Ellsworth Air Force Base,
Readiness Hangar
(Building 605)
Kenny Road at Southeast Corner
Of Intersection with G Avenue
Black Hawk Vicinity
Meade County
South Dakota

HABS No. SD-21-A

HABS
SD-21-A

PHOTOGRAPHS
HISTORICAL AND DESCRIPTIVE DATA

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HISTORIC AMERICAN BUILDINGS SURVEY

ELLSWORTH AIR FORCE BASE, READINESS HANGAR

(ELLSWORTH AIR FORCE BASE, BUILDING 605)

HABS No. SD-21-A

I. INTRODUCTION

Location:	The Readiness Hangar is located at Ellsworth Air Force Base in Meade and Pennington counties, South Dakota. The base lies approximately 10 miles east-northeast of Rapid City, the seat of Pennington County, and about 10 miles due east of the small community of Black Hawk in Meade County. The Readiness Hangar stands near the southwestern end of the base's current aircraft Flight Line. While the Readiness Hangar is located within the boundaries of Pennington County, the bulk of Ellsworth Air Force Base is in adjacent Meade County. For consistency, all HABS recordation at the base is assigned Meade County locational information.
Quad:	Bend
UTM:	Zone: 13; Easting 653120; Northing 488760
Date of Construction:	1952
Architect:	Preliminary plans were prepared by the U.S. Army Office of the Chief of Engineers, and finalized by Wilson & Company of Salina, Kansas.
Present Owner:	United States Air Force
Present Use:	Abandoned
Significance:	The Ellsworth Air Force Base Readiness Hangar is significant for its association with American military policy during the Cold War years of the early 1950s. During this era, the United States Air Force made substantial improvements at the nation's domestic air bases, including major projects designed for domestic defense and air base protection. Readiness hangars such as this one played a key role in this changing mission by housing and maintaining aircraft prepared to take off at a moment's notice to protect the base from outside attack.

The Readiness Hangar also serves as a significant representation of period military hangar architecture. The building's design was widely used for new hangar construction during World War II, particularly after wartime restrictions on steel use were imposed in 1942. Furthermore, its configuration typifies the basic form preferred for a readiness hangar by military planners of the early 1950s.

Historians: Mary McCormick and Mark Hufstetler
Renewable Technologies, Inc.
Butte, Montana
December, 1994

II. HISTORY

A. INTRODUCTION

This report, prepared for the Historic American Buildings Survey (HABS), provides historical and descriptive data on the former "Readiness Hangar" building at Ellsworth Air Force Base in western South Dakota. The hangar is a large wood-and-concrete building erected in 1951-52 as part of a program to defend the base--an important United States Air Force installation--from possible attack by military aircraft during the Cold War era. The Readiness Hanger (identified in the base's Real Property records as "Building 605") was later assigned other names to reflect its changing uses: for consistency, it is referred to by its historic name throughout this report.

Ellsworth Air Force Base was constructed by the United States Army in 1942 to serve as a temporary wartime aviation training facility. The base was reactivated following World War II to serve as a base for military bomber aircraft, and for other strategic purposes; it continues in this role in 1994. The United States Air Force assumed ownership of the base following the creation of that branch in 1947. Ellsworth Air Force Base's current name was adopted in 1953; the facility had earlier been known as Rapid City Army Air Base, Weaver Air Force Base, and Rapid City Air Force Base. As used in this report, the term "Ellsworth" refers to the current base, as well as the same facility under its former names.

B. ELLSWORTH AIR FORCE BASE, 1942-1994

Domestic military construction in the United States stagnated following the end of World War I, but American military base construction experienced a dramatic revival in response to the increasing international tensions of the late 1930s. This expansion was particularly evident in the aviation units of the United States Army, an indication of the growing strategic importance of military air power. Between 1937 and 1941, for example, the number of Army Air Corps facilities grew from 21 to 114, and still more aviation facilities were built as America embroiled itself in World War II.[1]

One phase of America's military aviation expansion program began in 1940, as the Army finalized plans to construct a number of new domestic military airfields for flight training and aircraft maintenance. Military site selection committees analyzed a number of potential locations for these new bases during 1941; the process almost inevitably generated substantial enthusiasm among the residents of communities being considered, since a new military facility could provide a region with a major economic stimulus.

One such potential site was the Municipal Airport grounds near Rapid City, South Dakota. The location, on a low plateau a few miles east of town, seemed largely favorable to military inspectors. The site's ultimate selection for an air base was assured through extensive lobbying by South Dakota's congressional delegation and local civic leaders. Rapid City was formally chosen as a new military airfield location in December 1941; local backing for the decision was proven when more than 99 percent of Rapid City's voters supported a bond issue to assist in base construction.[2]

Construction work at the future Rapid City Army Air Base (RCAAB) began early the following year, and the facility was essentially complete by September 1942. As built, the new base featured three concrete runways and several dozen buildings. Most buildings were small, wood-framed structures, reflecting the base's status as a temporary, wartime facility. RCAAB initially served as a training facility for Army B-17 bomber crews; it continued in this role until the war's end in 1945, when the facility was inactivated.[3]

RCAAB faced a period of uncertainty after the war, as many of the nation's temporary military bases were closed and disposed of. In 1947, however, the base was permanently reactivated as a major Army bomber base. This role continued after RCAAB was transferred to the newly-formed United States Air Force at the end of the year, and assumed the name "Rapid City Air Force Base" (RCAFB). Under Air Force control, the facility initially served as home to a fleet of B-29 bombers operated by the Air Force's 28th Bombardment Wing. The bomber fleet continued to operate from the temporary facilities constructed by the Army in 1942.[4]

In 1949, the fleet of B-29s at RCAFB was supplanted by the arrival of B-36 "Peacemaker" bombers at the base. The B-36 assignment gave the base a sustained level of importance within the Air Force, while simultaneously pointing out the need for substantial physical improvements to the World War II-era facility. The B-36 was one of the largest and heaviest aircraft in the world at the time, requiring the Air Force to undertake major runway and hangar improvements at RCAFB to accommodate the new craft. This construction marked the beginning of a significant period of growth in the RCAFB physical plant.[5]

A larger and more sustained period of expansion at RCAFB began in 1951. The strategic importance of Air Force as a whole grew significantly during the 1950s due to the international tension generated by the Cold War and the Korean conflict. Simultaneously, RCAFB emerged as a major operations center of the Air Force's Strategic Air Command (SAC). The base grew markedly between 1951 and 1956, with the construction of over a dozen new hangars, a control tower, new housing and mess facilities, a hospital, and numerous other structures.[6] The largest

construction project of the period was the building of Rushmore Air Force Station (1952-54), a massive facility just north of RCAFB intended for the storage and maintenance of strategic nuclear weapons. Meanwhile, RCAFB was renamed Ellsworth Air Force Base in 1953. [7]

Nationwide, the tensions generated by the Cold War made Air Force bases and other military installations seem dangerously vulnerable to enemy attack throughout the 1950s. This was a particular concern at Ellsworth, since the nuclear weaponry and the sophisticated bombers stationed there were believed to be especially attractive Soviet targets. Throughout the decade, both the Air Force and the Army added facilities at the base designed to facilitate its defense, including anti-aircraft batteries and, later, ground-to-air missile facilities. This concern for security also resulted in the construction of Readiness and Alert Hangar facilities at Ellsworth in 1952. Newspaper articles from the period encouraged local residents to be vigilant for approaching enemy aircraft, to help keep Rapid City from becoming "a second Pearl Harbor."[8] Locally, this defensive military posturing remained in place until it was made superfluous by the Intercontinental Ballistic Missile (ICBM) in the early 1960s.

The importance of Ellsworth within SAC continued to grow throughout the late 1950s and 1960s. The installation's future as a major bomber base was secured with the arrival of a fleet of B-52s in 1956. The base's military operations began to diversify in 1962 when a series of Titan ICBM launch facilities were activated near Ellsworth. The Titans were quickly replaced by the Minuteman missile system, and the last of 150 Minuteman silos assigned to Ellsworth was in place by the end of 1963. The bomber and missile functions at Ellsworth, supplemented by a variety of smaller installations, continued to make the base one of the most important installations in SAC throughout the 1960s, 1970s, and 1980s. In 1986 the base was designated as home for a fleet of new B1-B "Lancer" bombers, and much of Ellsworth's physical plant was modernized as a result.[9]

The early 1990s brought the end of the Cold War and resulted in substantial changes in military activity at Ellsworth. The base's role as an ICBM support facility finally ended in 1994. Ellsworth remained home to a large fleet of B1-Bs, but the alert facilities at the base were deactivated. SAC itself was inactivated in 1992, and Ellsworth was assigned to the newly-formed Air Combat Command (ACC). Despite these technological and political changes, however, Ellsworth's current mission to train and support military bomber aircraft remains strikingly similar to that implemented 52 years earlier.[10]

C. CONSTRUCTION PROGRAM AT DOMESTIC MILITARY AIR BASES, 1940-1952

Prior to World War II, the two United States Army support units responsible for domestic military construction were the Quartermaster Corps and the U.S. Army Corps of Engineers (Corps of Engineers). A multi-functioned organization, the Quartermaster Corps worked to meet the diverse service and supply needs of the U.S. Army; duties that became part of its historic mission included building camps and cantonments for sheltering and training Army troops. The Corps of Engineers, in contrast, carried out combat construction, and the building of fortifications, roads, and bridges. Over the years, the agency also became responsible for public works projects. Included in the latter category were harbor and river improvements, surveys and explorations, canals, public buildings, and other endeavors.[11]

The onset of War World II necessitated massive organization of the Army's domestic construction program. With the outbreak of war in Europe in the late 1930s, the Army initiated plans for the first major build-up of domestic military facilities in the United States since 1918. In spring of 1940, the Quartermaster Corps responded to the effort by readying plans for 300 structures of varying types and sizes to be built at Army camps and training centers, including air base facilitates. Although actual construction at few camps was underway within a few months, more rapid expansion of military facilities in the U.S. proved critical and the Quartermaster Corps quickly became overburdened. In November 1940, the Secretary of War addressed the problem by assigning the building of all Army Air Corps facilities to the Corps of Engineers. As the supply responsibilities of the Quartermaster Corps continued to increase, a bill was passed by Congress transferring construction, maintenance, and repair of all domestic Army structures to the Corps of Engineers. President Roosevelt signed the measure into law in early December 1941, just days before the Japanese attack on Pearl Harbor propelled the United States into the war.[12]

The Corps of Engineers was well-suited to meet the Army's wartime demands for domestic construction. Between 1919 and 1939, the Corps had developed into a well organized, fully equipped organization capable of handling nearly all types of construction. During the Great Depression of the 1930s, it had superintended a number of significant civil works projects, and gained considerable expertise in organizing complicated construction enterprises and directing large labor forces. The Corps of Engineers' ranks represented the nation's largest and most highly trained assemblage of military and civilian engineers. Its District Offices effectively covered every region of in the United States.[13]

The Corps of Engineers utilized a decentralized approach for construction at Army air bases and other wartime facilities. The District Offices were given major responsibility to

supervise and direct construction projects within their region. They assisted in real estate purchases for project sites, developed construction specifications, put design and construction contracts out for bid to private architectural firms and contractors, approved all final designs, and let construction contracts. Local architectural and contracting firms received preference in contract awards.[14]

Meanwhile, the Army Office of the Chief Engineer (OCE) assumed responsibility for developing standardized designs for Army buildings needed for the wartime effort. The OCE plans took the form of definitive drawings that could be adapted by private architectural and engineering firms to meet site conditions. Designs that allowed buildings to be quickly erected at minimal cost were emphasized; unnecessary architectural embellishments were strongly discouraged.[15]

The Army's domestic wartime construction program proved to be well-formulated and effective. By the end of the war in 1945, it had embraced more than 27,000 projects, including over 300 major Army air bases, at cost of $15.3 billion.[16] The success of the program secured the Corps of Engineers' construction-related role in the United States post-World War II defense program. In particular, the Corps of Engineers continued to supervise construction at military air base facilities, even after the 1947 transfer of Army Air Force units to the newly-formed United States Air Force.

The postwar era was initially marked by a concentration of the nation's air strength in a smaller number of slightly-improved bases. With the acceleration of Cold War tensions and the outbreak of the Koran War, however, a program of major expansion at the remaining bases began in the early 1950s. The "expansion program" concentrated, in part, on replacing many deteriorated wartime buildings, but was also intended to provide new structures to service the changing air defense mission of the United States Air Force. A large arsenal of nuclear weaponry and a strong fleet of heavy long-range bombers as a deterrent to war, coupled with radar and later anti-aircraft batteries and air-to-ground missile facilities for protection from outside attack, underscored the strategic goals of the "modernized" Air Force of the 1950s.[17]

As part of the expansion program, the Architectural Services Branch (ARB), of the Air Force Directorate of Installations, conducted an intensive survey at the air bases to determine their structural needs. Based on the survey findings, the ARB developed standardized designs for buildings of a variety of sizes and types, including many more specialized building forms than were erected during the war. Despite variations in form, all the designs called for the construction of permanent buildings that maintained a strictly utilitarian appearance, without "useless embellishments or nostalgic doodads." The plans were considered as preliminary

drawings, from which private architects and engineers were to develop final designs suited to local conditions, provisions for utilities, detailed specifications, and contract documents.[18]

Facilities built at the Air Forces bases in the early 1950s included headquarters buildings, technical training facilities, aircraft hangars, nuclear weapons storage facilities, housing, chapels, theaters, and other structures. This massive expansion program was closely followed by the development of sites to house operational missile units. The construction of these complex facilities dominated Air Force construction projects from 1957 to 1964.[19]

D. ARMY-AIR FORCE AIRPLANE HANGAR DESIGNS, 1908-1952

An airplane hangar may be broadly defined as a utilitarian structure used to house or service aircraft. In its basic form, a hangar encloses a large, unobstructed area having sufficient vertical clearance (height) and floor space (length and width) to accommodate an aircraft. Thus, the overall dimensions of a hangar are generally determined by the size and number of planes it is intended to shelter. In addition, an essential element of any hangar is an unobstructed opening, wide and tall enough to permit a plane's passage to and from the building.

The airplane hangar first emerged as a building form in United States around 1908, as the recently-invented airplane began to see limited use in both civilian and military settings. Most of the nation's earliest hangars were simple, wood-framed sheds; canvas tents and already-existing buildings, such as barns, also were used to shelter aircraft. The primitive designs and diminutive size of early hangars reflect the simple technology and small size of the biplanes which they housed.[20]

Greater attention to military hangar design and construction awaited the onset of World War I, the global conflict in which aerial warfare first played a significant combat role. Woefully weak in the air as it entered the war in 1917, the U.S. Army quickly formulated plans to expanded its fleet of aircraft and constructing several new air fields throughout the country for aviation training. An important physical component of the air expansion program was the construction of several hangars to serve as plane storage, and for repair and maintenance work. To facilitate their construction, the Army drafted a standardized hangar design that could be readily adapted at each new air field.[21] These standard "1917" hangars retained a strictly utilitarian appearance, but were far more substantial in size and sturdier in form than their earlier counterparts. Designed in two sizes (with openings measuring either 66 or 110 feet wide), the hangars were rectangular, wooden structures capable of housing several aircraft, and featuring low gambrel roofs and plain sliding doors at either end wall.[22]

Airplane hangar designs continued to evolve during the post-World War I era in response to the development of larger, more technically advanced aircraft. Most new design types were first advanced by the commercial aviation industry after the introduction of larger transport planes in the late 1920s made commercial air travel more feasible.[23] New hangar construction was marked by the use of reinforced concrete or structural steel framing, in a variety of forms, to create spans of greater length and height to accommodate increasingly larger aircraft. Wings or lean-to additions became common along one or both sides of the hangars, providing space for mechanical and other auxiliary facilities. Bands of large windows were typically used to provide ample interior light and ventilation.

Meanwhile, the importance of hangars in America's military infrastructure grew significantly as the international tensions of the late 1930s prompted the first major build-up of Army air bases since 1918. The Army initially geared its efforts toward the construction of large hangars, with clear-span interiors ranging from 200 to 275 feet wide.[24] In 1941, however, as the need for more hangar facilities became critical, the military generally turned to smaller, standardized forms that could be more quickly and inexpensively assembled. The most widely-used design offered a 120-foot wide by 28-foot high clear span, with a typical building length of 200 feet. The structural system and form of these hangars closely reflected concepts introduced by the commercial aviation industry in the preceding decade. Featured were Warren-type roof trusses supported by steel columns. Wings spanned along both sides of the hangar and multi-leaf, sliding hangar doors opened at one or both ends. A number of large, steel sash windows were provided throughout the building. Fire resistant materials, either asbestos-protected metal or corrugated asbestos siding, were used for exterior wall cladding.[25]

Wartime restrictions on steel and other metals, imposed in early 1942, forced the Army to turn to structural designs of alternative materials for hangar construction. Although many other innovative design-types were soon developed, hangers of the conventional pre-war form (i.e. a single hangar joined on both sides by wings) but substituting reinforced concrete or wood trusses became standard. A widely-used concrete design-type had a structural system formed by a series of closely spaced arched ribs, springing from the ground.[26] Three design-variations proved popular for wooden construction: the arch rib; the bow-string arch, featuring an arched top chord and straight bottom chord; and the crescent arch, in which the bottom chord was also arched. All three wooden variations commonly relied on construction technology developed in the late 1930s for long-span wood construction. In this technology, an arched member was built up of small sections of laminated lumber, stacked and bent to the curve of the arch radius, and then glued and spiked together. Wooden arch trusses, in either the bow-string or crescent configuration, were typically supported on a system of a concrete beams and buttressed columns.[27]

Other noticeable elements of hangar design were also dictated by the wartime restrictions on the use of structural steel. Wood-sash windows replaced metal-sash units. Simultaneously, the use of metal-protected asbestos and corrugated metal for wall cladding were discarded in favor of asbestos-cement shingles or stucco.[28]

For the most part, military hangars during World War II were used only for the storage and maintenance of aircraft. Their functional role at air bases, however, grew in the Cold War era, as the recently-created United States Air Force implemented increasingly-sophisticated national defense capabilities. During the air base "expansion program" of the 1950s, speciality hangars were introduced to house fighters, tankers, and other military aircraft kept at "readiness;" that is, ready to take off at a moment's notice to defend the base from outside air attack. These facilities appeared at locations that allowed quick access to a base's main runway; dormitory space was provided nearby to allow flight crews to live within just a few feet of their waiting aircraft. These speciality hangars were built in two basic classes: the "alert" hangar and the "readiness" hangar.[29]

Alert hangers were designed to hold aircraft that could be manned and airborne within 90 seconds. The standard alert hanger plan featured four separate hangar "pockets", each designed to shelter a single plane and equipped with fast-operating hangar doors at both ends. The pockets were configured in pairs on both sides of a central block, which contained maintenance facilities and waiting rooms for the flight crews.[30]

In contrast, a readiness hangar was intended as a more multi-purpose facility. First, it provided space where planes could be kept under cover and warm, and taken out to the runway with considerable dispatch, although not quite as quickly as from an alert hangar. Second, it acted as a aircraft maintenance shop. Readiness hangars typically utilized the form of a standard World War II aircraft hanger: a central hanger space flanked on both sides by wings housing workshops, a boiler room, and other facilities. Such buildings typically had sufficient clearance and floor space to accommodate all but the largest bombers of the 1950s era.[31]

In general, post-World War II hangar construction saw the renewed use of steel structural framing, wall cladding, and roofing. Large steel-framed buildings were simpler to construct than wood, were more fire resistant, and displayed an improved strength-to-weight ratio. Simple designs continued to predominate, with rectangular building masses, shed roofs, and minimal fenestration. One innovation was the use of "apertures" on some hangar leaf doors; these curved openings allowed the tail of an extra-large plane to extend outside the building, even with the door closed. A few more-innovative structural forms did appear, however; perhaps the most noteworthy were the large concrete rib-arch hangars built at RCAFB and Loring AFB (Maine) to house the Air Force's massive B-36 bomber.[32]

E. ELLSWORTH AIR FORCE BASE, READINESS HANGAR, 1951-1994

The Ellsworth AFB Readiness Hangar was built in 1951-52 as part of the base's large-scale construction and improvement program of the early 1950s. This building program, the largest at the base since its initial completion in 1942, reflected the base's evolving and expanding mission as well as the nationwide military buildup during the early years of the Cold War. New construction at the base began in earnest in 1950 and, encouraged by large congressional appropriations, increased significantly in the years that followed. The 1951 building program was massive, with $8,500,000 authorized for the base by March, and an additional $17,532,000 appropriated that September. A variety of projects were funded, including housing, mess halls, and warehouses; additional projects were not publicly detailed for security reasons.[33]

The decision to construct a readiness hangar at Ellsworth AFB in the early 1950s was in line with period Air Force efforts to improve the nation's defensive capabilities. At the time, several American air bases were perceived as prime targets for air attacks from potential aggressors. Consequently, military planners of the era proposed that special hangars be erected at each of those bases that could maintain aircraft capable of being airborne in a matter of seconds in order to intercept incoming hostile aircraft. A readiness hangar was one type of specialized hangar intended to serve this function, as well as to act as a airplane maintenance facility.[34]

The design selected for the Ellsworth AFB Readiness Hangar was derived from preliminary drawings issued by the Army Office of the Chief of Engineers (OCE) in December 1942.[35] These drawings outlined a large hangar flanked on both sides by lean-to additions, a tried-and-true configuration widely used during World War II and subsequently specified by the Air Force for a readiness hangar facility. More specifically, they reflected construction technologies and materials that came into common use for hangar construction after restrictions on steel were imposed by the military in 1942. They detailed a structural system comprised of crescent-shaped wood-arch trusses supported on concrete beams and buttressed columns, and called for asbestos-cement shingle cladding, and wood-sash windows. Most military hangers constructed during the 1950s relied heavily on steel framing and cladding, and the design chosen for the Ellsworth building was something of an anachronism by 1951. The reason for the use of a wood-arch design for the building is unknown; it may have been less expensive than a steel design, or have allowed for the use of already-existing building blueprints.

The Omaha District of the Army Corps of Engineers, which held responsibility for all construction activities at Ellsworth, retained the firm of Wilson & Company to revise the OCE drawings to met the particular conditions and requirements at the base. Headquartered in Salina,

Kansas, Wilson & Company was a private consulting firm, offering both architectural and design services. Its founder, Murray A. Wilson, received a Bachelor of Science degree in civil engineering in 1922 and subsequently worked for several state agencies in Kansas. In 1932, Wilson left government service and established a private consulting firm in partnership with architect R.J. Paulette. He organized Wilson & Company in 1941 after Paulette's death. In addition to their work at Ellsworth AFB, Wilson & Company had completed several major projects at a number of other military installations by the mid-1950s. Among the firm's significant military-related contracts were a $30 million improvement project at Camp Carson and a $15 million design contract for developments at the Pueblo Ordnance Depot, both in Colorado. Wilson & Company also prepared the architectural plans and engineering details for a flight hangar, materials building, and a 12,000-foot square office building at the Boeing Airplane Company plant in Wichita, Kansas.[36]

Construction of the Readiness Hangar presumably began soon after Wilson & Company completed the final building plans and specifications in May 1951. Reports of the subsequent construction process received virtually no mention in local newspapers, since the hangar presumably was considered a high-security facility by the Air Force. One notable exception, however, may have occurred. On August 7, 1951, the *Rapid City Journal* ran a story about the employment of local Indians on Ellsworth construction projects being built under contract by H & B Construction Company of Rapid City. The article mentions that the Indian labors were working on the construction of "a hangar," as well as several other projects.[37]

Work on the Readiness Hangar was completed in February 1952, at a total cost of $335,300.[38] As built, the hangar stood near the south end of the operational apron for the base's original (1942) Flight Line; the building was also near the south end of the base's primary runway. A large 1942 aircraft maintenance facility (building 601) was just to the north of the building; directly to the south was a newly-erected dormitory (building 606) for the readiness flight crews.

The Readiness Hangar's defensive role ended after the introduction of ground-to missile defense systems at Ellsworth in the late 1950s made the concept of defensive "readiness" aircraft redundant. The building continued to be used for aircraft maintenance for a several years; a "Life Support Branch" addition was made along the building's rear (east) wall in support of this operation in 1960. The hangar was remodeled and converted into an auto maintenance shop in 1971. By the late 1980s, these functions had been transferred to other facilities on base, and the hangar was being used solely for storage. It is now (1994) completely abandoned. Meanwhile, the building's original asbestos-shingle wall cladding was removed in 1992, as part of a base-wide abatement program and in preparation for the hangar's demolition.[39]

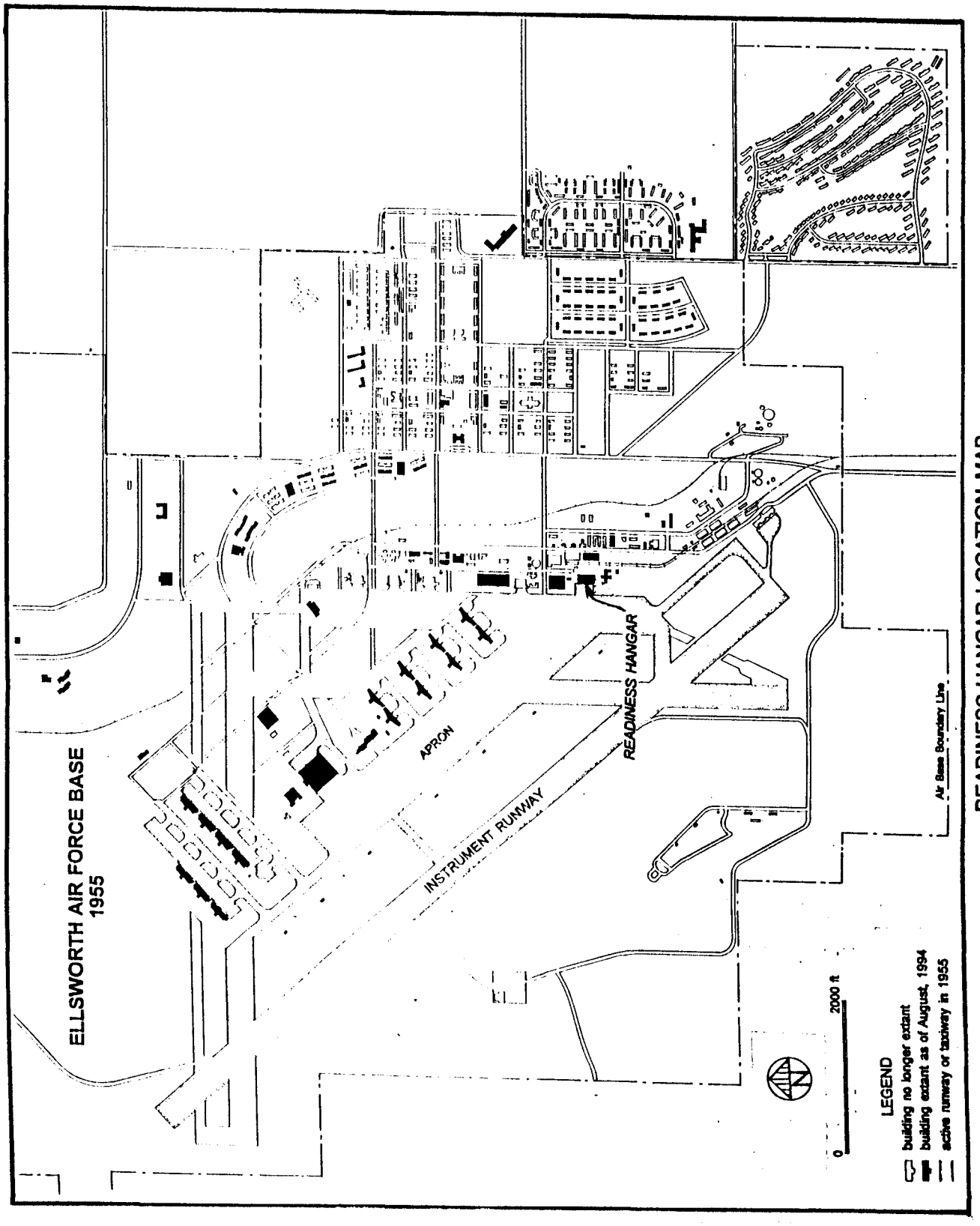
III. ARCHITECTURAL DESCRIPTION

The Readiness Hangar (building 605) is located in the southwestern portion of Ellsworth Air Force Base. The base is functionally divided into three geographic areas, devoted to housing and support services (to the east), ordnance storage and maintenance (north), and aircraft and base operations (west). The latter area, the largest of the three, includes the runway and taxiways, adjoining aprons and hangars, as well as maintenance, warehousing, and office facilities. The primary aircraft and operations areas, known as the "Flight Line," are arranged parallel to, and east of, the runway, on an approximate northwest-southeast axis. Additional facilities are located along a north-south axis just east of the Flight Line area; these buildings mark the location of the base's original 1942 Flight Line, and a now-abandoned north-south runway. (See the "Location Map" on page 14 of this report.)

The Readiness Hangar is located near the south end of the abandoned north-south runway, near the point where the abandoned runway intersected the current runway and Flight Line. The building faces west, with its hangar door allowing access to both the current and former Flight Lines. Other historic resources exist to the north, south, and east of the Readiness Hangar, including a large 1942 hangar and maintenance building to the north (Building 601), a readiness crew quarters building to the south (building 606), and historic warehouse facilities to the east. Together, Buildings 601, 605 and 606 provide a strong visual indication of the base's original north-south Flight Line area, and simultaneously serve as an architectural anchor for the base's current Flight Line.

The Readiness Hangar is a single-bay, arched-roofed hangar flanked on the sides by shed-roofed wings. The primary structural system is comprised of wooden, crescent-shaped arched trusses supported on a system of concrete beams and buttressed columns. The hangar proper measures 160' north-south x 117'4" east-west, with the arched ends at the east and west façades. The shed-roofed wings along the north and south sides are full-length, 30-foot wide structures. The building rests on a concrete foundation. The exterior walls have 1" x 8" horizontal board sheathing, exposed by the recent removal of the original asbestos-cement shingle siding. The hanger has several other alterations and additions made over time, most notably a full-length one story wing along the east (rear) side. Although currently abandoned and in somewhat deteriorated condition, the hangar retains its architectural integrity.

The roof system for the Readiness Hangar consists of seven, two-hinged arched trusses. The trusses span 160' (north-south), are spaced 19'2" on center (east-west). Each is a "crescent" truss, having the top as well as the bottom chord arched -- thus providing a higher vertical clearance at the center of the truss then at the ends. The chord members are constructed of stacked 2" x 6" boards, spiked and laminated together; the chords of the two end trusses are



READINESS HANGAR LOCATION MAP

slightly bulkier than those at the interior. The web system of each truss has 2" x 6" vertical and diagonal members arranged in a sawtooth pattern. Lateral bracing for the trusses is provided by vertical X-bracing; 2'-3"x 6" continuous spacers at the bottom chord; and the roof rafters which span between the top chord members. The 2" x 6" rafters are spaced 24' on center, and are tied together by lateral cross bridging. The rafters are sheathed with boards and two layers of rolled roofing (the top layer more recent than the bottom).

The spring line of the trusses is 17' above the finished hangar floor. The truss ends are bolted to welded steel plates which, in turn, are anchored to a concrete beam. The continuous beam rests in pockets at the face of reinforced concrete columns placed beneath each truss end. The lateral thrust of the trusses on the columns is taken up by sloping bars of reinforced concrete, and a sold reinforced concrete piers. The bars and piers form a "flying buttress," each of which rests on its own massive, reinforced concrete footing. A line of buttresses is inside each shed wing.

The hangar door dominates the west side of the building. As built, it consisted of a pair of seven-leaf sliding doors suspended from horizontal, wood "wind" girders, braced to the exterior truss at the west end of the roof. A set of double-flanged wheels carried each leaf on one of seven parallel tracks embedded in the concrete floor, with the leaves in each door recessing one behind the other into a wood-frame, rectangular "pocket" structure attached at the exterior end of a door. An overhead rolling guide maintained the doors in alignment and prevented the leaves from jamming. Operation of the door presumably was mechanical, although each leaf was equipped with a pull handle to facilitate manual movement.

Together the two sliding doors provided a 160' wide x 25' high opening into the hangar. Each door was comprised of six, 25'4-1/2" tall by 12' wide leaves, fabricated of plywood section, and a single 8-foot wide leaf at the exterior end. The 12' wide leaves each held a large, wood-sash window containing three, fixed, 20-light panels, one atop the other. Single person doors (measuring about 6'-8" tall x 2'-8" wide), called "pilot doors" were located at an interior leaf in each sliding doors. The pilot doors were wood, hollow-core units with a small rectangular window; they provided human access through the hangar door when it was closed. Positioned directly above the center of the sliding doors was a 10' square overhead door, called the "tail door; it served to accommodate the tail section of a plane passing through the building. The clearance obtained at the tail door was about 38'.

The hangar door was permanently closed when the building was converted into a auto maintenance shop in 1971. Interior leaves in both sides of the door have since been partially recessed and the two, large openings established now each hold an overhead garage door and

plywood infill. The original pilot door toward the north has been lost behind a sliding leaf and the one toward the south modified with an inoperable paneled-wood door that appears to be a recycled historic element.

A curtain wall infills the east end of the hangar. It is comprised of series wood columns and vertical grits. Each column rests on a concrete pier and extends up to the bottom chord of the end roof truss. The top of each column has a deep notch which fits and is secured onto the bottom chord. Each column is also tied to an interior truss by a diagonal brace. Spaces between the columns and grits either have 2" x 4" wall studs, spaced 24" on center, or hold window framing. Along the upper level of the wall is a row of seven, triple 12-over-12 double-hung windows.

The roof ends at the east and west façades have wall studs nailed directly onto the adjacent end truss. Piercing each are five vents, arranged in a arc as to follow the curve of the roof. The vents are rectangular, two-sided units with wooden louvers.

Clerestory areas along the north and south sides of the roof are created by shed-roofed dormers, rising above the shed wings. Each dormer measures about 3/4 of the total length of the roof and is filled by four sets of quadruple windows. The windows are wood-sash fixed windows, divided by mulins into 12 lights; many have been boarded shut.

The shed wings along the building's north and south elevations are of wood-frame construction. The as-built elevation plans for the hangar indicate that both of these sides had several window and door openings. Widows were predominately wood-sash, double-hung units with a multi-light configuration; they appeared in single, paired, and triple groupings. Several person doors were position on either wall; service entries include a large, sectional overhead door and a pair of swinging freight doors at the west end of the north façade. All the historic doors and windows have since been removed and the openings fitted with plywood or wood-siding infill and a replacement fenestration units.

The lower level of the building's east wall has been completely obscured by a full-length, one-story addition built in 1960. The addition has a concrete block walls, and a flat roof, with steel joists and metal decking. There are sets of metal-sash combination windows on three sides of the addition. A person door and a freight door are on the east side.

The north and south sides also have small additions. A wood-framed, shed-roofed addition is located on the north façade toward the west; it likely is a "power house shelter" constructed in 1954. More recent are small shed-roofed vestibules: two along the north façade and one on the south façade.

A free-standing chimney is located just to the south of the hangar. It served the boilers in the Readiness Hangar which provided heat for the hangar and two other nearby buildings (buildings 606 and 608). The chimney is a straight-sided brick structure, about 80' tall. It stands on a octagonal-shaped concrete pad and is capped by a narrow concrete coping. A row of metal rods projecting from the south side form a ladder that leads to a metal catwalk and the top of the structure. A sheet-metal duct projects from the north side of the chimney and extends into the hangar's boiler room.

The interior of the hangar reflects its utilitarian function. The hangar space proper is an unobstructed, open area with a concrete slab floor and most of the structural system of the building exposed. The areas between the columns on the north and south walls, and the lower section of the east wall are covered with unfinished sheets of drywall.

The wings of the hangar are divided into several rooms or compartments that have undergone several remodelings over the years. Prior to the conversion of the hangar to an auto maintenance shop in 1971, the north wing had two large rooms that were designated a "technical. supply and tool crib" room and "armament and electronics" room. The south wing had toilet and boiler rooms, and a much larger "hangar maintenance" area. Interior walls in the wings are unfinished drywall, except for concrete block walls at the boiler room. The boiler room originally housed three steam boilers; these were replaced by two new boilers in the 1960s.

In 1959, a mezzanine and stairway were added along the east half of the south wing. A similar mezzanine was also built along the south wall of the wing during the building's 1971 remodeling. Two new stairways provided access to the new floor. Small rectangular windows open from the mezzanine level to the hangar floor; it appears that these windows were already in place at the time of the 1971 remodel.

IV. FUTURE OF THE PROPERTY

The United States Air Force currently plans to demolish the Ellsworth Air Force Base Readiness Hangar. The Air Force has entered in to a Memorandum of Agreement with the Advisory Council on Historic Preservation to record the building to Historic American Buildings Survey standards. This documentation is intended as mitigation for the adverse effects caused by the building's demolition.

V. ENDNOTES

1. For a broad discussion of the growth of American military aviation during this period, see Ellis L. Armstrong, ed. *History of Public Works in the United States, 1776-1976* (Chicago: American Public Works Association, 1976), 620-637.

2. For an overview of the site selection process for the base, see "Master Plan, Ellsworth Air Force Base, Weaver, South Dakota,"1958, Manuscript on file at the South Dakota Air & Space Museum, Ellsworth AFB, South Dakota. An additional secondary source is Paul D. Cook, "A History of Ellsworth Air Force Base, South Dakota," 1982, Manuscript on file at Base Historic Preservation Office, Ellsworth AFB, South Dakota. Also see "City Votes Smashing Approval of Army Air Base Bond Issue," *Rapid City Daily Journal,* 31 December 1941; "Rapid City Named Site for $8,500,000 Army Air Base," *Rapid City Daily Journal,* 10 December 1941.

3. "Completion Report: The Rapid City Army Air Base, Rapid City, South Dakota," October 1942, Manuscript on file at the 28 CES/CEVE Office, Ellsworth AFB, South Dakota; Cook, "A History of Ellsworth Air Force Base," 4-5.

4. Cook, "A History of Ellsworth Air Force Base," 6-10.

5. Ibid.

6. Ibid.

7. Relatively little has been written about the construction of the Rushmore station and the nation's other period nuclear storage facilities, presumably due to Cold War national security concerns. See, Sandia National Laboratories (Albuquerque, New Mexico), "Ellsworth Air Force Base, South Dakota: Former Special Weapons Storage Area, Trip Report," March 1994, Letter copy on file at the Base Historic Preservation Office, Ellsworth AFB, South Dakota.

8. *Rapid City Daily Journal,* 11 December 1952. For a broad description of relevant Cold War defense issues, see " Nike Missile Site C-84, HAER No. IL-116" 1994, Historic American Engineering Report narrative prepared for the National Park Service, U.S. Department of the Interior."

9. "Ellsworth Air Force Base: 1994 Guide" (San Diego: Marcoa Publishing, Incorporated, 1994), 6-11.

10. Ibid.

11. Lenore Fine and Jesse A. Remington, *The Corps of Engineers: Construction in the United States,* vol. 3, *United States Army in World War II: The Technical Services* (Washington, D.C.: Office of the Chief of Military History, United States Army, 1972), 4-5; *History of Public Works*, 594.

12. For a discussion of the historic transfer of military construction obligations from the Quartermaster Corps to the Corps of Engineers, see *The Corps of Engineers: Construction in the United States,* 440-472; *History of Public Works*, 598.

13. Ibid. Construction activities at Ellsworth in 1942 were under the jurisdiction of the Corps of Engineers office in Fort Peck, Montana; the base was soon reassigned to the Omaha, Nebraska District Office.

14. *The Corps of Engineers: Construction in the United States*, 499-519.

15. Ibid.; "Hangar-Repair Shop for the Air Corps," *Engineering-News Record* 127 (October 23, 1941) : 112.

16. *The Corps of Engineers: Construction in the United States*, ix.

17. *History of Public Works*, 631-632.

18. "Air Force Buildings," *Architectural Record* 111 (January 1952) : 95-97.

19. Ibid.; *History of Public Works,* 633-634.

20. For a general summary of American aviation in the 1900s and early 1910s, see *Encyclopedia Americana,* 1992 ed., vol. 2, "Aviation," 589-682. Another useful source on early military aviation in the United States, including mentions of early hangar forms, is Ann Krueger Hussey, et al, *A Heritage of Service: Seventy-Five Years of Military Aviation at Kelly Air Force Base, 1916-1991"* (Kelly Air Force Base, Texas: Office of History, 1991).

21. *Aviation at Kelly Air Force Base*, 14.

22. Ibid.; "Building At the Airbases," *Engineering News-Record* 125 (October 24, 1940) : 57. Hangar of alternative designs were also erected at World War I Army air bases; perhaps the most inventive of these were represented by several steel and concrete hangars erected at Kelly Air Base in 1917; these actually modified, railroad siding buildings, see, *Aviation at Kelly Air Force Base,* 10-14.

23. "Aviation," 867.

24. "Building at the Airbases," 57.

25. "Hangar-Repair Shop for the Air Corps," 112-114.

26. "Concrete Arched Aeroplane Hangars," *The Engineer* 173 (March 20, 1942) : 247.

27. "War Buildings are Different," *Engineering News-Record* 129 (October 22, 1942) : 99; "Timber Bowstring Trusses Supported on Buttressed Concrete Columns," *Engineering News-Record* 129 (December 3, 1942) : 69-72; "Arches of Laminated Wood," *Architectural Record* 94 (July 1943) : 75; Alfred Zweig, "Long Span Laminated Timber Arches for an Aircraft Hangar," *Engineering News-Record* 133 (September 21, 1944) : 83-85; "These War Buildings Were Significant," *Engineering News-Record* 133 (October 19, 1944) : 117-118.

28. "War Buildings Are Different," 99; "These War Buildings Were Significant," 110.

29. "Air Force Buildings," 98-99.

30. Ibid., 98; "Quick-Opening Hangar," *Architectural Forum* 96 (June 1952): 58-59.

31. "Air Force Buildings," 99.

32. Ibid., 100-103.

33. *Rapid City Daily Journal* 15, 23, 25 March; 25 April; 14 September 1951.

34. "Air Force Buildings," 98-99.

35. See, drawing no. 39-01-33, 23 sheets of plans prepared for the Readiness Hangar, Rapid City AFB, Weaver, South Dakota, by Wilson & Company, May 22, 1951; each plan notes that it was adapted from standard O.C.E. drawing no. 1000-1261, December 31 1942, plans on file at Engineering Fleet, Ellsworth AFB, South Dakota.

36. *Kansas Construction Magazine*, 1 (Sept. 1948) : 35; *Who's Who in Engineering* (New York City: Lewis Historical Publishing Company, Inc., 1954), 2662; John Bright, ed. "*Kansas: The First Century,*" vol. 3 (New York: Lewis Historical Publishing Company, Inc., 1956), 285-286.

37. *Rapid City Daily Journal,* 7 August 1951.

38. "Real Property Record-Building 605, Ellsworth AFB, South Dakota." Manuscript record on file at the Real Property Office, Ellsworth AFB, South Dakota.

39. Ibid.; "Point Paper on Building 605," ca. 1990. Manuscript record on file at the Real Property Office, Ellsworth AFB, South Dakota.

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