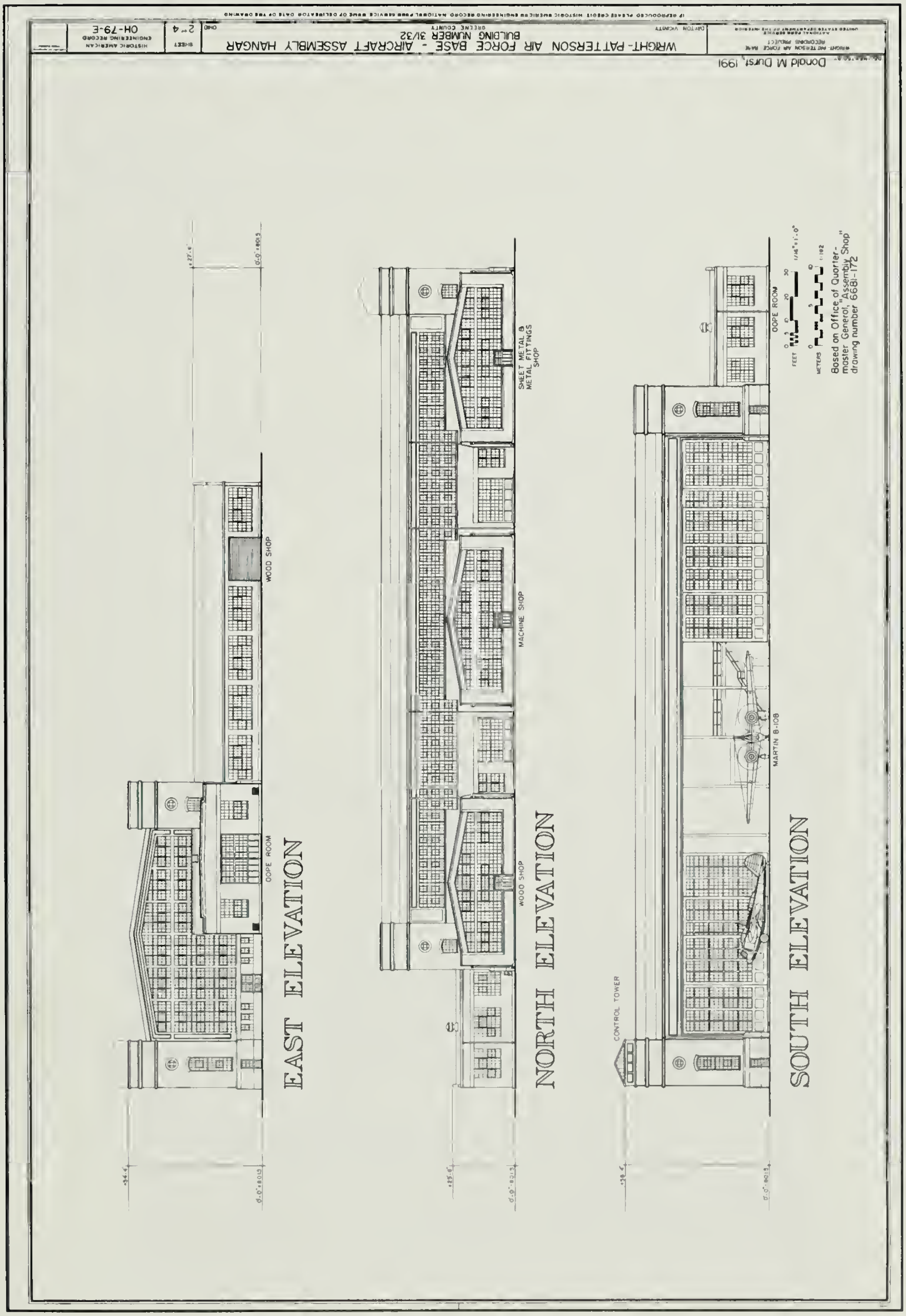


Figure 126: Aircraft Assembly Hangar, Building 31/32, 1927. (Delineated by Donald M. Durst, HAER, 1991)

BUILDING 32: ORIGINAL WRIGHT FIELD SHOPS

HAER No. OH-79-K

Construction Date: 1926-27

DESCRIPTION: Attached to the north side of Building 31 and covering an area of 283' x 264', Building 32 has a five-gabled front with two newer connecting gables several feet higher than the original ones. It has wide copper entablatures, low-pitched gable roofs, and rectangular brick corner columns that decorate the north face. The bearing wall is masonry with steel trusses, and the exterior wall is concrete block with red-brick veneer in a seven-course, American bond pattern. The west side retains a 1948 limestone block entryway with Art Deco-style details, including glass and aluminum doors and aluminum outdoor light fixtures. Smaller windows and new brick have replaced most of the original large window bays on the west side, and numerous ventilation and exhaust structures protrude from the black-shingled roof.

HISTORY: Building 32 was not identified as a separate building when it was first constructed in 1927, but was considered a portion of Building 31, to which it was connected. What is now called Building 32 began as three separate 65'-wide spurs each extending 120' north from Building 31. This was the original location of Wright Field's engineering shops, and, from west to east, the shops housed the sheet metal, machine and wood shops that supported work performed in Building 31.

In 1931 and 1932, a wood block floor was laid on top of the concrete floor to better absorb the shocks of shop operations and provide a safer work environment. In late 1940 and early 1941, all three buildings were extended to 4th Street and the two spaces in between were filled in, creating one large building 283' x 264' which was designated Building 32.

The engineering shops moved to Building 5 when it was completed in 1943. The Materials Laboratory then relocated from its former home across D Street in Building 16 to Building 32 where it remained for many years, despite the permanent tile partitions between the five sections of the structure which limited the facility's adaptability. Among the advantages of Building 32 over Building 16 were a larger cold room, capable of holding a temperature of -70°F, and a series of x-ray rooms with 12"-thick reinforced concrete walls and massive lead-lined doors.

In the 1940s and 1950s the Materials Laboratory incorporated several important facilities. The chemical and physical analysis equipment performed state-of-the-art analyses of materials samples, including molecular, mass, emission, and infrared spectroscopy and electron and x-ray diffraction. The metallographic facility studied the molecular and crystalline structures of experimental metals and compounds of vanadium, columbium (niobium), molybdenum, and titanium. This work contributed to knowledge of tensile strength, torsion resistance, and the creep and rupture potential of materials. Building 32 also housed several small centrifuges which conducted acceleration tests on materials samples from .5 to 8800 grams in mass. Finally, various environmental chambers occupied much of the building. Ranging from 1 cubic foot to 4500 cubic feet, these tested materials properties at hot and cold extremes of temperature, high and low humidity, and temperature gradients of up to 500 degrees per hour in the high-temperature rooms and up to 40 degrees per hour in the low-temperature rooms.

The supply and shop support activities were centralized in September 1952; machine shop personnel remained in Building 32 but under different management. In 1961 Materials Central moved its offices to Building 17, but Building 32 remained in use both as laboratories and offices. In 1963 a Military Construction Program funded modifications which improved the Advanced Metallurgical

Studies Area. During the 1970s and 1980s, the Materials Laboratory complex of Buildings 651 through 655 was constructed, and individual laboratories gradually moved from Building 32 as new space became available. The chemical, metallurgical, and non-metallic analysis laboratories were among the last to leave before Building 32's laboratory function ceased. Since that time, various offices, such as Acquisition Logistics, Short-Range Attack Missile (SRAM) System Program Office (SPO), Aeronautical Systems Division (now Aeronautical Systems Center) Weather Office, and ASD Small Business Office have occupied the building. In late 1992-1993, Building 32 will undergo a historically sympathetic rehabilitation. Afterwards, the southern section will be given to the Landing Gear Laboratory of adjacent Building 31, and the remainder of Building 32 will become flexible office space.

For sources, see Bibliography on page 215.

Figure 127: Original Wright Field shops, 1944. (USAF)

Figure 128: North facade of Building 32 complex, 1991.

Figure 129: Interior of Building 32, 1992.

BUILDING 36: MAINTENANCE BUILDING NO. 2

HAER No. OH-79-AE

Construction Date: 1929

DESCRIPTION: Maintenance Building No. 2 is a two-story, six-course American bond brick building with a low-pitched gable roof, and rectangular columns with concrete capitals decorating the corners. The current structure covers 52,000 square feet which includes two additions. The first is a small extension built onto the front in the same style as the original except with a stretcher bond, instead of American bond, brick pattern. The second addition sits along the north side of the original building. A sheet of brick extending from the roof about three-quarters of the way back is probably a former gable indicating that the northern expansion was constructed in two projects. Like the other addition, this section uses stretcher bond brick for its exterior walls, but it differs further from the original building since the gable is entirely of brick with no decorative columns, towers, or entablature.

HISTORY: The earliest section of Maintenance Shop No. 2 was built in 1929 on the site of the original Wright Field temporary heating plant which had burned down earlier that year. The original building constitutes only 8,000 of the current 52,000 square feet of the structure. Two additions were built in the late 1930s and early 1940s--a small extension attached to the front and another along the north side of the original building. Initially the entire north section was called Building 34, Maintenance Building Number 5. Shortly after the end of World War II, the structure's designation was reduced to the single number 36. Since the additions Building 36 has housed a variety of engineering shops, including refrigeration, carpentry, steam fitting, plumbing, metal, bench, locksmith, and paint shops. Today the Construction Management Section of the Engineering Construction Branch is located in Building 36, as is Civil Engineering's Simplified Acquisition of Base Engineering Requirements (SABER) office.

For sources, see Bibliography on page 215.

Figure 130: Building 36, looking east, 1991.

BUILDING 38: MAINTENANCE BUILDING NO. 3

HAER No. OH-79-V

Construction Date: 1932

DESCRIPTION: Building 38 was constructed in typical Wright Field style of six-course, American bond brick with end gables, wide metal entablatures, and concrete-filled bull's eyes on the rectangular, decorative corner columns. One element that makes this building different is the use of brick soldiers (bricks laid on end with the longest side vertical) placed above the concrete foundation and above the windows and doors at the south end of the building.

The building was originally an open structure with the north and west sides exposed; in 1939 the roof was extended further to the north in a gambrel fashion, and in 1940 the building was enclosed with bricks keeping the same six-course, American bond pattern with soldiers at the bottom. This created a structure measuring 340' x 69'. Attached to the northeast corner is a one-story addition, of similar style, measuring 104' x 48' which was added near the end of World War II. This extension has overhead doors at each end and was used to provide convenient space for simple standard maintenance such as oil changes and tune-ups.

HISTORY: Building 38, constructed in 1932, is one of the few structures at Wright Field which still retains its original function. When erected, it was designated Maintenance Building Number 3 and was used for automotive repair. Since World War II, Building 38 has undergone very little modification. While motor vehicles have changed immensely, the facilities of Building 38 are still used to repair and maintain them instead of being converted to office space as most of the old buildings have been. Today its official designation is the 645th Transportation Squadron Vehicle Maintenance and Repair Facility.

For sources, see Bibliography on page 215.

Figure 131: Building 38, looking northwest, 1991.

BUILDING 39: MAINTENANCE BUILDING NO. 1

HAER No. OH-79-AD

(Includes former Building 35)
Construction Date:(Building 35) 1929
(Building 39) 1941/1949

DESCRIPTION: Originally two separate buildings numbered 39 and 35, Maintenance Building No.1 is a one-story, six-course American bond brick structure. It has a low-pitched roof with three galvanized sheet metal gables, and rectangular columns with concrete coping at the corners. The space between the two original buildings was filled with a similar style brick structure in 1945. Many windows, particularly on the west building (original Building 39), have been bricked up.

HISTORY: Building 35, the original Wright Field Maintenance Shop, was erected in 1929, and Building 39, Maintenance Shop Number 4, was added on the west side in 1941. Both began as ordinary maintenance facilities but eventually became associated with some of the world's most advanced aeronautical technology. The 1940s was an eventful decade for the twin structures. Building 35 continued as a maintenance center, but some World War II era maps list Building 39 as "Station Hospital", which suggests that the structure was used as temporary space to accommodate the sick among the thousands of additional airmen stationed at Wright Field during the war. As a new structure with an open interior plan, a temporary (or even permanent) hospital could easily be set up.

By 1945 Building 39 was back to its original purpose, and a compatible gabled brick infill structure was erected to connect it with Building 35. The resulting building retained the number 39. On July 9, 1948, this building underwent a serious fire during which the west portion was destroyed and the east portion (formerly Building 35) experienced some damage. In 1951 a replacement west section was constructed, adhering closely to its former specifications.

Since then, the building has been used for offices and, while the interior has undergone various changes to accommodate different organizations, the exterior has remained largely unaltered. Occupants of the building have included the Air Installation Administrative Office for Area B (1949), the Comptroller (1962), the Aeronautical Systems Division (ASD) in 1963, and the Air Force Auditing Agency (1980s). In 1989 and 1990, two new offices occupied Building 39. The first was the Joint Program Office (JPO, not to be confused with the Joint Project Offices of the early 1950s) for the National Aerospace Plane (NASP). This organization is led by a director from the Air Force and is responsible for coordinating the development of the next generation of re-usable space vehicles with the Navy and NASA. Officially designated the X-30, the NASP is expected to eventually replace the space shuttle because of its ability to take off horizontally like an airplane, rather than blasting off like a traditional rocket. The one-stage NASP rocket engine will propel it from take-off to hypersonic speeds which will place it in low-earth orbit, allowing it to circle the earth many times before re-entering the atmosphere, decelerating, and landing like an aircraft. Plans for the NASP include both space research and rapid space travel to distant points on earth.

The other new tenant is the Video Teleconference Center (VTC). With this facility Air Force officials can interact with other Air Force, government, or contracting individuals via direct audio and video systems. This high-tech facility allows face-to-face discussions and negotiations to take place without the expense and time of travel. Utilizing secure communications lines, those using the VTC can discuss classified information without fear of interception.

For sources, see Bibliography on page 215.

Figure 132: Building 39, looking northeast, 1991.

BUILDING 51: FOUNDRY/GARAGE

HAER No. OH-79-W

(Includes former Building 46)
Construction Date: 1926-27

DESCRIPTION: The structure which is now Building 51 began as two separate, temporary buildings, numbered 46 and 51, which were later connected by a flat-roofed, brick structure. When first built the two had concrete floors and permanent steel frameworks but the roofs and walls had temporary coverings of corrugated sheet iron, which came from salvage operations at McCook Field. In 1929, the sheet metal was replaced with six-course American bond brick walls and metal windows. Shingle roofs were put on in the style of the surrounding Wright Field buildings with low-pitched concrete gables, copper entablatures, and rectangular, decorative corner columns. Building 46 was lengthened to the east in September of 1938, and in 1955 the two were connected and the whole structure designated Building 51. The south wall of the building still has two courses of corbeled brick at the top, underneath the gutter, and most of the original steel-sashed factory windows remain, except on the west side, where they have been bricked in and replaced with smaller aluminum-frame windows.

HISTORY: Building 46 was built as the foundry for the Materials Laboratory, while Building 51, to its north, was a garage and later housed other Materials Laboratory facilities. The foundry portion of the building has a remarkably steady history. Associated with the Materials Branch (later Laboratory) from the very beginning, it handled all of that organization's large heat-treating operations and performed foundry functions (pouring liquid metal in molds to form desired objects) for the laboratory and the remainder of the installation. These operations persisted until 1990.

Building 51 served as the station garage until the Materials Laboratory began to move in during World War II, and the garage function was handled effectively in the improved Building 38. In 1943 facilities for environmental materials testing were the first to move in. Using specialized chambers, researchers investigated the responses of materials to varying stresses of cold, heat, humidity, simulated sunlight (twin carbon-arc lamps), and ultraviolet light. In 1948 three fungi laboratories were installed by the Hughes-Simonson Engineering Company to investigate problems arising from fungal infestation of organic Air Force materials, including jet fuel which some microorganisms can convert into nutrients. This equipment served for over a decade but was surplused by 1960.

After World War II, Building 51 became known as the Package and Container Laboratory of the Materials Laboratory. This unit was transferred to the Materials Laboratory by Air Materiel Command shortly after the war in hopes of obtaining improvements in packaging materials and techniques. During the war all branches of the Armed Services had suffered tremendous losses of material due to breakage and deterioration while in transit or storage. This research facility had equipment such as vibration tables, tumbling drums, drop-test equipment, a water immersion pit, and a low temperature, low pressure chamber specifically designed to simulate conditions aboard cargo aircraft in flight. This facility remained until 1959.

In the early 1950s, the Materials Laboratory lobbied for a new, larger laboratory building or campus of buildings, but this effort failed. As a token, almost insignificant improvement, in 1955 Buildings 46 and 51 were connected to form the present Building 51. This lack of proper facilities hampered the Materials Laboratory's efforts to perform cutting-edge research, but it did not obstruct them entirely.

The Elastomer Compounding and Processing Facility developed improved elastomers, which are polymers (long chains of molecules linked in a simple, repetitive pattern) that have the elastic properties of natural rubber. The elastomers produced here exhibited increased resistance to extreme environments ranging from -80 to 600 degrees Fahrenheit, high concentrations of oxygen or ozone, and nuclear radiation. These elastomers proved useful for improved elastomeric seals, gaskets, and flexible connectors. One particularly important development involved the elastomer Viton A. Researchers in the Elastomer Branch discovered a method for room-temperature vulcanization of this plastic, opening up numerous new applications, including cabin and fuel tank sealing.

The metals processing facility in the foundry portion of Building 51 was involved in the drive during the 1950s to develop new aluminum and titanium alloys. To assist in this effort, they obtained a 700-ton extrusion press. This machine was capable of shaping metal at a rate of 900 inches per minute, making it the fastest extrusion press then in existence. The laboratory also obtained the world's largest fatigue machine, a 60-ton device captured from the German Messerschmidt Plant in Bavaria. After the repair of some minor bomb damage suffered in an Allied raid, it was used to test aircraft fasteners, such as full-size bolts. Conventional equipment was only strong enough to test smaller-scale copies of actual hardware. The fatigue machine was also used to spot-check the results from the conventional equipment to make sure that the small-specimen tests could be accurately correlated with the actual hardware.

Building 51 has also hosted elements of the Ceramics and Graphite, Polymer, Lubricants, Corrosion, and Chemistry Laboratories. As the new Materials Laboratory complex of Buildings 651 through 655 began to open in the 1970s and 1980s, most of Building 51's laboratories moved out, leaving only the foundry (Experimental and Raw Materials Processing Laboratory) and various offices still in residence. The Defense Contract Audit Agency was the last major office to vacate the building.

For sources, see Bibliography on page 215.

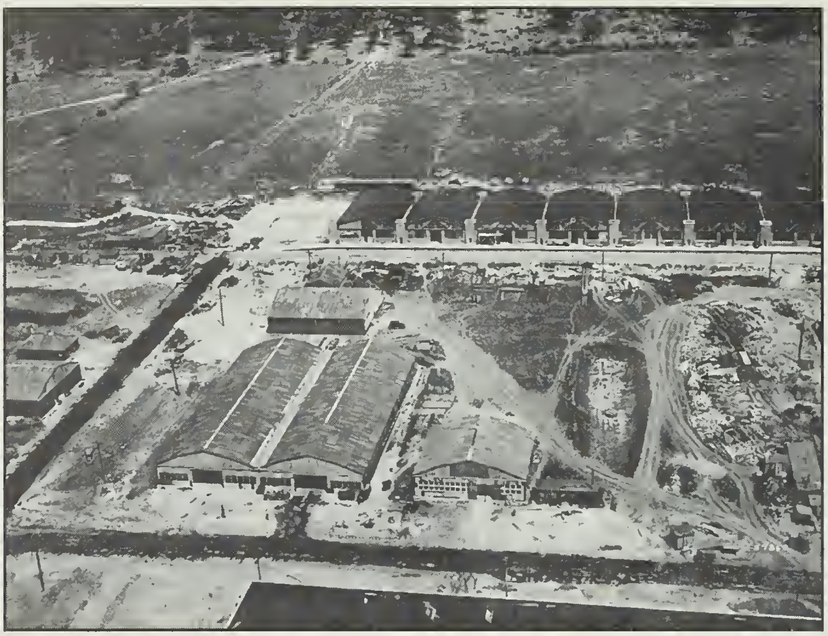


Figure 133: Building 51 and old Building 46 (on the right) with temporary corrugated iron covering, ca. 1926-28. (USAF)

Figure 134: Building 51, looking northeast (old Building 46 is in the foreground), 1991.

BUILDING 55: CENTRIFUGE BUILDING

HAER No. OH-79-X

Construction Date: 1942

DESCRIPTION: Originally a temporary World War II structure, this wood-framed building with bow string truss is now covered with metal siding. On the south end is a single door with canopy on the right, and six windows in two groups of three on the left. The west wall contains (from right to left) six windows, two single doors, three windows and a set of double doors. The north side has a single door flanked by two groups of three windows, and the rear of the building has a total of seventeen windows in five groups of three and a double window. All the windows are replacement in original casements, while all the doors are canopied. The main entrance is on the west side and appears to have been a double door at one time, as the frame extends to the right and is filled in with boards.

HISTORY: The Aero Medical Research Laboratory (later the Aero Medical Laboratory), established to research the effects of flight stress and to design equipment to better protect and assist pilots as aircraft technology advanced, built the Centrifuge Building in 1942 to test human endurance to the effects of acceleration. The second human centrifuge (the first was located in a building nicknamed the "Balloon Hangar"), operational from May 1943 until the summer of 1948, helped establish the unprotected and protected human tolerance to long term acceleration, and the human tolerance to acceleration onset rates. These experiments in the Second Human Centrifuge were essential for the development of the first G-suits, particularly the G-3, the Air Force's first standardized G-suit. The Centrifuge was also the site of the first studies of instrument-reading performance under acceleration.

The Aero Medical Laboratory dismantled the Centrifuge in 1948 and refurbished Building 55's interior to house its Clothing Branch. Since then, Building 55 has been the site for all new developments in Air Force uniform clothing, and personnel there also helped produce the early NASA space suits (including the monkey suits). Currently named the Aeronautical Systems Center Clothing Laboratory, the lab still assists in the development of flight suits and personal protective clothing.

For sources, see Bibliography on page 215.

Figure 135: Building 55, looking northeast, 1992.

BUILDING 56: WRIGHT FIELD WAREHOUSE

HAER No. OH-79-Y

Construction Date: 1926-27

DESCRIPTION: Building 56 is an eleven-bay structure, designed in typical Wright Field fashion of six-course, American bond, red brick with copper entablatures and towers at all corners and between the gabled bays. Each bay measures 68' x 104' and has a gable of steel-sashed factory style windows, and steel double doors flanked by large windows which match the gable. The towers have round cast-concrete bull's eye windows and most have a single door with concrete surround. On the west side there is still the original concrete loading dock and railroad track running along the length of the building.

HISTORY: When Wright Field opened in 1927, Building 56 served as its first receiving warehouse and supply facility. Built by M.E. White of Chicago and the H.R. Blagg Co. of Dayton, it began as an eight-bay structure, with an adjacent oil and fuel storage building to the south which was modified in 1929 to match the warehouse architecturally. In 1940 the Works Progress Administration constructed two additional bays which served to connect the main building with the outbuilding. Because the separate bay had not been constructed on an exact line parallel to the main structure, the south wall of the addition had to be adjusted accordingly, and the east tower connecting it to the old bay is almost 50 percent wider than the others to compensate. The building continued in the same function until the ending of World War II decreased the amount of supply traffic and the merger with Patterson Field in 1948 shifted the remainder of the supply function away from the railroad to the larger airfield on that side of the base. Since then Building 56 has housed both testing facilities and offices.

During the 1950s, after the warehouse functions had moved, several laboratories set up environmental test facilities in the various bays of Building 56. The Aerial Reconnaissance, Aeronautical Accessories, and Aircraft Laboratories all had chambers to investigate the response of photographic, electronic, structural, and miscellaneous equipment under various stressful conditions, such as high and low temperatures and relative humidities, high altitude, excessive sand and dust, and salt spray. The Aerial Reconnaissance Laboratory also had vibration tables to test equipment under mechanical and electromagnetic vibrations of up to 1000 cycles per second and thirty times the force of gravity (30G). This laboratory also investigated gasoline explosions at various temperatures and altitudes and tested its equipment under impact shocks of up to 77G. The Aircraft Laboratory and the Aeronautical Accessories Laboratory also tested hydraulic and pneumatic systems here.

During the 1960s, the Materials Laboratory also moved into Building 56. In fiscal year 1959, the laboratory finalized plans for a lubrication engineering test facility. The Lubrication Section transferred to the completed facility in Bay 11 in early 1961, and throughout the mid-1960s further units of the Materials Laboratory occupied bays in Building 56. In 1965 and 1966, basic physics and chemistry, as well as applied metallurgical and non-metallic materials research laboratories also located here, as did some Materials offices. The Materials Laboratory occupied Bays 7 through 11 until 1986. Through the 1980s, more office space was gradually created from former laboratory areas and the KC-10 (air-to-air refueling tanker) Directorate, offices of the Defense Nuclear Agency, and the T-46A (Next Generation Trainer) Directorate moved in. These programs have since been replaced by offices of Development Planning and Manufacturing Quality Assurance, the F-15 System Program Office (SPO), and the Directorates for Engineering, Allied Armaments Cooperation, and Mission Area Planning and Strategy.

For sources, see Bibliography on page 215.

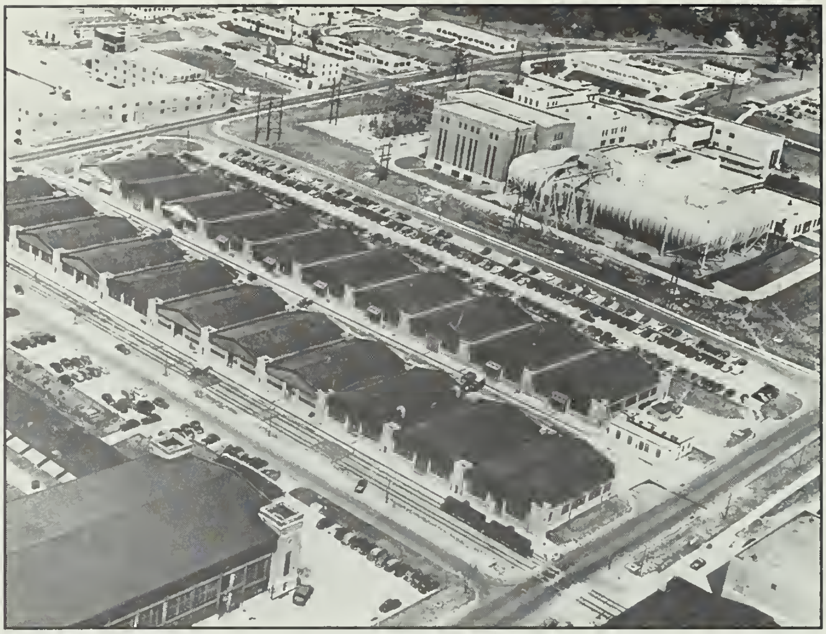


Figure 136: Buildings 56 and 57, in center, ca. 1940s. (USAF)

Figure 137: Detail of single bay, Building 56, 1991.

BUILDING 57: AIR FORCE SUPPLY WAREHOUSE

HAER No. OH-79-AF

Construction Date: 1942

DESCRIPTION: The Army Air Forces Supply Warehouse (Building 57) is a one-story ten-bay building of six-course, American bond brick with a low-pitched roof, wide copper entablature and gables of steel-sashed windows. Between the bays are rectangular brick towers with octagonal bull's eyes with concrete surround. Most of the bays have double steel doors flanked by large windows in the same style as the gable, although some have been bricked up. On the north side is a newer entrance with glass and aluminum doors and a glass transom. The building is very similar in appearance to Building 56 to the west, except that Building 56 has an additional bay, and a railroad siding that is still used on occasion.

HISTORY: The approach of war in the early 1940s prompted the Army Air Forces to greatly expand its facilities at Wright Field. One new structure was an additional supply warehouse built in 1942, just to the east of the original warehouse. While not directly on the existing railroad tracks, this was the largest space near them, and an extra spur was laid to reach Building 57's loading dock.

From the beginning, Building 57 was not used exclusively as a warehouse, and, like Building 56, its function quickly began shifting from storage and supply to laboratories and offices. The Engineering Analysis Division Directorate of Laboratories occupied 20,000 square feet, over one-quarter of the building, after its completion in 1942. This organization is significant because it possessed the first computing facilities at Wright-Patterson Air Force Base, using them to conduct research in computing techniques.

The Digital Computation Facility opened in 1950 with a Remington Rand Univac 1103 electronic computer. This machine was estimated to be 100,000 times faster than a mechanical calculator. Later, this facility obtained an IBM 7090 computer that utilized transistor technology. The 7090 was twenty-five times faster than the 1103. The facility solved system dynamics problems for the Systems Management Directorate and also accomplished research in numerical analysis and automatic programming techniques.

The Analogue Computation Facility opened in February of 1959 to conduct both basic and applied research. The Facility developed and operated special analogue-type equipment to simulate and solve weapon system problems. This was a typical general task for early computers, but Wright-Patterson possessed a $3.5 million Reeves System Dynamic Simulator, one of the largest and most advanced computers of the time. It consisted of four different computers, called stations, which operated individually or collectively with a total of 500 computing amplifiers. To insure the validity of both problems and solutions, it included automatic features not available on previous machines, including automatic programming, automatic voltage readouts, and automatic setting of functions, all of which increased efficiency by reducing the possibility of human error.

Inevitably these machines were superseded by newer, more advanced facilities in the 1960s. By that time, the remainder of the warehouse had also given way to offices and other laboratories, including the nuclear testing facility of the Materials Laboratory at the south end of the building. Since then the major occupants of Building 57 have been the Aeronautical Systems Division (ASD) System Program Offices (SPOs) for Life Support, Aeronautical Equipment, and the Mark XV Identification Friend or Foe (IFF).

For sources, see Bibliography on page 215.

Figure 138: Building 57, ca. 1940s. (USAF)

Figure 139: Building 57, looking southeast, 1991.

BUILDING 59: DYNAMOMETER STORAGE BUILDING

HAER No. OH-79-AG

Construction Date: 1932

DESCRIPTION: Building 59 is a two-story, common bond brick building with a low-pitched front, sheet-metal gabled roof, and rectangular towers on the corners. In 1942-43, the Works Progress Administration built two additions onto the original structure (resulting in Buildings 59A, 59B, and 59C). The one-story addition to the north has a flat roof, while the barn-shaped south addition rises three stories with a low-gabled roof.

HISTORY: The original section of the Dynamometer Storage Building (59B) was built in 1932 to store laboratory test equipment. There were two extensions during World War II, which became an Ignition Test Laboratory (59A) and an Accessories Laboratory (59C). These laboratories were designed to test fuel system components and accessories. Building 59C was used for testing hydraulic pumps, valves, actuators, fuel tanks, hose reels and other engine accessories.

In 1983, Building 59C became the Aero Propulsion and Power Directorate contractor maintenance office and shop. Since 1977, Buildings 59A and 59B have been used by a variety of organizations, primarily for storage.

For sources, see Bibliography on page 215.

Figure 140: Building 59, looking southeast, 1991.

BUILDING 61 AND 61A: OIL STORAGE FOR TORQUE STANDS

HAER No. OH-79-AR (Bldg. 61)
OH-79-AS (Bldg. 61A)

Construction Date: 1941

DESCRIPTION: Buildings 61 and 61A are very similar square, one-story, brick buildings with low-pitched, hipped, asphalt-shingled roofs with slight overhangs, wide entablatures and tin gutters. The fronts of both buildings have nine-pane steel-sashed windows and large double doors (steel on Building 61 and wood on Building 61A). Both have concrete foundations and surrounds. The back of Building 61A has a short, narrow ramp that leads down to the basement.

HISTORY: Buildings 61 and 61A were built in 1941, Building 61 as an oil storage building for the Torque Stands, and Building 61A as a fuel pumping facility for the Torque Stands. In 1963 they were both used as Reproduction Plant and Propulsion Research Test Buildings. In 1966 they were used for laboratory material testing. Neither building is currently in use.

For sources, see Bibliography on page 215.

Figure 141: Building 61, 1991.

BUILDING 62: ORDNANCE STORAGE NO. 1

HAER No. OH-79-AT

Construction Date: 1942

DESCRIPTION: Like other buildings in the area, Building 62 exhibits elements of the International architectural style with its flat parapeted roof with concrete coping, unadorned facade and ribbon windows. The rectangular, one-story building features six-course, American bond brick, bearing walls with structural steel beams, wood deck, and steel sashed windows with concrete sills. Building 62 also has a one-ton monorail crane inside.

HISTORY: Ordnance Storage No. 1 was built in 1942 during the Wright Field World War II construction boom as a storage facility. It became part of the Propulsion Research Laboratory in 1966, and later became the Air Breathing Laboratory. Today it is an Electrical Equipment Maintenance Facility, and has been occupied by electrical contractors (High Voltage Maintenance) since 1981.

For sources, see Bibliography on page 215.

Figure 142: Building 62, looking northeast, 1991.

BUILDING 63: ORDNANCE STORAGE NO. 2

HAER No. OH-79-AU

Construction Date: 1943

DESCRIPTION: Ordnance Storage Building No. 2 is a one-story, rectangular building with a flat, parapeted roof with concrete coping. The stretcher bond brick walls contain steel framing. The south entrance has concrete steps leading to double steel doors, and a stairway down to the basement that houses a gun range and the original ammunition storage bunkers.

HISTORY: Built in 1943 as the gun range and ordnance storage for the Armament Laboratory, Building 63 was converted to a bionics laboratory in the 1960s, and currently houses a portion of the Aircraft Survivability Research function. After a lengthy period of disuse, the range in the basement was recently reactivated with a newly installed electric rail gun for aircraft survivability testing.

For sources, see Bibliography on page 215.

Figure 143: Building 63, looking northeast, 1991.

BUILDING 64: AIRCRAFT PARTS WAREHOUSE

HAER No. OH-79-AV

Construction Date: 1942

DESCRIPTION: Building 64 is a triple-gabled building with a high concrete foundation and a seven-course, American bond brick facade. The raking cornice and eaves are wood fascia with hung gutters. The asphalt shingle roof retains its original roof vents, but the original skylights have been removed. In the west wall are two original wooden overhead doors with bell-shaped hanging lamps. Inside, some original wood beams remain in the roof structure. The south end has a three-brick rowlock arch over an original wooden overhead door. Recent additions include new office spaces, an access ramp, and the replacement of a garage door (bricked over) with a single door. A railroad siding on the west side services the building.

HISTORY: Built in 1942 as Lumber Storage Building No. 2, Building 64 (then identified as Building 69) became Base Supply and Equipment Warehouse in 1956, and Research Equipment Storage in 1987. From 1990 to the present, Building 64 has served as the Base Supply Service Store for Area B.

For sources, see Bibliography on page 215.

Figure 144: Building 64, looking northeast, 1991.

BUILDING 65: STATIC STRUCTURAL TEST LABORATORY HAER No. OH-79-F

Construction Date: 1944

DESCRIPTION: The Static Structural Test Laboratory is an imposing Art Deco building, consisting of an eight-story central block with six-story sections on the north and south ends, and five-story administrative blocks attached to the east and west sides. The sides of the central test building consist of variegated siding, some corrugated sheet steel and a poured concrete frame with brick infill. The floor of this section is 30"-thick concrete, based on solid rock, and covers 170' x 250' of open space. Steel anchor slots for securing planes and testing equipment are embedded in the floor every 5 feet and will support up to 10,000 pounds. A steel support jig sits on the east side of the test floor. Two 75-ton cranes and a 150-ton crane currently service the test area. Embedded in rock 37 feet below the surface and sealed with concrete, the 150-ton crane can support 10,500,000 foot pounds applied to a test structure in cantilever fashion. Behind this, in the east wing, is equipment to test structures at the elevated temperatures that can occur on high-speed aircraft.

The 69'-high administrative wings are cast-in-place concrete decorated by eight vertical serrations above the administrative doors on the west side with a 10' Art Deco-style Air Corps star in the center. Another 13' star is centered over the south bay doors. The industrial steel windows, fluted corner buttresses, and a concrete frieze with a series of 3' stars contribute to the Art Deco appearance.

HISTORY: Static testing at Wright Field was initially conducted in the Aircraft Assembly Hangar (Building 31), until the facility moved to Static Test Laboratory No. 1 (Building 23) in 1934. This building became inadequate due to increased activity prior to World War II, and was simply too small to house the unprecedentedly large aircraft being developed during the war; the Static Structural Test Laboratory (Building 65) was constructed in response to this problem. The architectural firm of Hazelet and Erdal of Chicago drew up the final design of the building, and the F.K. Vaughn Building Co. of Hamilton, Ohio, completed construction on November 8, 1944. The new building provided enough space for the planned tests on the enormous B-36 Peacemaker intercontinental bomber, which was larger than the modern B-52.

During World War II structures engineers began to devote more resources to fatigue testing, prompted by the huge increase in the number of flying hours that aircraft were subjected to each year. Fatigue failure was duplicated under laboratory conditions, some of the early tests being carried out on the B-24 nose gear, resulting in the development of a stronger gear. Additional data was accumulated from investigations of crashes.

In the 1950s the laboratory began testing components taken directly from the production line, and under the Aircraft Structural Integrity Program (ASIP) the testing of "virgin" structures became standard in military contracts. This decade also witnessed the introduction of bonded-rubber tension pads, which could be attached to any part of the aircraft for batter distribution.

In 1954, as part of a major effort to improve test facilities, the Elevated Temperature Test Facility was completed, originally as a 3-megawatt facility and now operating on 50 megawatts. The first structures tested were the Titan, Thor and Hawk missiles; two years later the F-106 was the subject of the first ever full-scale elevated temperature static test, soon followed by the B-58. In the 1960s, temperatures of 3200°F were achieved during testing. The 1970s witnessed a period when high temperature testing was eclipsed by other weapons systems testing, dictated by military requirements during the Vietnam conflict, but by the late 1980s the facility was operating at a greater capacity than ever before, and plans have been submitted to add additional modular graphite heating units which would produce temperatures in excess of 4000°F.

The most radical advancement in structures testing at Wright-Patterson, however, was the development of digital computers; in 1958 the Division adopted a computerized structural analysis program which drastically accelerated the analytical process and yielded far more detailed results. Research included the examination of mission profiles to determine critical loading conditions and materials behavior studies to improve advanced vehicle design. Since the early 1970s the Analysis and Optimization Branch has operated the Aerospace Structures Information and Analysis Center (ASIAC), an agency for the accumulation, integration and dissemination of theoretical and applied structures data. In 1978 a new computer-aided design program, STAGING (Structural Analysis through Generalized Interactive Graphics), enabled design engineers to graphically display mathematical models. The program was superseded by CADS (Computer Aided Design System) in the early 1980s. Other programs developed in the 1980s included FASTOP, which designed aircraft lifting surfaces; ASTROS (Automated Structural Optimization System) designed to integrate all the components involved in the early stages of aerospace structures design, including analyses for loads, strength, vibrations, aeroelasticity and design sensitivity; and SAMCJ (Strength Analysis of Multi-Fastener Composite Joints), which also provided support for the ICAM (Integrated Computer Aided Manufacturing) program at the Materials Directorate of Wright Laboratory.

For sources, see Bibliography on page 215.

Figure 145: Building 65, 1944. (USAF) [See also photograph on page 26.]

Figure 146: Interior of Building 65, 1944. (USAF)

Figure 147: Detail of star insignia over main entrance, Building 65, 1991.

Figure 148: Building 65, looking northeast, 1991.

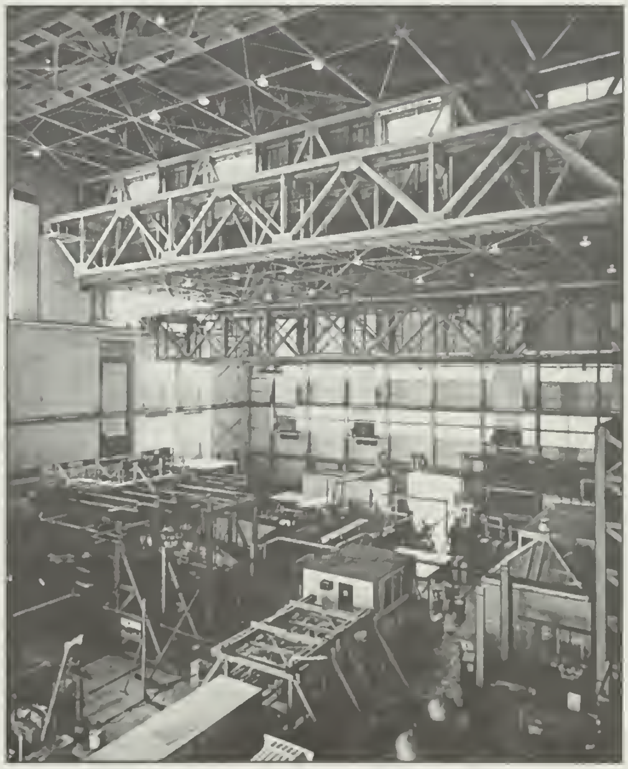


Figure 149: Interior of Building 65, 1991.

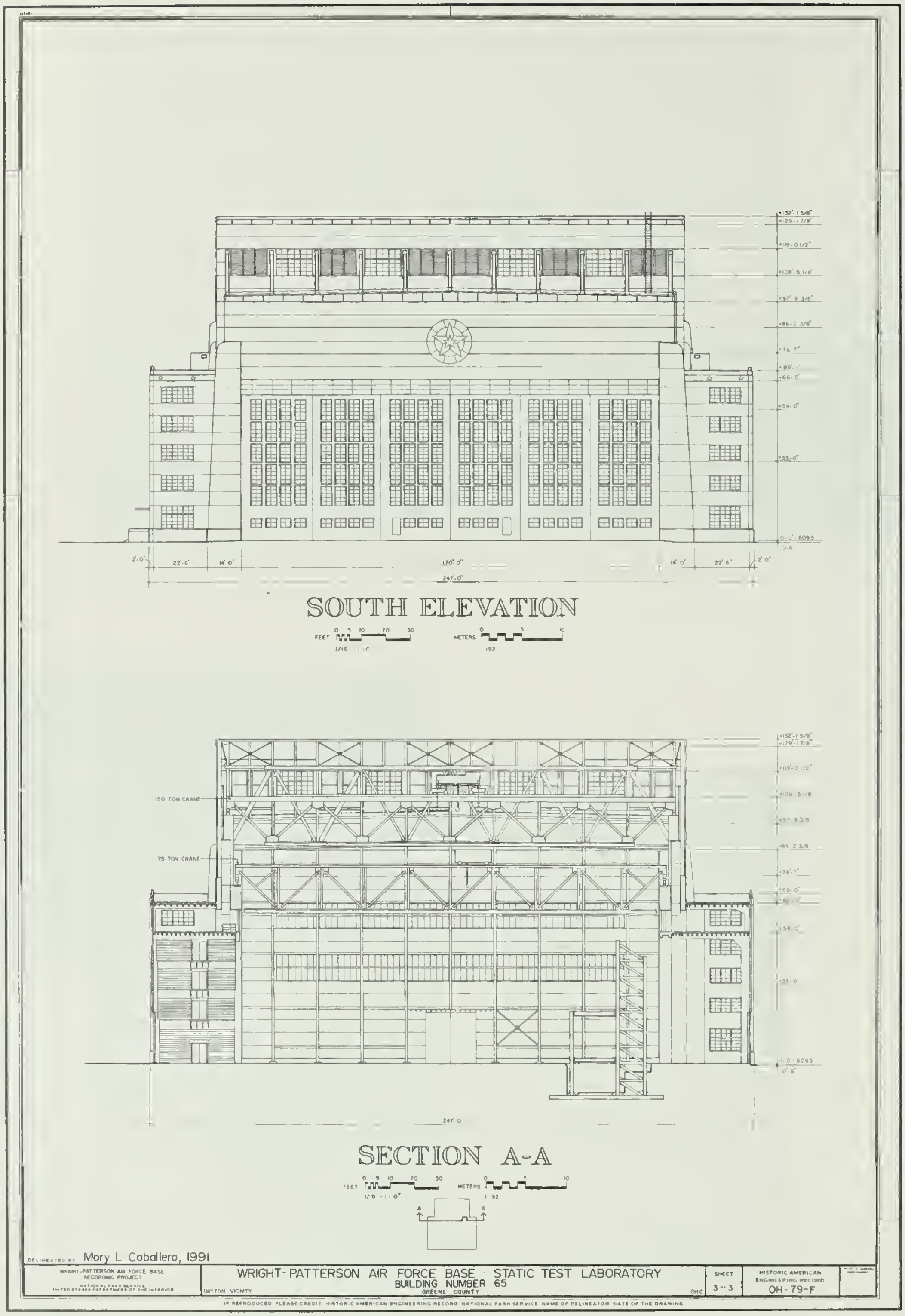
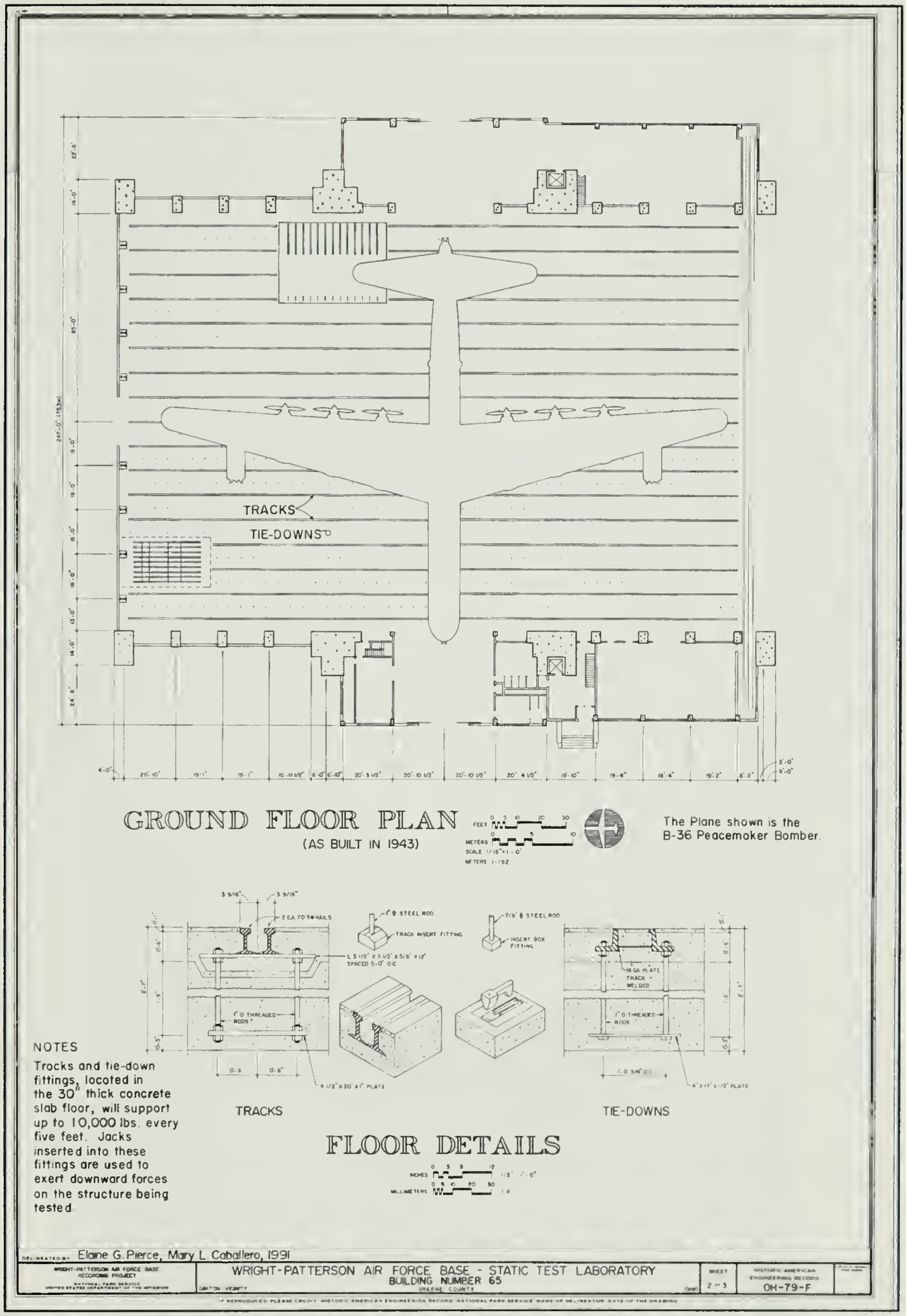


Figure 150: Static Test Laboratory, Building 65, 1944. (Delineated by Mary L. Caballero, HAER, 1991)



NOTES

Tracks and tie-down fittings, located in the 30" thick concrete slab floor, will support up to 10,000 lbs. every five feet. Jacks inserted into these fittings are used to exert downward forces on the structure being tested.

Figure 151: Static Test Laboratory, 1944. (Delineated by Elaine G. Pierce and Mary L. Caballero, HAER, 1991)

BUILDING 66: CENTRAL HEATING PLANT

HAER No. OH-79-AH

Construction Date: 1929

DESCRIPTION: Building 66 is a three-story, six-course American bond brick building with a high concrete foundation and a flat parapeted roof. Six two-story window panels with factory glass are below a concrete belt course. Three-part, punched-mullion windows are set in the foundation and in the top section above the belt course. A ramp leads down to the basement with double steel doors. The building had a coal yard behind it and is serviced by railroad sidings on the north side.

Major additions to the building were completed in 1935, 1944 and 1958. Many other additions and extensive modifications have taken place through the years. Its distinctive smokestack was removed in 1983.

HISTORY: Building 66 was built in 1929 at a cost of just over $250,000 to replace the original 1927 heating plant which burned down, and at the time was the largest pulverized coal plant in the Air Corps. The plant operated by grinding raw coal (of the nut and slack type, up to 1½" in diameter) down to the consistency of flour and blowing the coal powder, via induced draft fans, into one of seven boilers where it was burnt in suspension. The resulting heat provided steam for all of Area B via underground tunnels. One interesting feature of the plant was the inclusion of explosion doors on top of the boilers to relieve the pressure in the case of inadvertent ignition. The building was served by a railroad siding, thereby correcting one of the costlier defects of McCook Field by allowing coal to be brought directly to the heating plant. A coal pile was located directly behind the building.

The plant was in continuous use until 1983, when 75 percent of its operations were shut down and some of the larger equipment sold; one of the boilers ended up in Germany and another one went to a sawmill in North Carolina. By 1991 the building had been phased out of service completely and, along with most of its remaining equipment, currently sits in a state of extreme disrepair, awaiting demolition.

For sources, see Bibliography on page 215.

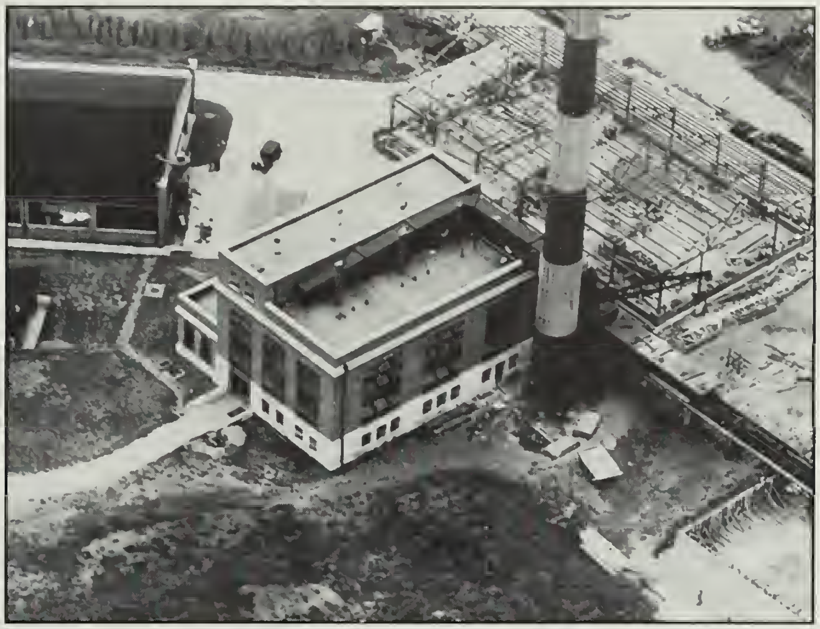


Figure 152: Building 66, 1929, next to the construction of Building 36. (USAF)

Figure 153: Building 66, looking west, 1991.

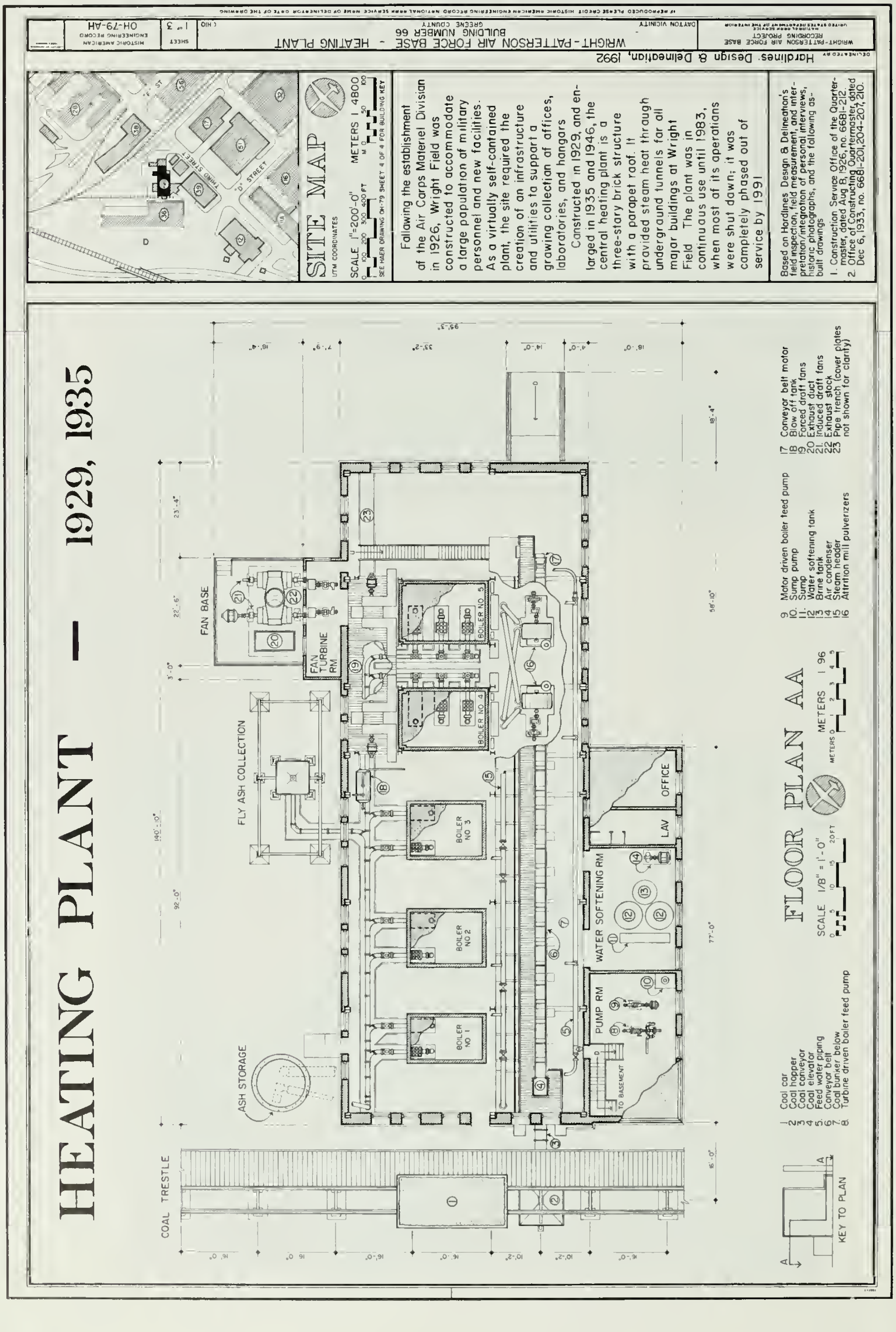


Figure 154: Heating Plant, Building 66, 1935. (Delineated by Hardlines: Design & Delineation, HAER, 1992)

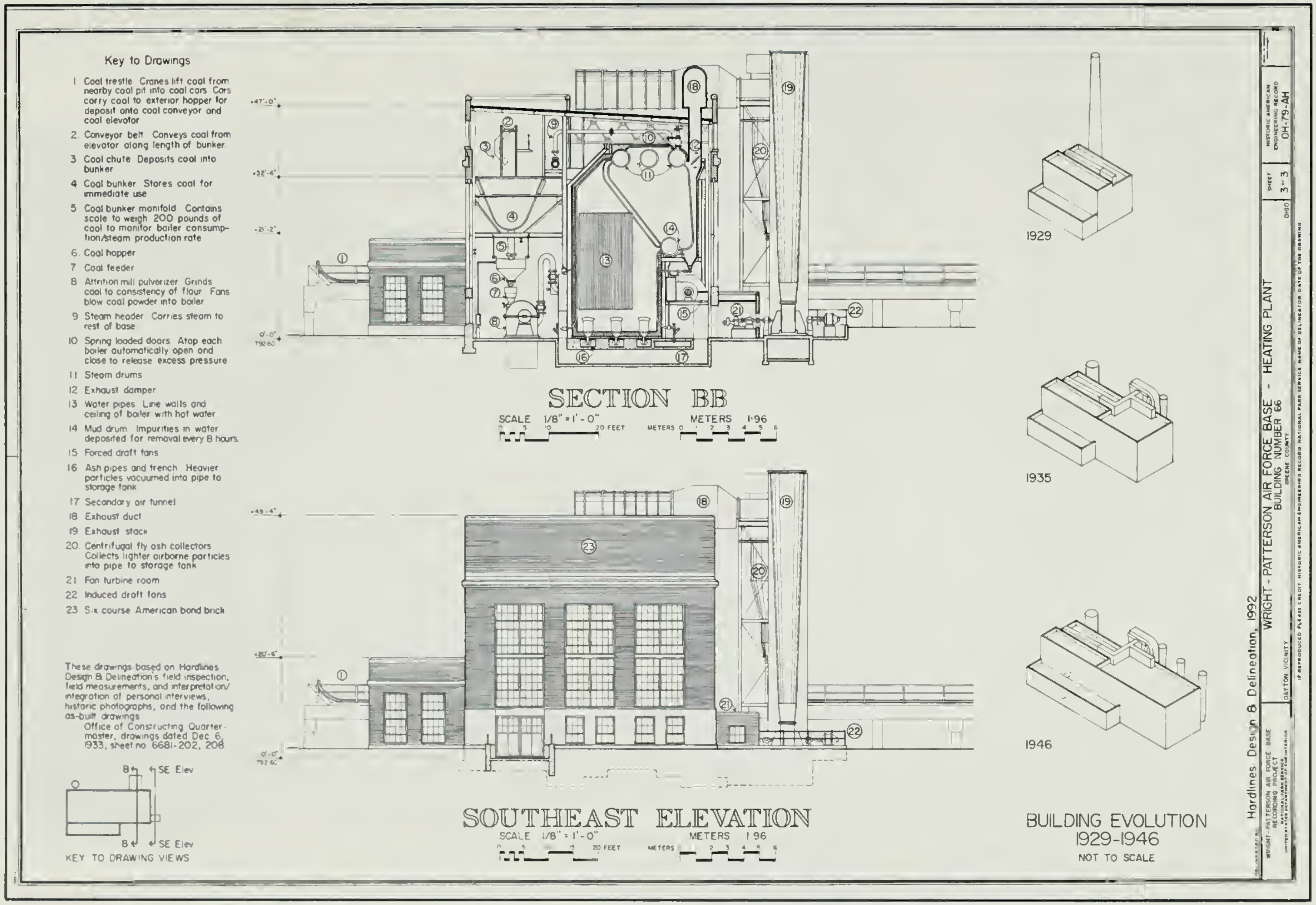


Figure 155: Heating Plant, Building 66, 1935. (Delineated by Hardlines: Design & Delineation, HAER, 1992)

BUILDING 67: EMERGENCY POWER PLANT

HAER No. OH-79-AI

Construction Date: 1942

DESCRIPTION: The Emergency Power Plant is a high-bay, rectangular, six-course American bond brick building with a high concrete foundation and a low-parapeted flat roof with concrete coping. The two square-corner, front-facing, three-quarter towers also have concrete coping. The entrance features tall wooden double doors with nine-pane windows and a metal canopy. Replacement windows and a concrete lintel extend across the east side.

Mounted partially below the concrete floor, a large Worthington motor-generator dominates the interior. Other equipment in the building includes a Worthington Carbondale evaporative cooler and two air compressors.

Although virtually abandoned and its equipment in disrepair, the building itself remains in relatively good condition.

HISTORY: Built in 1942 to support the increasing power needs of the war effort, Building 67 no longer functions as an emergency power plant, although it maintains some limited switching capabilities, supporting Building 66.

For sources, see Bibliography on page 215.

Figure 156: Building 67, looking northwest, 1991.

BUILDING 70: FUEL AND OIL TEST LABORATORY

HAER No. OH-79-AW

Construction Date: 1943

DESCRIPTION: The Fuel and Oil Test Laboratory is a rectangular, two-story, brick building with a low parapeted flat roof with concrete coping. Ribbon style replacement windows with concrete lintels and sills extend the length of the building. A ramp with posts and rails lead to an arched tunnel entrance to the basement. Steps on either side of the tunnel meet at the top and lead to the wide, stone entrance with reeded articulations flanking the original glass-paneled doors and transom. In contrast with this Art Deco entrance, the rest of the building exhibits elements of the International style with its simple, clean lines. Moreover, the building features numerous exposed pipes, vents, and electrical wiring in metal casings that emphasize the functional nature of its design.

HISTORY: Built in 1943 to accommodate the Fuel and Oil Branch of the Power Plant Laboratory (now the Aero Propulsion and Power Directorate), Building 70 has been in continuous use as a fuels analysis facility since World War II. The Laboratory had the capabilities to investigate fuel storage characteristics at different temperatures, fuel heat transfer and heat sink characteristics, and fuel lubricity and rheology. Specialized equipment there included a climatic test room (capable of temperatures to 130°F and 100% humidity), chemistry laboratories, engine test stands, six single-cylinder engines (specially designed for fuels and lubricants testing), burner test rigs, and gear testing devices. Among the many advances developed in Building 70's facilities was an oil dilution system for cold weather starting, standardized for all types of aircraft.

Building 70 currently houses the San Antonio ALC Energy Management Laboratory. The first floor consists primarily of laboratory space, while the second floor contains mostly office space. The basement accommodates storage vaults and utilities.

For sources, see Bibliography on page 215.

Figure 157: Building 70, looking northeast, 1991.

BUILDING 71 COMPLEX: POWER PLANT LABORATORY HAER No. OH-79-AX (Bldg. 71)
Construction Dates: OH-79-AY (Bldg. 71A)
71 (Power Plant Engine Test Torque Stands): 1932 OH-79-AZ (Bldg. 71B)
71A (Propulsion Research Laboratory, Air Breathing): 1941 OH-79-BA (Bldg. 71D)
71B (Power Plant Laboratory): 1943
71D (Propulsion Research Laboratory, Fuel and Lubricants): 1944

DESCRIPTION: Building 71 is a monumental concrete structure consisting of ten 40' stacks designed to accommodate seven torque stands--six for engine endurance tests and one for propeller tests. The concrete stacks are connected to each other by enclosed passages. The building is of symmetrical design with repetitive tubular steel sound baffles emerging from the top above each torque stand. Originally open to the sky, the baffles are now enclosed. Each engine support pier consists of a block of concrete sunk 20' into the ground and encased completely in cork to absorb the intense vibration generated during engine and propeller endurance testing.

Building 71A is a large cast-in-place concrete building with twin square towers and a connecting building that has horizontal grooves incised across the facade and flat roofline. The structure comprises four test cells with control rooms. Each two-cell unit measures 95' x 169' x 60' with 20-22" thick walls and a roof of inverted beam and slab construction to give a smooth ceiling. Multi-paned, steel-sashed awning windows are on the first floor only. The second story (a later addition) is made of smooth concrete. Large hangar doors open vertically.

Building 71B is a four-story, cast-in-place concrete building with steel-sashed windows and vertically opening hangar doors.

Building 71D is a small rectangular two-story structure, built of cement block with a flat roof and multi-pane factory-style glass windows.

HISTORY:

Building 71

The Power Plant Engine Test Torque Stands (Building 71) were completed in 1932, replacing two temporary engine test cells constructed in 1927. In attempting to increase the power output and durability of engines, the seven torque stands performed crucial performance and endurance tests lasting up to 150 hours at a time. The tests also helped develop new types of engines, improve fuels, and extend supercharging to higher powers and altitudes. In the late 1940s Test Cells 1 and 2 were modified to Turbo-Prop engines and Test Cells 3, 4, 5 and 6 were converted to Turbo-Jet Engine Cells, and later had exhaust mufflers installed to reduce engine noise. During the 1960s 3, 4 and 5 stands were primarily used to conduct engine oil qualification tests using J-56 and J79 engines. In 1963 the Inertial Starter Test Rig was installed in Test Cell 7. This Test Rig had a variable inertial load capability for performance testing of various jet engine starters (electric, air, combustion and cartridge). In 1967 No. 1 Stand was modified to become the Magneto Hydrodynamics Research Facility. In the 1990s Building 71 no longer houses engine testing, and is now used by the Materials Directorate in a support capacity for its Laser Hardened Materials Test Facility.

Building 71A

Four additional engine torque stands (A to D) were built between 1939 and 1942 for testing more powerful engines producing more propeller thrust than could be accommodated in the seven test cells already in Building 71. The whole structure was designated Building 71A. The stands were designed by the office of the U.S. Army Quartermaster; Ferro Concrete Construction Co., of Cincinnati, Ohio, was the contractor. In 1945 the stands were modified for gas turbine engine testing, with A and B configured for turbo-prop engines and C and D for turbo-jet engines. Bay B was modified further, first in 1960-61 when it was converted to an arc jet test facility for testing electro thermal propulsion devices with up to 10 lbs. thrust in near space environments; ten years later the facility became part of a laser systems laboratory, and was rebuilt in 1976-77 for testing turbo-fan engines. In 1963-65 Bay A was stripped and a space power environment chamber installed, designed to test liquid metal thermionic and thermoelectric generator modules and evaluate high temperature system components in space environments. Since 1985 Bays B and C have been on loan to the Wright Lab Materials Directorate's Laser Hardened Materials Evaluation Laboratory, in conjunction with Acurex Corporation and Universal Energy Systems. Bay D retains its use as a Sea Level Engine Test Cell.

Buildings 71B-71D

Building 71B was built in 1943 to accommodate the expanded wartime testing missions of the Power Plant Laboratory, with four test stands labelled G, H, I and J. G stand was the last operable reciprocating engine stand; between 1961 and 1963 its north end was used by the Aero Medical Research Laboratory to conduct human drop test experiments. In the 1970s it was modified to house the Compressor Research Facilities Control and Computer Facility. In 1964 I stand was gutted and a 120", 30,000 psi hypersonic shock tunnel was installed as a part of RAMJET research. Today Building 71B is occupied by the Aero Propulsion and Power Directorate, Aircraft Fire Protection.

Building 71C, the Outdoor Engine Test Stands, was built in 1952 and situated in a wooded area about ¼ mile south of Building 71. Known as "the rabbit patch" due to its location, the structure was torn down in the 1950s.

Building 71D was built by the Power Plant Laboratory in 1944 and houses the water cooling tower.

For sources, see Bibliography on page 215.

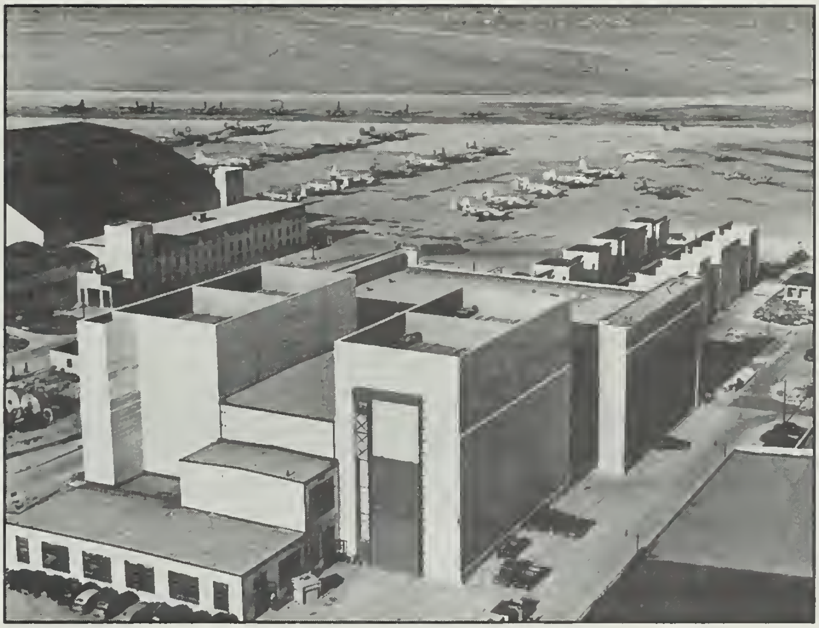


Figure 158: Building 71 complex, 1944. (USAF)

Figure 159: Building 71 complex, looking northeast, 1991.

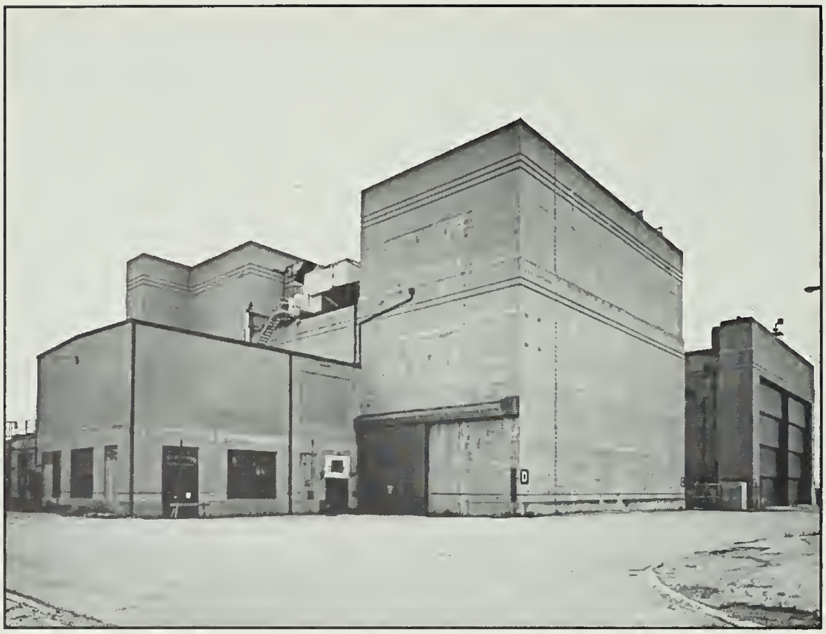


Figure 160: Building 71A (Propulsion Research Laboratory, Air Breathing), looking southwest, 1991.

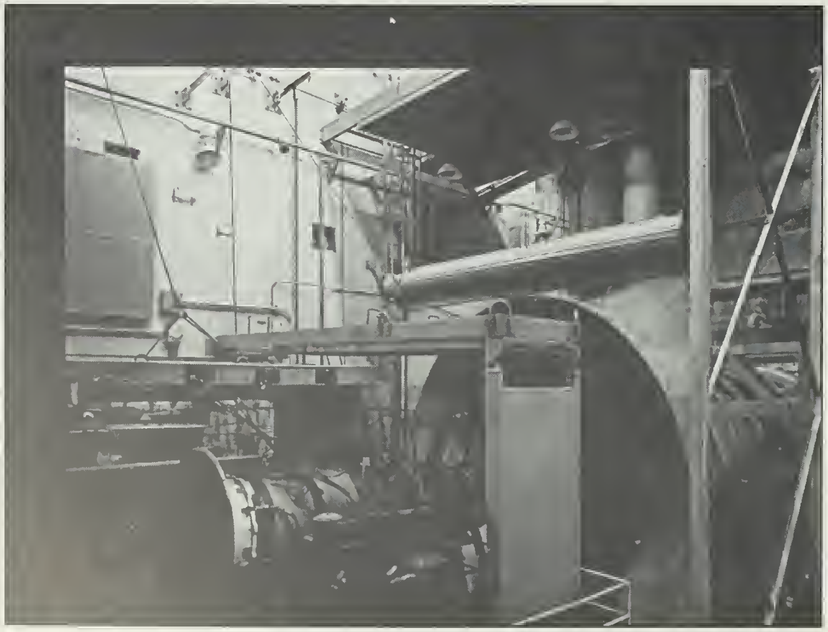


Figure 161: Jet engine test stand, Building 71A, 1991.

BUILDING 76: WRIGHT FIELD FIREHOUSE

HAER No. OH-79-AJ

Construction Date: 1929

DESCRIPTION: The Firehouse is a two-story, six-course American bond brick structure with a flat parapeted roof. The garage bays have overhead doors and are capped with soldier course lintels. Two rectangular brick pilasters span the height of the facade, while one pilaster is centered on each side of the building, marking the boundary between the original building and the 1943 addition. Corner pilasters adorn all four corners of the building. At the rear, extending above the building, is a small, one room tower-like structure with a pyramid roof and single window, which is used for hose drying. A plaque mounted on the pilaster between the two garage bays dedicates the building to Frank A. Smith, who lost his life during construction of the station.

HISTORY: Built in 1929 as the original Wright Field firehouse, Building 76 has undergone considerable alterations, but continues to serve as the fire station for Area B. Originally, the building consisted of a one-story section for office space, and a two-story section which included 4 garage bays with living space above. During World War II the fire station's space was more than doubled by extending the building back and adding a second story above the office space. After 1943, two of the garage bay pillars were removed to accommodate the larger vehicles being used for firefighting. The windows and exterior lights have since been modernized.

For sources, see Bibliography on page 215.

Figure 162: Building 76, looking northeast, 1991.

BUILDINGS 81 AND 82: MAIN GATE GUARD HOUSE AND PASSENGER STATION

HAER No. OH-79-Z

Construction Date: 1931

DESCRIPTION: Measuring 22' x 17', the Guard House (Building 81) is a simple stone building with a Mission-style, clay tile, hipped roof. It has a concrete foundation, compass steel-sashed, arched windows with rustic voussoirs and concrete sills, and round-headed wood doors, also with rustic voussoirs. The entrance wing wall, with attached lantern lights, curves from the northeast wall of the Guard House. Between Building 81 and Building 82 are the original wrought-iron vehicular and pedestrian gates.

The Main Gate Passenger Station (Building 82) is very similar in style to the Guard House. It is slightly smaller, measuring 22' x 14'. The west face was formerly open, but the two small and one large openings have since been closed to form two windows and a door that match those of the Guard House. Like Building 81 it has a Mission-style, clay tile, hipped roof, a concrete foundation, compass steel-sashed arched windows with rustic voussoirs and concrete sills, and round-headed wood doors, also with rustic voussoirs. The entrance wing wall, with attached lantern lights, curves from the southwest wall of the Passenger Station.

HISTORY: Building 81, the original Guard House, and Building 82, the Passenger Station for the Cincinnati-Lake Erie interurban electric trolley, anchored the main entrance of the Wright Field complex from the time of their completion in 1931 until 1943 when the main gate was moved to a new site and a new checkpoint built. The two buildings have been unused since then, but they still stand alongside the original wrought-iron gates and stone wing walls with piers and towers on either side.

For sources, see Bibliography on page 215.

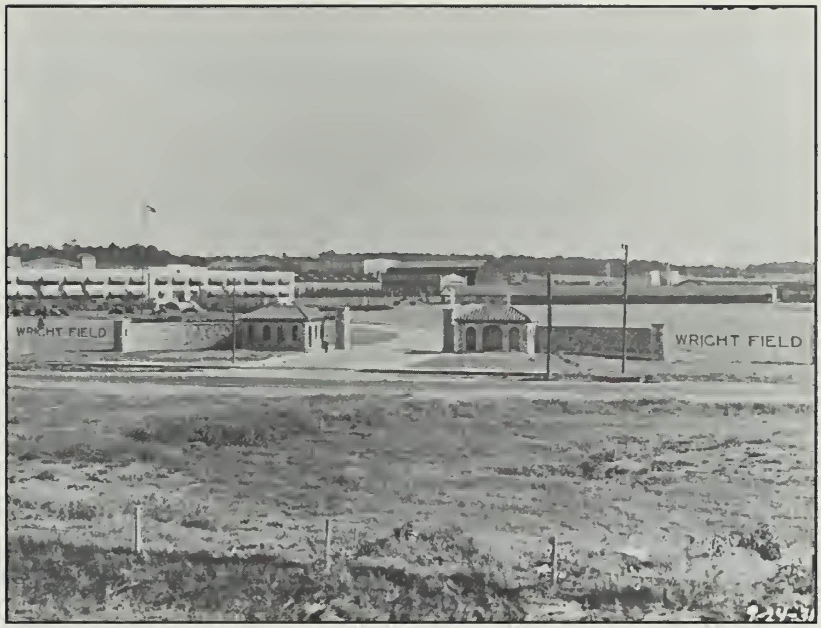


Figure 163: Main gates, Wright Field, 1931. (USAF)

Figure 164: Main gates, looking south, 1991.

Figure 165: Detail of gate post and Building 81, 1992.

Figure 166: Building 82, 1992.

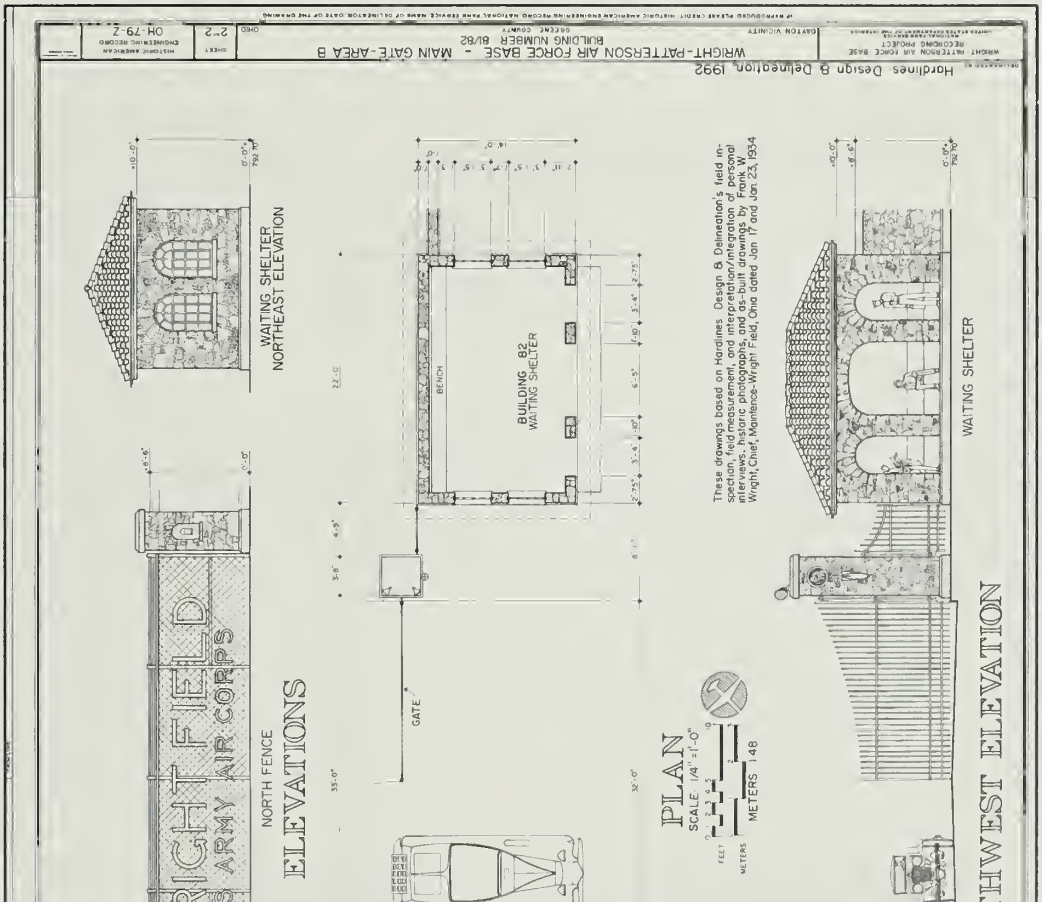


Figure 167: Main Gate, Area B, Buildings 81 and 82. 1931. (Delineated by Hardlines: Design & Delineation, HAER, 1992)

BUILDING 86: MAIN PUMP HOUSE

HAER No. OH-79-AK

Construction Date: 1927

DESCRIPTION: The Main Pump House is a typical Wright Field-style, one-story, six-course American bond brick building with a concrete foundation and a hipped slate roof. All the windows are steel sashed with concrete sills. A concrete frieze band surrounds the original section and the flat-roofed addition on the east side. The east wall contains full-story, double steel doors with eight-pane windows. An I-beam for a traveling hoist extends through the top of the doors. On the west side, a double steel door with pivoting three-over-three window panes features a double rowlock arch, flanked by two six-over-six tall window bays. A brick chimney with a painted smoke stack is centered on the roof.

HISTORY: Built in 1927 as part of the original Wright Field construction, Building 86 was the Main Water Pump House for Well No. 3, and was in continuous use until 1987. It currently functions only as an electric switch house, although the pumps are still intact.

For sources, see Bibliography on page 215.

Figure 168: Building 86, looking west, 1991.

BUILDING 250: ROTOR TEST TOWER

HAER No. OH-79-BD

Construction Date: 1950

DESCRIPTION: At the center of the rotor test site is a 50'-tall structural steel tower, covered with sheet steel. The tower has a 30-foot-square base and measures 6' across at the top. The concrete control room is located directly under the tower structure, and from here a large variable speed drive connects with a direct-driven vertical output shaft which turns the rotor blades. An elevator carries personnel to a removable work platform at the top of the tower.

A safety enclosure with a diameter of 100' surrounds the tower and extends 25' above and below the plane of rotation. It consists of heavy wire mesh which hangs between eight structural steel vertical trusses. The removable work platform and a one-ton monorail crane extend across the top of the tower from the enclosure.

HISTORY: The Rotor Test Tower was built in 1950 to test helicopter blades of up to 100' in diameter. It has a ground clearance of 50' to eliminate the ground-turbulence which arises when the blades are too low. The equipment has a maximum power of 4,000 horsepower and can operate at speeds ranging from 150 to 600 revolutions per minute. The shaft is strong enough to resist thrusts of 50,000 pounds and side loads of 10,000 pounds, while the tower itself can sustain side loads of up to 100,000 pounds. Instruments in the control room measure speed, power, thrust, and the side load imposed on the output shaft, and also track the rotor blades individually.

To the east of the present rotor tower is a concrete pad which once supported an older rotor tower. This tower was originally installed inside Building 20A, the propeller test acoustical enclosure, near the end of World War II, but was moved outside around 1950 to make room for propeller test rig Number 4. The test equipment consisted of two 500-horsepower, variable-speed, electric motors driving through a gear box into one common vertical shaft. Test articles of up to 100' in diameter were attached to the shaft about 10' above the ground and rotated between 185 and 790 revolutions per minute. Instruments could measure the speed, power, and thrust imposed on the output shaft. The shaft could sustain thrusts up to 10,000 pounds, and the tower could support instantaneous side loads up to 25,000 pounds. A 40'-high safety enclosure of structural steel and heavy wire mesh surrounded this tower at a diameter of 100'. Staff at the Propeller Lab relate that the mesh is hand-woven using elevator cables from the Empire State Building in New York. Unlike the larger tower, the drive equipment could be removed so that tie-down tests could be conducted on complete helicopters. However, in all tests at this facility, the proximity of the rotor to the ground created turbulence patterns that hampered attempts to effectively duplicate in-flight situations.

Farther to the east is a gyroscopic propeller test stand (Building 438), which was constructed in 1956 and used for approximately fifteen years. This was designed to test propellers under a variety of vibratory stress conditions. Test propellers were mounted inside a steel drum 19½' in diameter by 3½' thick, which is evacuated to a simulated altitude of over 100,000 feet. The propeller horsepower required is reduced by this vacuum so that propellers up to 20' in diameter, capable of absorbing up to 20,000 horsepower, can be spun with a 60-horsepower electric motor. Superimposed on the normal rotation of the propeller is the rotation of the entire steel drum containing the test unit at speeds of up to 25 revolutions per minute. The gyroscopic action set up by this dual rotation produces vibratory stresses similar to those caused in flight by air flowing through the propeller at abnormal angles. Propeller stresses induced by this rig simulate even the most severe flight conditions. Despite the capabilities of this unique device, it has not been used in nearly twenty years.

For sources, see Bibliography on page 215.

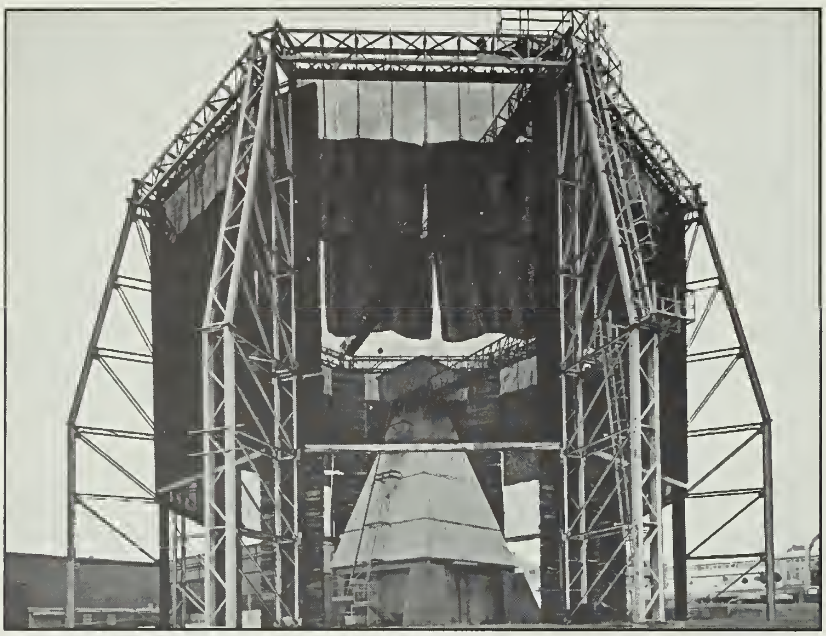


Figure 169: Rotor test stand, 1991.

Figure 170: Gyroscopic rotor test stand, 1991.

BUILDING 821: RADAR TEST BUILDING

HAER No. OH-79-AA

Construction Date: 1947-48

DESCRIPTION: The Radar Test Building (Building 821) is one of the most notable structures on the base, boasting a distinctive design and history. While under construction, its unique appearance brought it the nickname "the Cathedral," although most of its occupants simply refer to it as "the Barn." The building consists of thirteen parabolic arches, reaching 78' high, 200' long and with a span of 80'. Each arch weighs approximately 3¾ tons, and consists of two segments joined at the apex. Each segment is comprised of nineteen laminations, making them 9¼" thick. To minimize radar reflections, the building was originally constructed without metal, even using wooden pegs in place of nails. A one-story, brick office structure is attached to the west side of the building and antenna towers were added later for use by the Antenna Division. The interior of Building 821 is mostly a large open area with office spaces at ground level along the west side.

HISTORY: Built in 1947-1948 as the first radar test facility at Wright-Patterson Air Force Base, Building 821 has been used predominantly for antenna and radar cross section studies throughout its existence.

In the early 1950s, Bill Bahret, regarded by some as the "father of radar camouflage," designed and built the Air Force's first anechoic chamber for analyzing radar echo. The chamber stood in the middle of the floor, and radar absorption cones covered most of the interior walls. Although Bahret and his engineers knew that an object's shape and material had something to do with what showed up on radar, they did not set out to do "stealth" research. In fact, in those early days of radar cross section experimentation, the goal was simply to learn how radar interacted with bodies.

By the mid-1950s, the team in Building 821 was beginning to understand the relationship between radar and objects, and the different variables involved; only then did they start to wonder if they could actively reduce a model's radar "signature." Beginning in the late 1950s, a great deal of the early signature control technology was developed by the Propagation Group (precursor to the Radar Test Laboratory). This also included signature enhancement technology for such applications as decoys. Moreover, the Laboratory did not work on aircraft exclusively, but experimented on everything from missiles to satellites, and assisted the Army and Navy in designing their vehicles. As a corollary to their work, the Laboratory also developed innovative electronic equipment and instruments, despite the restrictions of working with crude technology. By the 1960s, Building 821 had become a mecca for "low observables" technology, attracting many scientists involved in stealth technology.

Building 821 continued to function as the Radar Test Building until 1990. However, for several years before, concerns had been growing which led to the eventual demise of Building 821's role as a radar facility: first, the Wright Aeronautical Laboratories wished to consolidate their operations (Avionics now resides in Buildings 620 and 22, and Signature Technology in Building 254); second, the amount of maintenance needed to sustain the aging building for radar testing was escalating (Building 821 has a history of maintenance problems, including a perpetually leaky roof, poor heating, and faulty alarm systems); moreover, Building 821's location just outside the main confines of the base poses security problems, especially for a facility doing highly classified research. In 1991, Logistics Supply took over Building 821 to use for shipping, receiving, and storage.

For sources, see Bibliography on page 215.

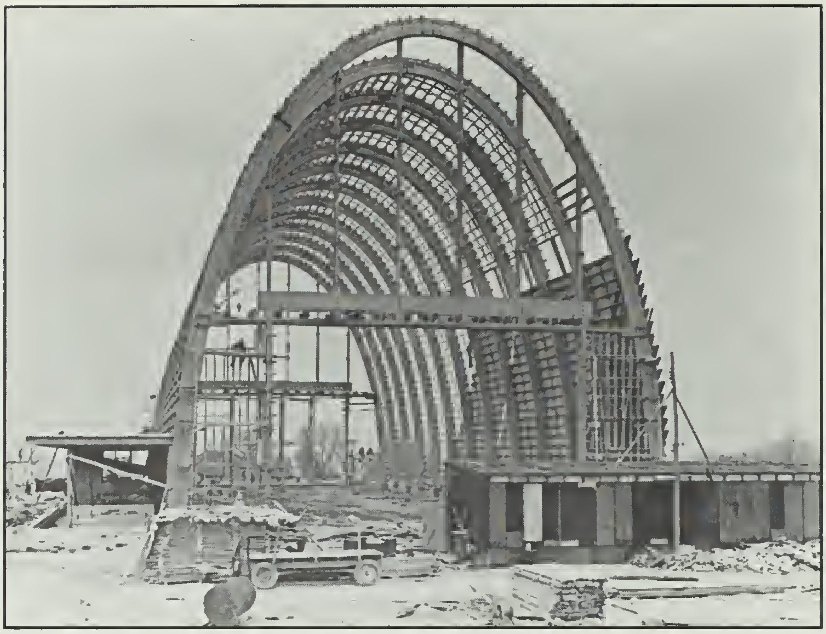


Figure 171: Wooden frame of Building 821, ca. 1947-48. (USAF)

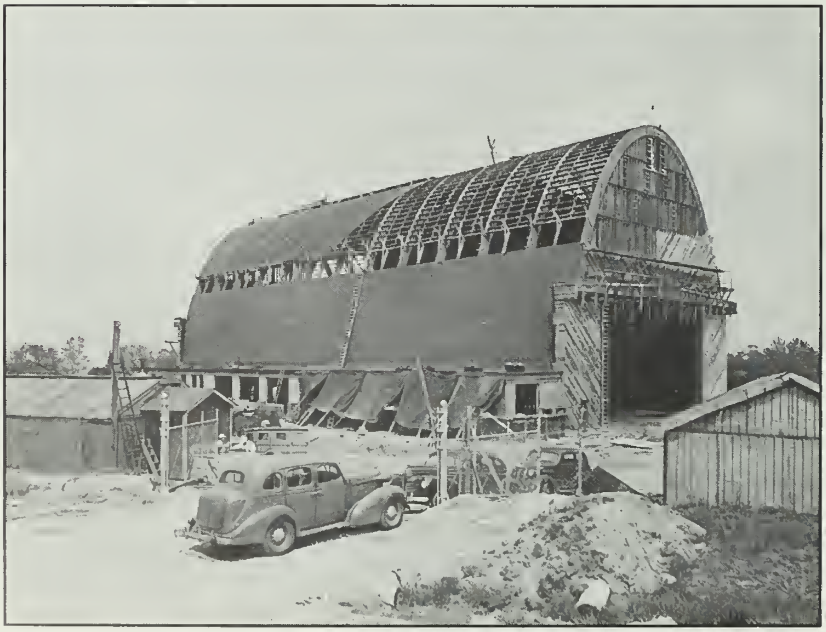


Figure 172: Applying wooden sheathing to Building 821, ca. 1947-48. (USAF)

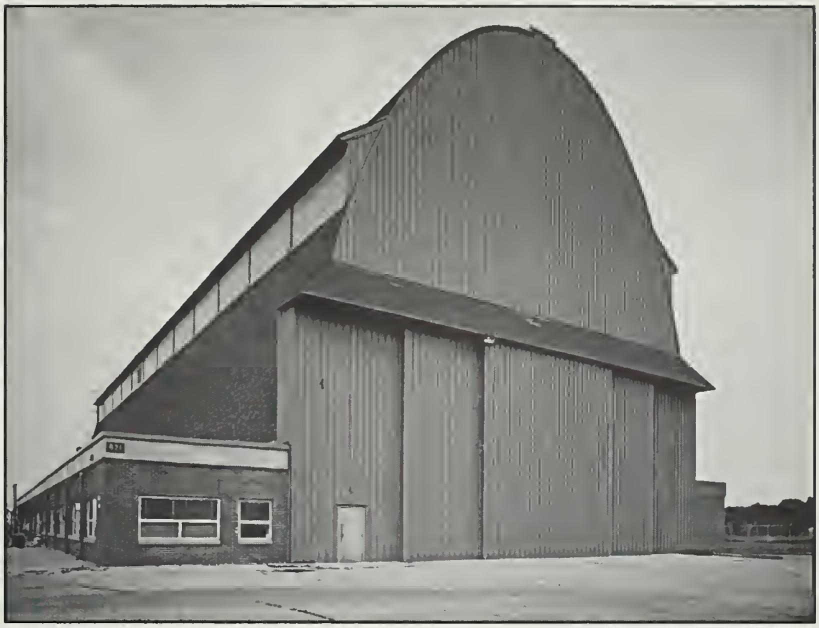


Figure 173: Building 821, looking east, 1991.

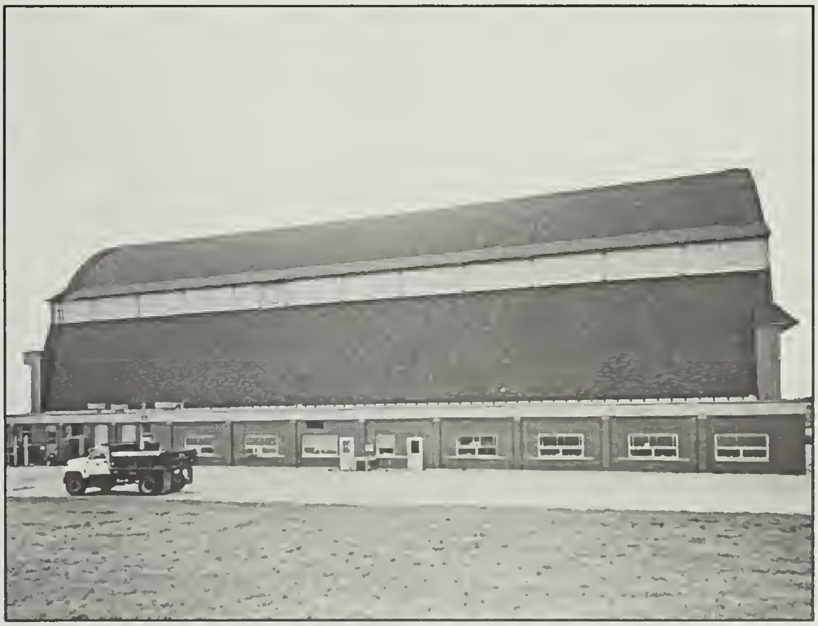


Figure 174: Building 821, looking southeast, 1992.

Figure 175: Interior view of ceiling, Building 821, 1991.

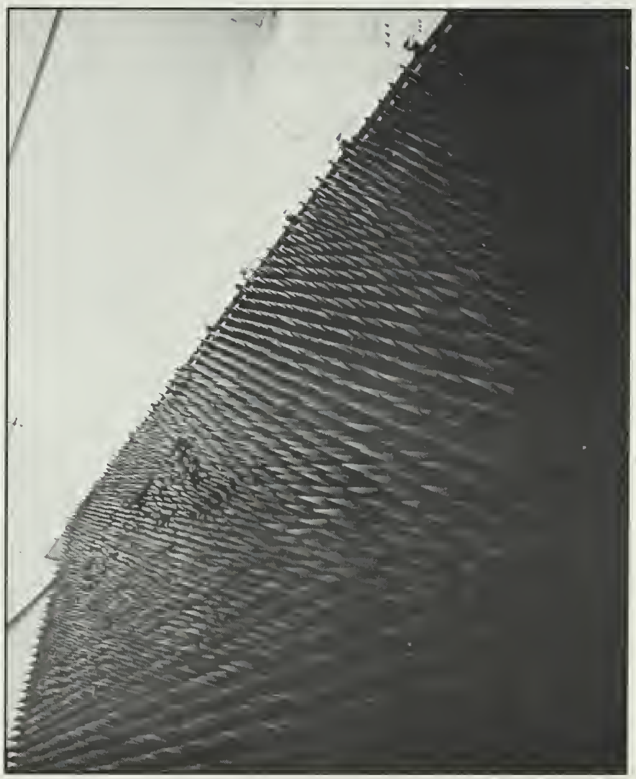


Figure 176: Detail of radar cones, Building 821, 1991.

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Propulsion Laboratory Buildings: Fred W. Oliver, Charles W. Norman
Audio-Visual Laboratory: Dave Baldridge, Earl Becker, John Vovroch
Ordance Storage, Armament Laboratory: Ralph Lauzze
Firehouse: Chief Darryl Wilcoxin, Neil Mangan
Vertical Wind Tunnel: Earl O. Sine
Radar Test Building: Bill Bahret
Wind Tunnel Complex: Dan Parobek, Stanley R. Palmere